Special Publication SJ2000-SP1

District Water Supply Plan
Appendixes

Edited by
Barbara A. Vergara, P.G.

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

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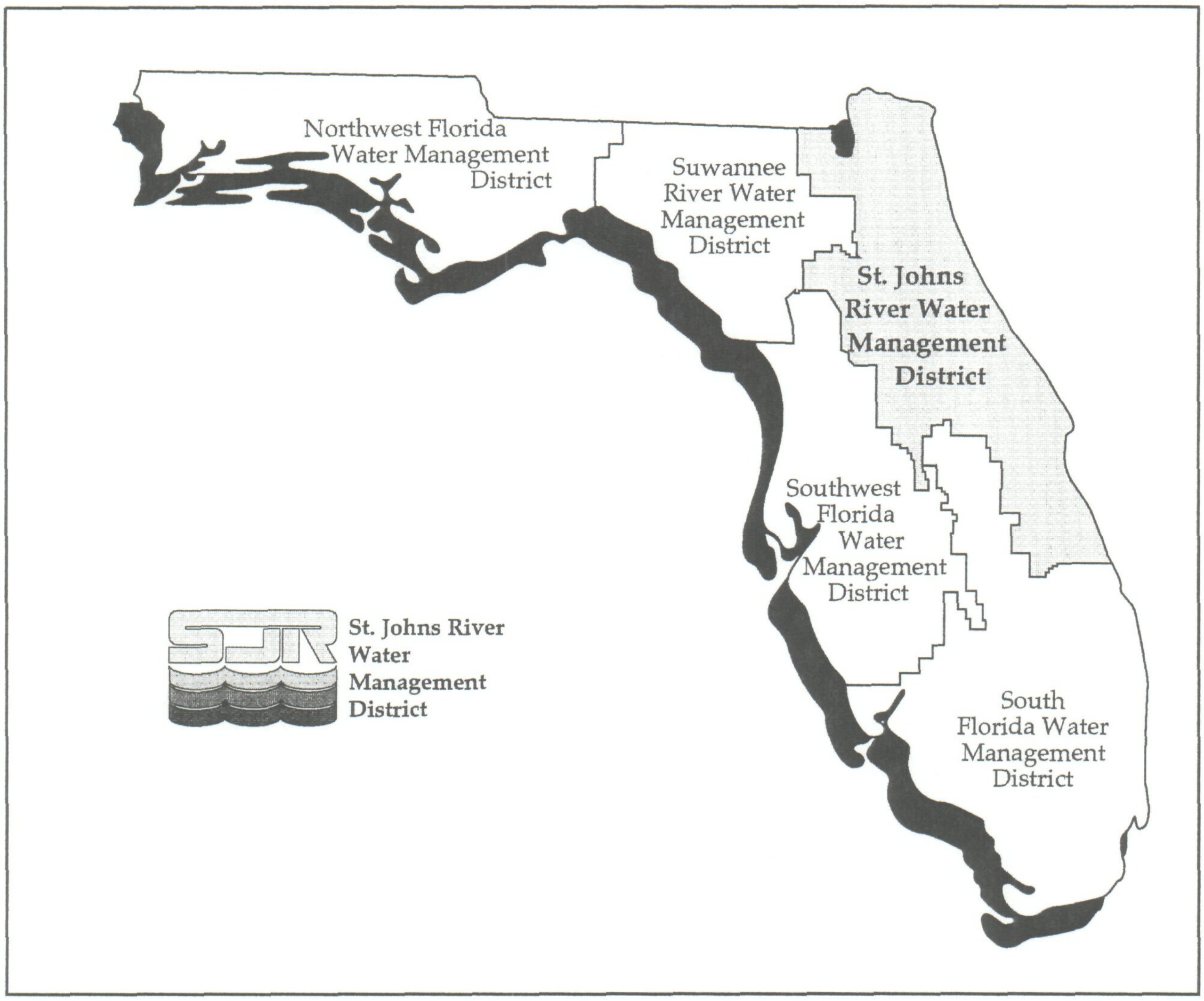
St. Johns River Water Management District
Palatka, Florida

2000



The St. Johns River Water Management District (SJRWMD) was created by the Florida Legislature in 1972 to be one of five water management districts in Florida. It includes all or part of 19 counties in northeast Florida. The mission of SJRWMD is to manage water resources to ensure their continued availability while maximizing environmental and economic benefits. It accomplishes its mission through regulation; applied research; assistance to federal, state, and local governments; operation and maintenance of water control works; and land acquisition and management.

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Appendix A

Section 373.0361, *Florida Statutes*

373.0361 Regional water supply planning.--

(1) By October 1, 1998, the governing board shall initiate water supply planning for each water supply planning region identified in the district water management plan under s. 373.036, where it determines that sources of water are not adequate for the planning period to supply water for all existing and projected reasonable-beneficial uses and to sustain the water resources and related natural systems. The planning must be conducted in an open public process, in coordination and cooperation with local governments, regional water supply authorities, government-owned and privately owned water utilities, self-suppliers, and other affected and interested parties. A determination by the governing board that initiation of a regional water supply plan for a specific planning region is not needed pursuant to this section shall be subject to s. 120.569. The governing board shall reevaluate such a determination at least once every 5 years and shall initiate a regional water supply plan, if needed, pursuant to this subsection.

(2) Each regional water supply plan shall be based on at least a 20-year planning period and shall include, but not be limited to:

(a) A water supply development component that includes:

1. A quantification of the water supply needs for all existing and reasonably projected future uses within the planning horizon. The level-of-certainty planning goal associated with identifying the water supply needs of existing and future reasonable-beneficial uses shall be based upon meeting those needs for a 1-in-10-year drought event.

2. A list of water source options for water supply development, including traditional and alternative sources, from which local government, government-owned and privately owned utilities, self-suppliers, and others may choose, which will exceed the needs identified in subparagraph 1.

3. For each option listed in subparagraph 2., the estimated amount of water available for use and the estimated costs of and potential sources of funding for water supply development.

4. A list of water supply development projects that meet the criteria in s. 373.0831(4).

(b) A water resource development component that includes:

1. A listing of those water resource development projects that support water supply development.

2. For each water resource development project listed:

a. An estimate of the amount of water to become available through the project.

b. The timetable for implementing or constructing the project and the estimated costs for implementing, operating, and maintaining the project.

c. Sources of funding and funding needs.

d. Who will implement the project and how it will be implemented.

(c) The recovery and prevention strategy described in s. 373.0421(2).

(d) A funding strategy for water resource development projects, which shall be reasonable and sufficient to pay the cost of constructing or implementing all of the listed projects.

(e) Consideration of how the options addressed in paragraphs (a) and (b) serve the public interest or save costs overall by preventing the loss of natural resources or avoiding greater future expenditures for water resource development or water supply development. However, unless adopted by rule, these considerations do not constitute final agency action.

(f) The technical data and information applicable to the planning region which are contained in the district water management plan and are necessary to support the regional water supply plan.

(g) The minimum flows and levels established for water resources within the planning region.

(3) Regional water supply plans initiated or completed by July 1, 1997, shall be revised, if necessary, to include a water supply development component and a water resource development component as described in paragraphs (2)(a) and (b).

(4) Governing board approval of a regional water supply plan shall not be subject to the rulemaking requirements of chapter 120. However, any portion of an approved regional water supply plan which affects the substantial interests of a party shall be subject to s. 120.569.

(5) By November 15, 1997, and annually thereafter, the department shall submit to the Governor and the Legislature a report on the status of regional water supply planning in each district. The report shall include:

(a) A compilation of the estimated costs of and potential sources of funding for water resource development and water supply development projects, as identified in the water management district regional water supply plans.

(b) A description of each district's progress toward achieving its water resource development objectives, as directed by s. 373.0831(3), including the district's implementation of its 5-year water resource development work program.

(6) Nothing contained in the water supply development component of the district water management plan shall be construed to require local governments, government-owned or privately owned water utilities, self-suppliers, or other water suppliers to select a water supply development option identified in the component merely because it is identified in the plan. However, this subsection shall not be construed to limit the authority of the department or governing board under part II.

Appendix B

Minimum Flows and Levels Established to Date

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

CHAPTER 40C-8, F.A.C.

MINIMUM FLOWS AND LEVELS

Revised
November 4, 1998

CHAPTER 40C-8, F.A.C.

MINIMUM FLOWS AND LEVELS

40C-8.011	Policy and Purpose.
40C-8.021	Definitions.
40C-8.031	Minimum Surface Water Levels and Flows and Groundwater Levels

40C-8.011 Policy and Purpose.

(1) This chapter establishes minimum flows and levels for surface watercourses and minimum levels for groundwater at specific locations within the St. Johns River Water Management District.

(2) Where appropriate, minimum flows and levels may reflect seasonal and long term variations and may include a schedule of variations and other measures appropriate for the protection of nonconsumptive uses of a water resource.

(3) In establishing minimum flows and levels, the Governing Board shall use the best information and methods available to establish limits which prevent significant harm to the water resources or ecology. The Governing Board will also consider, and at its discretion provide for, the protection of nonconsumptive uses, including navigation, recreation, fish and wildlife habitat, and other natural resources.

(4) Where a minimum flow has been established for a specific watercourse or a minimum level has been established for a specific surface water body, the flow or level is expressed as a fluctuation regime which will include a series of minimum flows or levels reflecting a temporal hydrologic regime that will prevent significant harm to water resources or ecology.

(5) Minimum flows and levels prescribed in this chapter are used as a basis for imposing limitations on withdrawals of groundwater and surface water, for reviewing proposed surface water management and storage systems and stormwater management systems, and for imposing water shortage restrictions. The limitations and review criteria which relate to these minimum flows and levels are prescribed in other rule chapters of the District.

Specific Authority: 373.044, 373.113 FS. Law Implemented: 373.042, 373.415 FS. History--New 9-16-92. Amended 8-17-94.

40C-8.021 Definitions. Unless the context indicates otherwise, the following terms shall have the following meanings.

(1) "Blackwater Creek" means that watercourse designated Blackwater Creek within the Wekiva River Hydrologic Basin as defined by section 40C-41.023, F.A.C.

(2) "Determined minimum surface water flow" means a flow, expressed in cubic feet per second combined with a temporal element. The temporal element may be specifically expressed as a duration and return interval or may be generally expressed as a hydroperiod category.

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(3) "Determined minimum surface water level" means an elevation in feet NGVD combined with a temporal element. The temporal element, for purposes of this chapter may be specifically expressed as a duration and return interval or may be generally expressed as a hydroperiod category.

(4) "Intermittently exposed" means a hydroperiod category where surface water is present throughout the year except in years of extreme drought. In most lakes this category does not typically support emergent vegetation and would be characterized as open water or floating-leaved deep marsh. Water levels causing inundation are expected to occur more than ninety per cent of the time over a long term period of record.

(5) "Intermittently flooded" means a hydroperiod category where the substrate is usually exposed, but surface water is present with variable frequency and duration. Water levels causing inundation are expected to occur on average approximately once every ten years or more. Years may intervene between periods of inundation. On recharge lakes (sandhill type lakes), the dominant vegetation growing at this elevation can change as soil moisture conditions change, from a dominance of upland species to wetland species or the reverse. Duration of inundation is on the order of several months. Water levels are expected to inundate less than two per cent of the time over a long term period of record.

(6) "Long term or "long term period of record" means at least a 30 year continuos period.

(7) "Minimum frequent high" means a chronically high surface water level or flow with an associated frequency and duration that allows for inundation of the floodplain at a depth and duration sufficient to maintain wetland functions.

(8) "Minimum infrequent high" means an acutely high surface water level or flow with an associated frequency and duration that is expected to be reached or exceeded during or immediately after periods of high rainfall so as to allow for inundation of a floodplain at a depth and duration sufficient to maintain biota and the exchange of nutrients and detrital material.

(9) "Minimum average" means the surface water level or flow necessary over a long period to maintain the integrity of hydric soils and wetland plant communities.

(10) "Minimum frequent low" means a chronically low surface water level or flow that generally occurs only during periods of reduced rainfall. This level is intended to prevent deleterious effects to the composition and structure of floodplain soils, the species composition and structure of floodplain and instream biotic communities, and the linkage of aquatic and floodplain food webs.

(11) "Minimum infrequent low" means an acutely low surface water level or flow with an associated frequency and duration which may occur during periods of extreme drought below which there will be a significant negative impact on the biota of the surface water which includes associated wetlands.

(12) "NGVD" means National Geodetic Vertical Datum of 1929.

(13) "Permanently flooded" means a hydroperiod category where water covers the land surface throughout the year in all years. Vegetation, if present, is composed of aquatic macrophytes.

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(14) "Phased Restriction" means the level or flow (based on the past 30 consecutive day average level or flow) at which a water use shortage phase (Phase I - IV as defined by 40C-21.251, F.A.C.), is declared and its associated restrictions imposed.

(15) "Seasonally flooded" means a hydroperiod category where surface water is typically present for extended periods (30 days or more) during the growing season, resulting in a predominance of submerged or submerged and transitional wetland species. During extended periods of normal or above normal rainfall, lake levels causing inundation are expected to occur several weeks to several months every one to two years.

(16) "Semi-permanently flooded" means a hydroperiod category where surface water inundation persists in most years. When surface water is absent the water table is usually near the land surface. In many lakes with emergent marshes this water level is near the lower elevation that supports emergent marsh or floating vegetation and peat substrates, or other highly organic hydric substrates. This characterization may not be true for herbaceous wetlands around sandhill type lakes, which often have emergent vegetation that follows declining water levels to below the lower elevation of peat substrate. Water levels causing inundation are expected to occur approximately eighty percent of the time over a long term period of record. Water levels causing inundation are expected to re-occur, on average, about every five to ten years for extended periods (several or more months) during moderate droughts.

(17) "Temporarily Flooded" means a hydroperiod category where surface water is present or the substrate is flooded for brief periods (up to several weeks) approximately every five years. Plants of upland and wetland species are characteristic. The composition of the vegetation at this water level is dependent upon whether the flooding predominantly occurs in the growing season, whether seepage from higher elevations is pronounced, and the nature of the soil. Lake water levels are expected to equal or exceed this elevation five per cent of the time or less over a long term period of record.

(18) "Typically saturated" means a hydroperiod category where for extended periods of the year the water level should saturate or inundate. This results in saturated substrates for periods of one-half year or more during non-flooding periods of typical years. Water levels causing inundation are expected to occur fifty to sixty per cent of the time over a long term period of record. This water level is expected to have a recurrence interval, on the average, of one or two years over a long term period of record. Obligate wetland plant species are expected to be predominate near this water level.

(19) "Wekiva River" means that watercourse designated Wekiva River within the Wekiva River Hydrologic Basin as defined by section 40C-41.023, F.A.C.

Specific Authority: 373.044, 373.113 FS. Law Implemented: 373.042, 373.415 FS. History--New 9-16-92. Amended 8-17-94, 6-8-95.

40C-8.031 Minimum Surface Water Levels and Flows and Groundwater Levels.

(1) The following minimum surface water levels and flows and minimum groundwater levels are established:

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Wekiva River at the SR 46 Bridge.

	Level (ft NGVD)	Flow (cfs)	Duration (days)	Return Interval (years)
Minimum Infrequent High	9.0	880	≥7	≤5
Minimum Frequent High	8.0	410	≥30	≤2
Minimum Average	7.6	240	180	≥1.7
Minimum Frequent Low	7.2	200	≤90	≥3
Phase 1 Restriction	7.0	190	NA	NA
Phase 2 Restriction	6.9	180	NA	NA
Phase 3 Restriction	6.7	160	NA	NA
Phase 4 Restriction	6.5	150	NA	NA
Minimum Infrequent Low	6.1	120	≤7	≥100

Wekiva River Minimum Groundwater Levels and Spring Flows

	Head (ft NGVD)	Discharge (cfs)
Messant Spring	32	12
Seminole Spring	34	34
Rock Spring	31	53
Wekiva Spring	24	62
Miami Spring	27	4
Sanlando Spring	28	15
Starbuck Spring	31	13
Palm Spring	27	7

Black Water Creek at the SR 44 Bridge

	Level (ft NGVD)	Flow (cfs)	Duration (days)	Return Interval (years)
Minimum Infrequent High	27.0	340	≥7	≤5
Minimum Frequent High	25.8	145	≥30	≤2
Minimum Average	24.3	33	180	≥1.7
Minimum Frequent Low	22.8	.5	≤90	≥15
Phase 1 Restriction	22.7	2	NA	NA
Phase 2 Restriction	22.5	1	NA	NA
Phase 3 Restriction	22.4	0.6	NA	NA
Phase 4 Restriction	22.3	0.3	NA	NA
Minimum Infrequent Low	21.9	0	≤7	≥100

(2) The following minimum surface water levels are established:'

LAKE NAME	COUNTY	HYDROPERIOD CATEGORY	MINIMUM INFREQUENT HIGH	MINIMUM FREQUENT HIGH	MINIMUM AVERAGE LEVEL	MINIMUM FREQUENT LOW	MINIMUM INFREQUENT LOW
ARGENTA	Putnam	Seasonally Flooded		50.1			
		Typically Saturated			47.7		
		Semipermanently Flooded				46.3	
ASHBY	Volusia	Seasonally Flooded		13.8			
		Typically Saturated			12.1		
		Semipermanently Flooded				11.1	
BANANA	Putnam	Seasonally Flooded		38.0			
		Typically Saturated			36.2		
		Semipermanently Flooded				34.4	
BELL	Putnam	Temporarily Flooded		42.5			
		Typically Saturated			40.5		
		Semipermanently Flooded				38.7	
BIRD POND	Putnam	Temporarily Flooded		41.8			
		Typically Saturated			39.5		
		Semipermanently Flooded				38.1	
BLUE POND	Clay	Temporarily Flooded		174.1			
		Typically Saturated			173.3		
		Semipermanently Flooded				171.7	
BROOKLYN	Clay	Temporarily Flooded		114.6			
		Typically Saturated			108.0		
		Semipermanently Flooded				101.0	
BROWARD	Putnam	Temporarily Flooded		40.0			
		Typically Saturated			38.25		
		Semipermanently Flooded				36.5	
CLEAR	Putnam	Temporarily Flooded		37.4			
		Typically Saturated			36.4		
		Semipermanently Flooded				34.9	
COLBY	Volusia	Seasonally Flooded		28.3			
		Typically Saturated			26.6		
		Semipermanently Flooded				25.2	
COMO	Putnam	Seasonally Flooded		38.0			
		Typically Saturated			36.2		
		Semipermanently Flooded				34.4	
COMO, LITTLE LAKE	Putnam	Seasonally Flooded		38.0			
		Typically Saturated			36.6		
		Semipermanently Flooded				35.2	
COWPEN	Putnam	Temporarily Flooded		89.1			
		Typically Saturated			85.7		
		Semipermanently Flooded				84.2	
COW POND	Volusia	Seasonally Flooded		40.5			
		Typically Saturated			39.8		
		Semipermanently Flooded				37.6	
CRYSTAL/BAKER	Putnam	Seasonally Flooded		35.5			
		Typically Saturated			33.9		
		Semipermanently Flooded				33.0	
DAUGHARTY	Volusia	N/A	46.3				
		N/A		45.5			
		N/A			44.5		
		N/A				43.0	
		N/A					41.5

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LAKE NAME	COUNTY	HYDROPERIOD CATEGORY	MINIMUM INFREQUENT HIGH	MINIMUM FREQUENT HIGH	MINIMUM AVERAGE LEVEL	MINIMUM FREQUENT LOW	MINIMUM INFREQUENT LOW
DAVIS	Volusia	Seasonally Flooded		36.8			
		Typically Saturated			36.0		
		Semipermanently Flooded				34.6	
DEEP	Putnam	Seasonally Flooded		35.0			
		Typically Saturated			33.1		
		Semipermanently Flooded				32.2	
DIAS	Volusia	Seasonally Flooded		34.5			
		Typically Flooded			34.1		
		Semipermanently Flooded				32.8	
DISSTON	Flagler	Seasonally Flooded		13.8			
		Typically Flooded			13.2		
		Semipermanently Flooded				12.5	
DORR	Lake	Seasonally Flooded		43.5			
		Typically Saturated			43.1		
		Semipermanently Flooded				42.1	
DREAM POND	Putnam	Seasonally Flooded		49.0			
		Typically Saturated			47.5		
		Semipermanently Flooded				46.0	
DRUDY	Volusia	Seasonally Flooded		42.3			
		Typically Saturated			41.8		
		Semipermanently Flooded				40.5	
ECHO	Putnam	Seasonally Flooded		38.8			
		Typically Flooded			36.7		
		Semipermanently Flooded				35.2	
EMPORIA	Volusia	Seasonally Flooded		37.5			
		Typically Saturated			36.4		
		Semipermanently Flooded				35.0	
ESTELLA	Putnam	Seasonally Flooded		38.6			
		Typically Saturated			37.2		
		Semipermanently Flooded				36.5	
GENEVA	Clay	Seasonally Flooded		103.0			
		Typically Saturated			101.0		
		Semipermanently Flooded				98.5	
GEORGES LAKE	Putnam	Seasonally Flooded		98.4			
		Typically Saturated			97.8		
		Semipermanently Flooded				97.0	
GORE	Flagler	Seasonally Flooded		21.6			
		Typically Saturated			20.8		
		Semipermanently Flooded				19.8	
GRANDIN	Putnam	Seasonally Flooded		81.8			
		Typically Saturated			81.3		
		Semipermanently Flooded				80.1	
HELEN	Volusia	Temporarily Flooded		46.1			
		Typically Saturated			44.2		
		Semipermanently Flooded				43.6	
HOWELL	Putnam	Seasonally Flooded		34.5			
		Typically Saturated			33.6		
		Semipermanently Flooded				31.8	
KERR	Marion	Seasonally Flooded		24.4			
		Typically Saturated			22.9		
		Semipermanently Flooded				21.5	
LIZZIE	Putnam	Seasonally Flooded		43.9			
		Typically Saturated			42.7		
		Semipermanently Flooded				41.7	

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LAKE NAME	COUNTY	HYDROPERIOD CATEGORY	MINIMUM INFREQUENT HIGH	MINIMUM FREQUENT HIGH	MINIMUM AVERAGE LEVEL	MINIMUM FREQUENT LOW	MINIMUM INFREQUENT LOW
LOWER LAKE LOUISE	Volusia	Seasonally Flooded		32.0			
		Typically Saturated			30.5		
		Semipermanently Flooded				29.2	
MAGNOLIA	Clay	Seasonally Flooded		124.7			
		Typically Saturated			124.2		
		Semipermanently Flooded				121.4	
MALL, LITTLE LAKE	Putnam	Seasonally Flooded		38.7			
		Typically Saturated			36.8		
		Semipermanently Flooded				35.2	
MARGARET	Putnam	Seasonally Flooded		35.2			
		Typically Saturated			34.5		
		Semipermanently Flooded				32.5	
MARVIN	Putnam	Seasonally Flooded		38.6			
		Typically Saturated			37.3		
		Semipermanently Flooded				36.3	
MCGRADY	Putnam	Seasonally Flooded		41.5			
		Typically Saturated			39.9		
		Semipermanently Flooded				37.8	
MCKASEL	Putnam	Temporarily Flooded		36.7			
		Typically Saturated			35.5		
		Semipermanently Flooded				34.1	
MELROSE	Putnam	Seasonally Flooded		105.2			
		Typically Saturated			104.2		
		Semipermanently Flooded				102.8	
MILLS	Seminole	Temporarily Flooded		42.5			
		Typically Saturated			41.4		
		Semipermanently Flooded				39.9	
NETTLES/ENGLISH	Putnam	Seasonally Flooded		44.3			
		Typically Saturated			42.7		
		Semipermanently Flooded				41.7	
NORRIS	Lake	Seasonally Flooded		30.5			
		Typically Saturated			29.7		
		Semipermanently Flooded				29.1	
NORTH COMO PARK	Putnam	Seasonally Flooded		41.3			
		Typically Saturated			39.7		
		Semipermanently Flooded				38.5	
OMEGA	Putnam	Temporarily Flooded		57.4			
		Typically Saturated			56.1		
		Semipermanently Flooded				54.0	
ORIO	Putnam	Seasonally Flooded		37.1			
		Typically Saturated			35.6		
		Semipermanently Flooded				34.7	
PAM	Putnam	Temporarily Flooded		39.3			
		Typically Saturated			37.5		
		Semipermanently Flooded				36.1	
PIERSON	Volusia	Seasonally Flooded		35.5			
		Typically Saturated			34.2		
		Semipermanently Flooded				32.5	

LAKE NAME	COUNTY	HYDROPERIOD CATEGORY	MINIMUM INFREQUENT HIGH	MINIMUM FREQUENT HIGH	MINIMUM AVERAGE LEVEL	MINIMUM FREQUENT LOW	MINIMUM INFREQUENT LOW
PREVATT	Orange	Seasonally Flooded		56.0			
		Typically Saturated			53.0		
		Semipermanently Flooded				50.9	
PRIOR	Putnam	Seasonally Flooded		42.3			
		Typically Saturated			40.0		
		Semipermanently Flooded				39.0	
PURDOM	Volusia	Seasonally Flooded		37.0			
		Typically Saturated			36.4		
		Semipermanently Flooded				35.0	
SAND	Putnam	Seasonally Flooded		40.9			
		Typically Saturated			39.0		
		Semipermanently Flooded				36.6	
SAND HILL	Clay	Seasonally Flooded		132.0			
		Typically Saturated			131.65		
		Semipermanently Flooded				129.5	
SHAW	Volusia	N/A	38.5				
		N/A		36.9			
		N/A			36.2		
		N/A				34.0	
		N/A					32.0
SILVER	Putnam	Seasonally Flooded		36.5			
		Typically Saturated			35.1		
		Semipermanently Flooded				34.0	
STELLA	Putnam	Seasonally Flooded		39.9			
		Typically Saturated			39.6		
		Semipermanently Flooded				38.0	
SUNSET	Lake	Seasonally Flooded		85.9			
		Typically Saturated			83.5		
		Semipermanently Flooded				81.0	
SYLVAN	Seminole	Seasonally Flooded	q	40.4			
		Typically Saturated			38.9		
		Semipermanently Flooded				37.5	
TARHOE	Putnam	Seasonally Flooded		37.0			
		Typically Saturated			36.0		
		Semipermanently Flooded				35.2	
THREE ISLAND LAKES	Volusia	Seasonally Flooded		23.4			
		Typically Saturated			21.8		
		Semipermanently Flooded				18.8	
TRONE	Putnam	Seasonally Flooded		37.5			
		Typically Saturated			35.7		
		Semipermanently Flooded				34.3	
UPPER LAKE LOUISE	Volusia	Seasonally Flooded		35.4			
		Typically Saturated			34.7		
		Semipermanently Flooded				33.8	
WAUBERG	Alachua	Seasonally Flooded		67.4			
		Typically Saturated			67.1		
		Semipermanently Flooded				65.6	
WINNEMISETT	Volusia	Seasonally Flooded		59.5			
		Typically Saturated			57.8		
		Semipermanently Flooded				56.0	

(3) The following minimum levels are established for Blue Cypress Water Management Area (BCWMA):

(a) The minimum average level, calculated as the long term mean of BCWMA water levels, is 24 feet NGVD. Water levels shall be at or above this level at least 75% of time over the long term.

(b) The minimum frequent low is 23.0 feet NGVD. The daily BCWMA water level shall not fall to this level or below more often than once every 2.5 years over the long term.

(c) The minimum infrequent low is 22.5 feet NGVD. The BCWMA water level shall not fall to this level or below for 60 continuous days more frequently than once every 10 years over the long term.

(4) Ground or surface water withdrawals or surface water works must not cause the infrequent high or frequent high surface water flows and levels to occur less frequently or for at lesser duration than stated. Ground or surface water withdrawals or surface water works must not cause the minimum average, frequent low, or infrequent low surface water levels and flows to occur more frequently or for longer durations than stated.

Specific Authority: 373.044, 373.113 FS. Law Implemented: 373.042, 272.0421 373.103, 373.415 FS. History--New 9-16-92. Amended 8-17-94, 6-8-95, 1-17-96, 8-20-96, 10-20-96, 11-4-98.

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Appendix C

Minimum Flows and Levels Priority List and Schedule

St. Johns River Water Management District
Minimum Flows and Levels Priority List and Schedule
Calendar Years 2000, 2001, and 2002

Year 2000

Waterbody Type	Waterbody Name	County	Voluntary Peer Review
Rivers	None		
Aquifer (Springs)	None		
Lakes	Bel-Air	Seminole	Yes
	Brantley	Seminole	
	Burkett	Orange	
	Deforest	Seminole	Yes
	East Crystal	Seminole	Yes
	Gleason	Volusia	
	Howell	Seminole	
	Irma	Orange	
	Johns Lake	Orange	
	Pearl	Orange	
	Pine Island	Lake	
	Swan	Putnam	
	West Crystal	Seminole	Yes
Wetlands	Boggy Marsh	Lake	

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St. Johns River Water Management District
Minimum Flows and Levels Priority List and Schedule

Year 2001

Waterbody Type	Waterbody Name	County	Voluntary Peer Review
Rivers	St. Johns River Near Deland*	Volusia/ Seminole	Yes
Aquifers (Springs)	Gemini	Volusia	Yes
	Green	Volusia	Yes
Lakes	Apshawa North	Lake	
	Apshawa South	Lake	
	Banana	Seminole	
	Bear Gully	Seminole	
	Cherry	Lake	
	Flat	Lake	
	Fox	Brevard	
	Griffin	Lake	Yes
	Horseshoe	Seminole	
	Indian	Volusia	
	Johnson	Clay	
	Lowery	Polk	Yes
	Martha	Orange	
	Minneola	Lake	
	Nicotoon	Marion	
	Pebble	Clay	
	Sawgrass	Lake	
	South	Brevard	

* Minimum Flows and Levels location may be adjusted as needed to protect the river from impacts of selected withdrawal sites.

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St. Johns River Water Management District
Minimum Flows and Levels Priority List and Schedule

Year 2002

Waterbody Type	Waterbody Name	County	Voluntary Peer Review
Rivers	Orange Creek	Marion	Yes
	St. Johns River Near SR50*	Brevard/ Orange	Yes
Aquifers (Springs)	None		
Lakes	Avalon	Lake	
	Charles	Marion	
	Emma	Lake	
	Emma	Seminole	
	Halfmoon	Marion	
	Hiawassee	Orange	
	Lucy	Lake	
	Lochloosa	Alachua	Yes
	Orange	Alachua	Yes
	Rice	Seminole	
	Rose	Orange	
	Sherwood North	Orange	
Wetlands	The Savannah	Volusia	

* Minimum Flows and Levels location may be adjusted as needed to protect the river from impacts of selected withdrawal sites.

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Appendix D

Decision Model Description

DECISION MODEL DESCRIPTION

Alternative water supply studies included the development of decision models for determining minimal cost water allocation strategies by incorporating water management constraints, environmental impact constraints, cost constraints, optimization of existing groundwater source withdrawals, and alternative water supplies.

Two types of decision models were used to obtain the solutions outlined in this report for Work Group Areas I and II. These are a groundwater optimization model and an economic optimization model. Each model has different objectives. The groundwater optimization model makes maximum use of existing and proposed groundwater supplies while meeting specified environmental protection goals and constraints. Costs are not a part of this modeling procedure. Deficits are identified in quantity by public supply demand areas.

The economic optimization model considers alternatives to existing and proposed wells and all associated costs. The objective is to minimize the costs of meeting projected 2020 demands while selecting from a number of existing, proposed, and alternative sources, yet still meeting environmental protection goals and constraints. This task would not be necessary if all future water supply needs could be met by optimizing groundwater withdrawal. A number of alternative water supply strategies may satisfy individual user requirements but may fail in other areas, including political constraints, "local sources first" policies, environmental protection goals, or costs. The decision models may be used to help water resource managers sort through the possibilities and examine a subset of water supply plans that satisfy additional criteria such as variations on demand area or individual well equity, maximum distances from sources to demand areas, the conditions for external routing between interconnects, and county-only or district-only sources.

No one set of decision model output may be considered to be the solution to year 2020 water resource problems. However, the decision model may be rerun and refined as necessary to gain additional information and insight about the water supply problem, the simulation model, and projected future water demands.

Purpose and Scope

The scope of the decision-modeling approach is limited to examining steady-state water allocation scenarios on a macroscale using given available resources and is subject to computer hardware and software limitations.

This modeling approach applies a combined optimization/simulation technique which incorporated SJRWMD groundwater flow and transport simulation models for the study area. Several site-specific water resource allocation optimization models were developed. These optimization models incorporated quantity and quality considerations to determine optimum groundwater allocation strategies which satisfy future water service demands and minimize adverse environmental impacts at specified locations.

Model Objectives

The two main decision-modeling objectives are (1) to maximize use of existing and proposed groundwater supplies and (2) to minimize the total cost of providing water for a regional area while constraining the environmental impacts at sensitive areas. However, the model is capable of exploring other management objectives, such as minimizing environmental impacts while calculating the cost of providing water. Model objective functions may be easily revised to assist water supply managers in comparing or contrasting different water supply strategies.

Modeling Framework

The optimization models identify optimum water allocations scenarios to meet 2020 demands by applying conditions of equity for all demand areas. Projected demands are met with a combination of existing and proposed groundwater sources, potential new fresh and brackish groundwater sources, surface water, and external routing between existing public suppliers. The models identify public water supply demand areas having potential deficits due to limitations placed on the model in the form of environmental constraints. Deficits are also identified when the combination of existing, proposed, and alternative water sources fail to satisfy all projected future water supply demands. Deficits identified by the model can be due to the sensitivity of wetland drawdown, spring flow, lake level, water quality, or equity constraints.

Both models rely on the widely used three-dimensional groundwater simulation model MODFLOW (McDonald and Harbaugh 1988; Harbaugh and McDonald 1996), a saltwater upconing model (CH2M HILL 1998), the General Algebraic Modeling System (GAMS) (Brook et al. 1996), and the CPLEX linear and mixed integer programming solvers (CPLEX Optimization 1996).

Figure 1 illustrates how constraints are incorporated in the optimization/decision-modeling process. Model inputs for both processes include aquifer responses to pumping, 1995 and projected 2020 water demands, a set of existing and proposed well withdrawal sites with capacities, 1995 and projected 2020 (non-optimized) surficial heads, spring discharges, and chloride concentrations, environmental and hydrologic constraints, and equity constraints. These inputs are obtained from GIS information, water quality data, well characteristics, and historical or projected well withdrawal rates. The data are used as input to the groundwater flow and water quality (transport) models. The flow and transport models provide the aquifer responses to pumping. Finally, the aquifer responses are used as input to the groundwater optimization and economic optimization models.

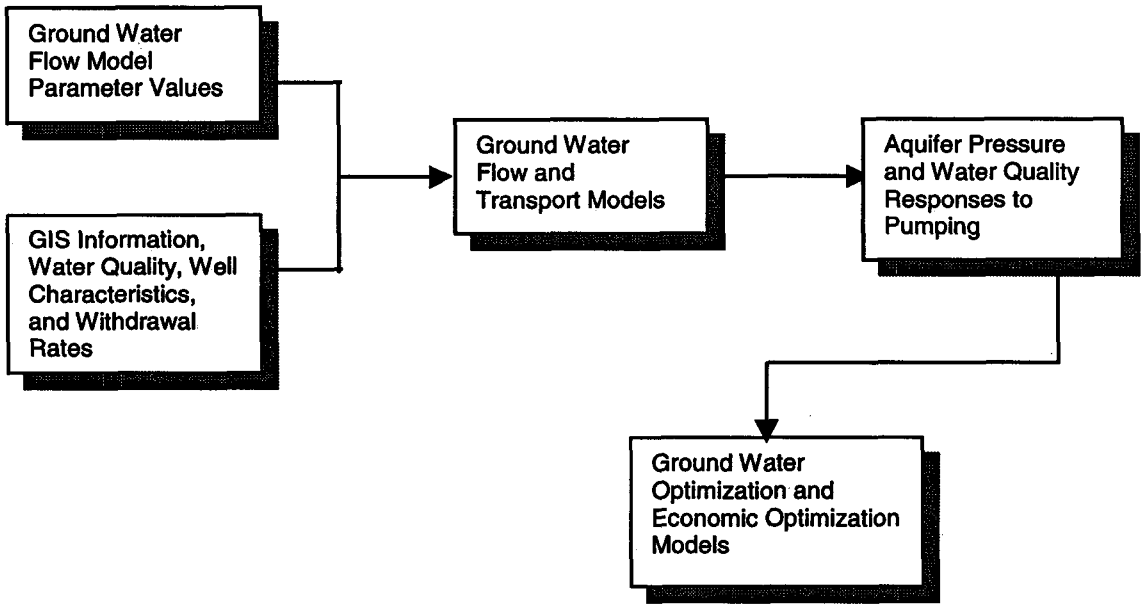

Figure 1. Incorporation of constraints in the optimization/decision model

Figure 2 depicts the decision-modeling process. The upper half of the figure illustrates the process for existing and potential groundwater sources only. The lower half shows the process considering alternatives to existing and potential groundwater sources and is considerably more complex.

In the first process, model inputs include aquifer responses to pumping obtained from groundwater flow and transport models, projected water demands, and environmental and hydrologic constraints. The optimization model sorts through all the possibilities and outputs a groundwater withdrawal strategy that meets all the specified constraints and identifies deficits at some demand area locations. At this point, the constraints may be reviewed or revised and other changes may be made to the model input. The process may be repeated as many times as necessary until water supply managers and users are satisfied with the results.

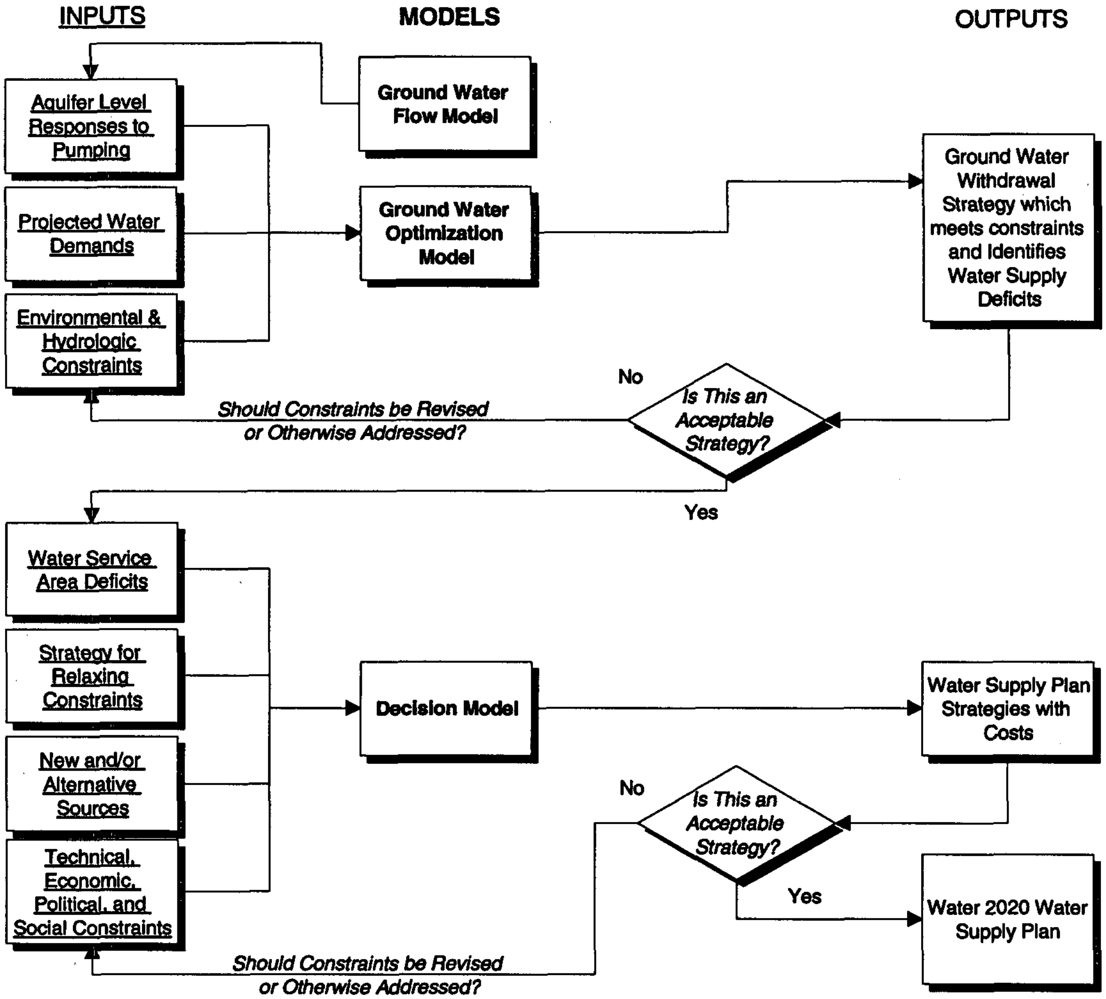

Figure 2. Decision-Modeling Process

Groundwater optimization model output includes well withdrawal rates; the aquifer response to withdrawal rates in terms of surficial drawdown, spring discharge, and water quality; and deficits identified at each demand area. Existing economic optimization model formulations assume that there is no impact due to surface water withdrawal at the proposed surface water sites at rates within the specified capacities.

The optimization process identifies demand areas that may have potential water resource problems, or deficits, subject to the specified constraints. It may be necessary to find alternatives to existing and potential groundwater sources to eliminate any deficits found by the groundwater optimization model. The economic optimization model is then required to determine the optimal water supply strategy which considers all of the information in the groundwater optimization mode, but also includes alternatives to existing and potential sources.

The process outlined in the lower half of figure 2 includes all the inputs for the groundwater optimization model with the addition of public supply demand area deficits, a strategy or strategies for relaxing constraints, a number of alternative water supplies, and any technical, economic, political, or social constraints as well as distances from alternative sources to demand areas (approximated as straight lines), fixed costs (construction, capital, etc.) for alternative sources and unit costs (operating and maintenance) for existing, proposed, and alternative sources.

Using the specified inputs, the model is run to output a water supply plan with cost data. If this plan is acceptable, it may be selected for use. If not, the constraints may be revised or otherwise addressed. Some environmental constraints may be relaxed, while political and social considerations can also be addressed with additional decision model runs.

References

Brook, A., D. Kendrick, and A. Meeraus. 1996. *GAMS: A User's Guide*. Release 2.25. Danvers, Mass.: The Scientific Press.

CH2M HILL. 1998. *Brackish Groundwater: Source Identification and Assessment*. Technical Memorandum D.1.B. Prepared for St. Johns River Water Management District. Gainesville, Fla.

CPLEX Optimization, Inc. 1996. *CPLEX*. Incline Village, Nev.

Harbaugh, A.W., and G.M. McDonald. 1996. *Users Documentation for MODFLOW-96: An Update to the U.S. Geological Survey Modular Finite-Difference Ground-Water Flow Model*. Open-file report 96-485. Denver, Colo.: U.S. Geological Survey.

McDonald, G.M., and A.W. Harbaugh. 1988. *A Modular Three-Dimensional Finite-Difference Groundwater Flow Model*. Techniques of Water Resources Investigations, Book 6, Chapter A1. Denver, Colo.: U.S. Geological Survey.

Appendix E

St. Johns River Water Management District Water Supply Needs by County

Table X. Total Water Demand for 1995 and 2020 for SJRWMD by Category and County
Average Year and 1-in-10 Drought / Population and User Based Projections

Alachua County

				2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
	1995			Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Public Supply	20.44	0.00	20.44	30.65	0.00	30.65	34.68	0.00	34.68	32.49	0.00	32.49	36.76	0.00	36.76
Domestic	2.28	0.00	2.28	2.76	0.00	2.76	2.76	0.00	2.76	2.93	0.00	2.93	2.93	0.00	2.93
Agriculture	4.82	0.21	5.03	6.97	0.39	7.36	6.97	0.39	7.36	7.82	0.43	8.25	6.97	0.39	7.36
Recreation	4.70	0.58	5.28	6.67	0.82	7.49	6.67	0.82	7.49	6.84	0.84	7.68	6.67	0.82	7.49
Commercial/Industrial	1.91	0.00	1.91	2.71	0.00	2.71	2.71	0.00	2.71	2.71	0.00	2.71	2.71	0.00	2.71
Thermoelectric	0.40	0.00	0.40	0.40	0.00	0.40	0.40	0.00	0.40	0.40	0.00	0.40	0.40	0.00	0.40
Totals	34.55	0.79	35.34	50.16	1.21	51.37	54.19	1.21	55.40	53.19	1.27	54.46	56.44	1.21	57.65

Baker County

				2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
	1995			Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Public Supply	0.65	0.00	0.65	0.92	0.00	0.92	1.30	0.00	1.30	0.98	0.00	0.98	1.38	0.00	1.38
Domestic	1.51	0.00	1.51	1.89	0.00	1.89	1.89	0.00	1.89	2.00	0.00	2.00	2.00	0.00	2.00
Agriculture	1.28	0.86	2.14	1.27	0.86	2.13	1.27	0.86	2.13	1.38	0.93	2.31	1.27	0.86	2.13
Recreation	0.14	0.00	0.14	0.21	0.00	0.21	0.21	0.00	0.21	0.21	0.00	0.21	0.21	0.00	0.21
Commercial/Industrial	0.19	0.00	0.19	0.27	0.00	0.27	0.27	0.00	0.27	0.27	0.00	0.27	0.27	0.00	0.27
Thermoelectric	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	3.77	0.86	4.63	4.56	0.86	5.42	4.94	0.86	5.80	4.84	0.93	5.77	5.13	0.86	5.99

Bradford County

				2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
	1995			Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Public Supply	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Domestic	0.12	0.00	0.12	0.15	0.00	0.15	0.15	0.00	0.15	0.16	0.00	0.16	0.16	0.00	0.16
Agriculture	0.09	0.00	0.09	0.09	0.00	0.09	0.09	0.00	0.09	0.11	0.00	0.11	0.09	0.00	0.09
Recreation	0.08	0.00	0.08	0.11	0.00	0.11	0.11	0.00	0.11	0.11	0.00	0.11	0.11	0.00	0.11
Thermoelectric	0.31	0.00	0.31	0.75	0.00	0.75	0.75	0.00	0.75	0.75	0.00	0.75	0.75	0.00	0.75
Totals	0.60	0.00	0.60	1.10	0.00	1.10	1.10	0.00	1.10	1.13	0.00	1.13	1.11	0.00	1.11

Brevard County

				2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
	1995			Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Public Supply	38.96	12.15	51.11	58.28	16.81	75.09	64.62	16.81	81.43	61.78	17.82	79.60	68.50	17.82	86.32
Domestic	6.22	0.00	6.22	2.13	0.00	2.13	2.13	0.00	2.13	2.26	0.00	2.26	2.26	0.00	2.26
Agriculture	113.19	11.62	124.81	78.73	11.68	90.41	78.73	11.68	90.41	84.58	12.75	97.33	78.73	11.68	90.41
Recreation	3.89	6.35	10.24	5.72	9.33	15.05	5.72	9.33	15.05	5.85	9.54	15.39	5.72	9.33	15.05
Commercial/Industrial	1.80	0.00	1.80	1.87	0.00	1.87	1.87	0.00	1.87	1.87	0.00	1.87	1.87	0.00	1.87
Thermoelectric	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	164.06	30.12	194.18	146.73	37.82	184.55	153.07	37.82	190.89	156.34	40.11	196.45	157.08	38.83	195.91

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Clay County

				2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
	1995			Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Public Supply	11.83	0.00	11.83	19.25	0.00	19.25	20.78	0.00	20.78	20.41	0.00	20.41	22.03	0.00	22.03
Domestic	3.03	0.00	3.03	3.64	0.00	3.64	3.64	0.00	3.64	3.86	0.00	3.86	3.86	0.00	3.86
Agriculture	0.80	0.00	0.80	1.39	0.00	1.39	1.39	0.00	1.39	1.49	0.00	1.49	1.39	0.00	1.39
Recreation	1.01	0.52	1.53	1.65	0.85	2.50	1.65	0.85	2.50	1.69	0.87	2.56	1.65	0.85	2.50
Commercial/Industrial	4.46	0.00	4.46	4.67	0.00	4.67	4.67	0.00	4.67	4.67	0.00	4.67	4.67	0.00	4.67
Thermoelectric	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	21.13	0.52	21.65	30.60	0.85	31.45	32.13	0.85	32.98	32.12	0.87	32.99	33.60	0.85	34.45

Duval County

				2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
	1995			Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Public Supply	98.93	0.00	98.93	129.63	0.00	129.63	152.37	0.00	152.37	137.41	0.00	137.41	161.51	0.00	161.51
Domestic	7.96	0.00	7.96	5.08	0.00	5.08	5.08	0.00	5.08	5.38	0.00	5.38	5.38	0.00	5.38
Agriculture	2.19	0.18	2.37	2.84	0.28	3.12	2.84	0.28	3.12	2.97	0.29	3.26	2.84	0.28	3.12
Recreation	3.76	0.88	4.64	4.93	1.16	6.09	4.93	1.16	6.09	5.06	1.19	6.25	4.93	1.16	6.09
Commercial/Industrial	24.75	0.00	24.75	29.03	0.00	29.03	29.03	0.00	29.03	29.03	0.00	29.03	29.03	0.00	29.03
Thermoelectric	5.47	0.00	5.47	7.04	0.00	7.04	7.04	0.00	7.04	7.04	0.00	7.04	7.04	0.00	7.04
Totals	143.06	1.06	144.12	178.55	1.44	179.99	201.29	1.44	202.73	186.89	1.48	188.37	210.73	1.44	212.17

Flagler County

				2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
	1995			Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Public Supply	4.40	0.00	4.40	10.07	0.00	10.07	12.94	0.00	12.94	10.67	0.00	10.67	13.72	0.00	13.72
Domestic	1.19	0.00	1.19	0.12	0.00	0.12	0.12	0.00	0.12	0.13	0.00	0.13	0.13	0.00	0.13
Agriculture	8.77	0.16	8.93	7.19	0.37	7.56	7.19	0.37	7.56	8.30	0.39	8.69	7.19	0.37	7.56
Recreation	0.16	1.06	1.22	0.36	2.43	2.79	0.36	2.43	2.79	0.37	2.49	2.86	0.36	2.43	2.79
Commercial/Industrial	0.18	0.00	0.18	0.41	0.00	0.41	0.41	0.00	0.41	0.41	0.00	0.41	0.41	0.00	0.41
Thermoelectric	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	14.70	1.22	15.92	18.15	2.80	20.95	21.02	2.80	23.82	19.88	2.88	22.76	21.81	2.80	24.61

Indian River County

				2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
	1995			Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Public Supply	10.87	0.00	10.87	16.71	0.00	16.71	28.36	0.00	28.36	17.71	0.00	17.71	30.06	0.00	30.06
Domestic	3.99	0.00	3.99	0.87	0.00	0.87	0.87	0.00	0.87	0.92	0.00	0.92	0.92	0.00	0.92
Agriculture	67.33	170.02	237.35	67.91	172.60	240.51	67.91	172.60	240.51	81.88	212.47	294.35	67.91	172.60	240.51
Recreation	4.88	2.41	7.29	7.52	3.70	11.22	7.52	3.70	11.22	7.71	3.80	11.51	7.52	3.70	11.22
Commercial/Industrial	0.16	0.00	0.16	0.29	0.00	0.29	0.29	0.00	0.29	0.29	0.00	0.29	0.29	0.00	0.29
Thermoelectric	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	87.23	172.43	259.66	93.30	176.30	269.60	104.95	176.30	281.25	108.51	216.27	324.78	106.70	176.30	283.00

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Lake County

	1995			2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
				Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Public Supply	22.97	0.00	22.97	39.15	0.00	39.15	74.17	0.00	74.17	41.50	0.00	41.50	78.62	0.00	78.62
Domestic	6.02	0.00	6.02	1.27	0.00	1.27	1.27	0.00	1.27	1.35	0.00	1.35	1.35	0.00	1.35
Agriculture	43.91	7.06	50.97	64.01	9.28	73.29	64.01	9.28	73.29	78.03	11.34	89.37	64.01	9.28	73.29
Recreation	9.27	7.59	16.86	15.58	12.74	28.32	15.58	12.74	28.32	15.98	13.07	29.05	15.58	12.74	28.32
Commercial/Industrial	10.23	1.14	11.37	13.57	0.51	14.08	13.57	0.51	14.08	13.57	0.51	14.08	13.57	0.51	14.08
Thermoelectric	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	92.40	15.79	108.19	133.58	22.53	156.11	168.60	22.53	191.13	150.43	24.92	175.35	173.13	22.53	195.66

Marion County

	1995			2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
				Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Public Supply	13.54	0.00	13.54	22.42	0.00	22.42	26.67	0.00	26.67	23.77	0.00	23.77	28.27	0.00	28.27
Domestic	10.40	0.00	10.40	14.79	0.00	14.79	14.79	0.00	14.79	15.68	0.00	15.68	15.68	0.00	15.68
Agriculture	5.80	0.72	6.52	6.91	0.79	7.70	6.91	0.79	7.70	7.96	0.88	8.84	6.91	0.79	7.70
Recreation	1.59	1.15	2.74	2.63	1.90	4.53	2.63	1.90	4.53	2.70	1.95	4.65	2.63	1.90	4.53
Commercial/Industrial	1.85	0.00	1.85	1.26	0.00	1.26	1.26	0.00	1.26	1.26	0.00	1.26	1.26	0.00	1.26
Thermoelectric	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	33.18	1.87	35.05	48.01	2.69	50.70	52.26	2.69	54.95	51.37	2.83	54.20	54.75	2.69	57.44

Nassau County

	1995			2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
				Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Public Supply	4.35	0.00	4.35	6.97	0.00	6.97	11.50	0.00	11.50	7.39	0.00	7.39	12.19	0.00	12.19
Domestic	2.63	0.00	2.63	2.17	0.00	2.17	2.17	0.00	2.17	2.30	0.00	2.30	2.30	0.00	2.30
Agriculture	0.25	0.00	0.25	0.28	0.00	0.28	0.28	0.00	0.28	0.32	0.00	0.32	0.28	0.00	0.28
Recreation	15.15	2.47	17.62	24.24	3.95	28.19	24.24	3.95	28.19	24.90	4.05	28.95	24.24	3.95	28.19
Commercial/Industrial	34.49	2.25	36.74	30.58	2.37	32.95	30.58	2.37	32.95	30.58	2.37	32.95	30.58	2.37	32.95
Thermoelectric	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	56.87	4.72	61.59	64.24	6.32	70.56	68.77	6.32	75.09	65.49	6.42	71.91	69.59	6.32	75.91

Okeechobee County

	1995			2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
				Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Domestic	0.06	0.00	0.06	0.10	0.00	0.10	0.10	0.00	0.10	0.11	0.00	0.11	0.11	0.00	0.11
Agriculture	14.19	0.00	14.19	13.32	0.00	13.32	13.32	0.00	13.32	16.06	0.00	16.06	13.32	0.00	13.32
Commercial/Industrial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	14.25	0.00	14.25	13.42	0.00	13.42	13.42	0.00	13.42	16.17	0.00	16.17	13.43	0.00	13.43

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Orange County

				2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
	1995			Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Public Supply	104.89	0.00	104.89	174.68	0.00	174.68	206.21	0.00	206.21	185.16	0.00	185.16	218.58	0.00	218.58
Domestic	3.79	0.00	3.79	6.01	0.00	6.01	6.01	0.00	6.01	6.37	0.00	6.37	6.37	0.00	6.37
Agriculture	16.18	17.76	33.94	18.20	9.10	27.30	18.20	9.10	27.30	21.64	10.80	32.44	18.20	9.10	27.30
Recreation	7.56	1.44	9.00	12.25	2.33	14.58	12.25	2.33	14.58	12.53	2.39	14.92	12.25	2.33	14.58
Commercial/Industrial	3.61	0.00	3.61	3.53	0.00	3.53	3.53	0.00	3.53	3.53	0.00	3.53	3.53	0.00	3.53
Thermoelectric	0.41	0.00	0.41	1.25	0.00	1.25	1.25	0.00	1.25	1.25	0.00	1.25	1.25	0.00	1.25
Totals	136.44	19.20	155.64	215.92	11.43	227.35	247.45	11.43	258.88	230.48	13.19	243.67	260.18	11.43	271.61

Osceola County

				2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
	1995			Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Domestic	0.04	0.00	0.04	0.08	0.00	0.08	0.08	0.00	0.08	0.08	0.00	0.08	0.08	0.00	0.08
Agriculture	6.53	9.99	16.52	5.98	9.99	15.97	5.98	9.99	15.97	6.90	10.59	17.49	5.98	9.99	15.97
Commercial/Industrial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	6.57	9.99	16.56	6.06	9.99	16.05	6.06	9.99	16.05	6.98	10.59	17.57	6.06	9.99	16.05

Polk County

				2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
	1995			Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Domestic	0.89	0.00	0.89	1.23	0.00	1.23	1.23	0.00	1.23	1.30	0.00	1.30	1.30	0.00	1.30
Agriculture	2.42	0.24	2.66	5.31	0.57	5.88	5.31	0.57	5.88	6.58	0.70	7.28	5.31	0.57	5.88
Thermoelectric	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	3.31	0.24	3.55	6.54	0.57	7.11	6.54	0.57	7.11	7.88	0.70	8.58	6.61	0.57	7.18

Putnam County

				2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
	1995			Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Public Supply	3.32	0.00	3.32	4.18	0.00	4.18	5.62	0.00	5.62	4.43	0.00	4.43	5.96	0.00	5.96
Domestic	5.10	0.00	5.10	5.58	0.00	5.58	5.58	0.00	5.58	5.91	0.00	5.91	5.91	0.00	5.91
Agriculture	11.85	0.81	12.66	26.26	0.85	27.11	26.26	0.85	27.11	30.07	1.08	31.15	26.26	0.85	27.11
Recreation	0.20	0.00	0.20	0.25	0.00	0.25	0.25	0.00	0.25	0.26	0.00	0.26	0.25	0.00	0.25
Commercial/Industrial	11.50	34.75	46.25	13.12	41.31	54.43	13.12	41.31	54.43	13.12	41.31	54.43	13.12	41.31	54.43
Thermoelectric	0.70	14.50	15.20	1.03	16.42	17.45	1.03	16.42	17.45	1.03	16.42	17.45	1.03	16.42	17.45
Totals	32.67	50.06	82.73	50.42	58.58	109.00	51.86	58.58	110.44	54.82	58.81	113.63	52.53	58.58	111.11

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Seminole County

				2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
	1995			Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Public Supply	51.22	0.00	51.22	82.43	0.00	82.43	96.21	0.00	96.21	87.38	0.00	87.38	101.98	0.00	101.98
Domestic	2.56	0.00	2.56	2.13	0.00	2.13	2.13	0.00	2.13	2.26	0.00	2.26	2.26	0.00	2.26
Agriculture	9.46	0.34	9.80	7.75	0.42	8.17	7.75	0.42	8.17	8.78	0.45	9.23	7.75	0.42	8.17
Recreation	4.92	1.23	6.15	7.82	1.95	9.77	7.82	1.95	9.77	8.00	2.00	10.00	7.82	1.95	9.77
Commercial/Industrial	0.14	0.00	0.14	0.22	0.00	0.22	0.22	0.00	0.22	0.22	0.00	0.22	0.22	0.00	0.22
Thermoelectric	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	68.30	1.57	69.87	100.35	2.37	102.72	114.13	2.37	116.50	106.64	2.45	109.09	120.03	2.37	122.40

St. Johns County

				2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
	1995			Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Public Supply	10.52	0.00	10.52	14.09	0.00	14.09	34.43	0.00	34.43	14.94	0.00	14.94	36.50	0.00	36.50
Domestic	4.24	0.00	4.24	2.80	0.00	2.80	2.80	0.00	2.80	2.97	0.00	2.97	2.97	0.00	2.97
Agriculture	30.07	0.00	30.07	32.40	0.00	32.40	32.40	0.00	32.40	39.22	0.00	39.22	32.40	0.00	32.40
Recreation	3.84	2.26	6.10	6.92	4.06	10.98	6.92	4.06	10.98	7.08	4.16	11.24	6.92	4.06	10.98
Commercial/Industrial	0.06	0.00	0.06	0.11	0.00	0.11	0.11	0.00	0.11	0.11	0.00	0.11	0.11	0.00	0.11
Thermoelectric	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	48.73	2.26	50.99	56.32	4.06	60.38	76.66	4.06	80.72	64.32	4.16	68.48	78.90	4.06	82.96

Volusia County

				2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
	1995			Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Public Supply	47.72	0.00	47.72	68.02	0.00	68.02	91.06	0.00	91.06	72.10	0.00	72.10	96.52	0.00	96.52
Domestic	9.95	0.00	9.95	12.04	0.00	12.04	12.04	0.00	12.04	12.76	0.00	12.76	12.76	0.00	12.76
Agriculture	24.45	3.42	27.87	21.64	3.51	25.15	21.64	3.51	25.15	26.67	4.45	31.12	21.64	3.51	25.15
Recreation	7.63	2.41	10.04	10.91	3.45	14.36	10.91	3.45	14.36	11.22	3.54	14.76	10.91	3.45	14.36
Commercial/Industrial	0.69	0.00	0.69	0.99	0.00	0.99	0.99	0.00	0.99	0.99	0.00	0.99	0.99	0.00	0.99
Thermoelectric	0.37	0.00	0.37	0.66	0.00	0.66	0.66	0.00	0.66	0.66	0.00	0.66	0.66	0.00	0.66
Totals	90.81	5.83	96.64	114.26	6.96	121.22	137.30	6.96	144.26	124.40	7.99	132.39	143.48	6.96	150.44

St. Johns River Water Management District

				2020 Demand Projections (mgd)											
				Average Year						1-in-10 Drought					
	1995			Population Based			User Based			Population Based			User Based		
Category	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Ground	Surface	Total
Public Supply	444.61	12.15	456.76	677.45	16.81	694.26	860.92	16.81	877.73	718.12	17.82	735.94	912.58	17.82	930.40
Domestic	71.98	0.00	71.98	64.84	0.00	64.84	64.84	0.00	64.84	68.73	0.00	68.73	68.73	0.00	68.73
Agriculture	363.58	223.39	586.97	368.45	220.69	589.14	368.45	220.69	589.14	430.76	267.55	698.31	368.45	220.69	589.14
Recreation	68.78	30.35	99.13	107.77	48.67	156.44	107.77	48.67	156.44	110.51	49.89	160.40	107.77	48.67	156.44
Commercial/Industrial	96.02	38.14	134.16	102.63	44.19	146.82	102.63	44.19	146.82	102.63	44.19	146.82	102.63	44.19	146.82
Thermoelectric	7.66	14.50	22.16	11.13	16.42	27.55	11.13	16.42	27.55	11.13	16.42	27.55	11.13	16.42	27.55
Totals	1,052.63	318.53	1,371.16	1,332.27	346.78	1,679.05	1,515.74	346.78	1,862.52	1,441.88	395.87	1,837.75	1,571.29	347.79	1,919.08

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Appendix F

Strategic Water Conservation Assistance at the St. Johns River Water Management District, 1999

STRATEGIC WATER CONSERVATION ASSISTANCE AT THE ST. JOHNS RIVER WATER MANAGEMENT DISTRICT, 1999

The need for future water supply source development and facility construction can be substantially reduced by making optimum use of water resources. Therefore, efficient water use was one of the first considerations by the St. Johns River Water Management District (SJRWMD) when planning to meet future water demands was begun.

SJRWMD has proactive programs to require, promote, and facilitate water conservation. These programs contribute to the goals of assuring adequate water supplies for all reasonable-beneficial uses and protecting water supply sources and water-dependent natural systems to assure continued productivity and environmental quality into the future.

SJRWMD uses a combination of regulatory power, technical assistance, and financial assistance to maximize conservation and reduce the need to develop new supply sources and treatment facilities. Revisions to the SJRWMD consumptive use permitting rule, providing for more specific water conservation requirements, became effective in February of 1999. SJRWMD anticipates maintaining those regulatory requirements in the future, as well as enhancing levels of technical and financial assistance.

Conservation Policy

The SJRWMD Governing Board's policy is to implement water conservation to the maximum extent feasible in accordance with the state of Florida's objective to encourage and promote water conservation and reuse [373.250(1), *FS*, 403.064(1), *FS*, and 62-40, *F.A.C.*]. Therefore, all SJRWMD programs pertaining to water conservation; including all pertinent regulatory requirements, planning, coordination efforts, and funding programs; are applied districtwide.

Regulations

Chapter 40C-2, *F.A.C.*, SJRWMD's water use permitting rule, requires conservation as a part of all consumptive use permits (CUPs). All CUP applicants must meet the following requirement in order to obtain a CUP from SJRWMD:

40C-2.301(4) Conditions for Issuance of Permits
(e) All available water conservation measures must be implemented unless the applicant demonstrates that implementation is not economically, technically, or environmentally feasible....

Guidance for applying Section 40C-2, *F.A.C.*, is provided in the SJRWMD CUP Applicant's Handbook. The Applicant's Handbook specifies conservation practices which all permit applicants must satisfy. These practices include, but are not limited to, the following:

- Water system audit
- Meter survey
- Leak detection
- Meter replacement program
- Water conservation education program
- Water conservation rate structure
- Other water conservation measures as needed or appropriate

In addition to requiring specific water conservation measures where feasible, the SJRWMD consumptive use permitting program also provides the incentives for implementing conservation through extended permit durations.

Non-Regulatory Efforts

The quantities of water saved through conservation activities in SJRWMD far exceed those that are required by specific permit conditions because of active non-regulatory efforts. SJRWMD provides assistance to

Cost-Shared Projects. SJRWMD provides cost sharing assistance to local governments, utilities, and other major water users through cost-sharing funds to a maximum of 50 percent of the project cost. Currently, planned projects include rebate programs for rain sensor devices for automatic sprinkler system shutoffs with the Volusian Water Alliance and low-flow toilet replacements with the City of Melbourne. SJRWMD also is contributing to the construction of a liner to prevent seepage from a small recreational lake at the Easter Seal Foundation's Camp Challenge. Other projects will be added when identified.

Data Collection From Cost-Shared Projects. SJRWMD is taking advantage of opportunities to collect data under controlled circumstances through its cost-shared conservation projects. Collection and analysis of data from these projects will be used to evaluate the success of a project and the general effectiveness of the conservation practice being implemented, as well as to provide information pertaining to the implementation of future similar projects.

Cooperative Conservation Education Project. SJRWMD is in the process of developing a cooperative program to assist permittees in optimizing the effectiveness of their water conservation public education requirement. The approach used by SJRWMD is to develop materials and programs which individual permittees can implement to meet permit conditions for conservation. SJRWMD has chosen this approach in order to avoid having individual permittees spend time and money developing duplicate materials and programs in each locality. Developing selected materials and programs for permittees to implement allows each permittee to focus its own spending more effectively on implementation of its education program and makes more efficient use of their staff and funds. This approach also assures that the permittees will be sending a consistent SJRWMD approved message to their customers and employees. This assistance includes production of radio and television public service announcements, displays, presentations, indoor and outdoor customer water audits, and water-efficient landscape designs. However, the responsibility of implementing water conservation remains with the permittee, regardless of their participation in the SJRWMD cooperative public education program.

Technical Assistance. SJRWMD provides technical assistance to local governments, utilities, and other major water users for assessing conservation needs and opportunities, and for the development of conservation programs.

Coordination. SJRWMD coordinates with local governments, state agencies, and other groups to promote conservation. SJRWMD coordinates with local governments, utilities, and water users through the following listed standing committees and working groups to develop a coordinated regional approach to water supply planning and management. Conservation efforts are key components in the strategies formulated by the following groups:

- Agricultural Advisory Committee (districtwide)
- Water Utility Advisory Board (districtwide)
- Fern Advisory Committee (Lake, Putnam, and Volusia counties)
- *Water 2020* water supply planning work groups (Brevard, Duval, Flagler, Lake, Marion, Orange, Osceola, Polk, Putnam, St. Johns, Seminole, and Volusia counties)

Alternative Water Supply Investigations

SJRWMD has performed studies of various conservation alternatives as part of its *Water 2020* long-term water supply planning project. Those investigations concern the following topics.

Effects of water use restrictions on actual water use. Effects of water use restrictions imposed by SJRWMD during water shortage events in 1989, 1993, and 1994 in the Wekiva River Basin were studied. The purpose of this study was to assess the need for modification of the SJRWMD water shortage rule in order to most effectively restrain high demand during times of low supply availability. The need for rule revision was confirmed by the finding of increased peaks in demand and no statistically significant change in total demand during times of water use restrictions. (PBSJ. 1998. *Water Supply Needs and Sources Assessment: Alternative Water Supply Strategies Investigation: Phase II—Effects of Water Use Restrictions on Actual Water Use.* Spec. Pub. SJ98-SP12, Palatka, Fla.: St. Johns River Water Management District)

Implementation of water conservation rate structures. The effects of water conservation rate structures for eight specific utilities in SJRWMD were studied. Although the concept of price elasticity for water demand is firmly established, the effects of changes in rates and rates structures vary with existing local conditions. This study provided examples of how the application of water conservation rates would affect water use at eight example locations within SJRWMD in order to assess the local applicability of the practice. (PBSJ. 1998. *Water Supply Needs and Sources Assessment: Alternative Water Supply Strategies Investigation: Implementation of Water Conservation Rate Structures.* Spec. Pub. SJ98-SP15. Palatka, Fla.: St. Johns River Water Management District)

Cost effectiveness of specific conservation practices. The cost effectiveness of specific water conservation practices was studied by comparing the amounts of water saved with the cost of implementing the water conservation practice. This information can be used to select cost-effective conservation practices for enhancing future consumer demand management. (PBSJ. Cost Effectiveness of Specific Conservation Practices, in press)

Effects of water conservation on utility charge rates. The economic impacts of decreased water use on utility income were studied in order to the magnitude of rate adjustments needed to make up for lost sales volume. (PBSJ. Effects of Water Conservation on Utility Charge Rates, unpublished)

Appendix G

Strategic Reclaimed Water Assistance at the St. Johns River Water Management District, 1999

STRATEGIC RECLAIMED WATER ASSISTANCE AT THE ST. JOHNS RIVER WATER MANAGEMENT DISTRICT, 1999

SJRWMD has proactive programs to require, promote, and facilitate the use of reclaimed water. These programs contribute to the goals of assuring adequate water supplies for all reasonable-beneficial uses and protecting water supply sources and water-dependent natural systems to ensure continued productivity and environmental quality into the future. SJRWMD uses a combination of regulatory power, technical assistance, and financial assistance to maximize reuse and reduce the need to develop new supply sources and treatment facilities.

Reuse Policy

SJRWMD Governing Board's policy is to implement reuse to the maximum extent feasible in accordance with the state of Florida objective to encourage and promote water conservation and reuse (373.250(1) and 403.064(1), *FS*, and 62-40, *F.A.C.*)

Therefore, all SJRWMD programs pertaining to reuse; including all pertinent regulatory requirements, planning, coordination efforts, and funding programs; are applied districtwide. This policy includes the designation of the entire District as a water resource caution area for the purpose of requiring reuse feasibility studies by the Florida Department of Environmental Protection (DEP) during the wastewater treatment facilities permitting process (62-610.820, *F.A.C.*).

Regulations

Chapter 40C-2, *F.A.C.*, SJRWMD's water use permitting rule, requires the use of reclaimed water where feasible. All consumptive use permit (CUP) applicants must meet the following requirements in order to obtain a CUP from SJRWMD:

40C-2.301(4) Conditions for Issuance of Permits
(f) When reclaimed water is readily available it must be used in place of higher quality water sources unless the applicant demonstrates that it is not economically, environmentally, or technically feasible.
(g) For all uses except human food preparation and direct human consumption, the lowest acceptable quality water source, including reclaimed water (which includes storm water) must be utilized for each consumptive use. To use a higher quality water source an applicant must demonstrate that the use of all lower quality water sources will not be economically, environmentally, or technically feasible. If the applicant demonstrates that the use of a lower quality water sources would result in adverse environmental impacts that outweigh the water savings, a higher quality source may be used.

Guidance for applying Section 40C-2, *F.A.C.*, is provided in the SJRWMD CUP Applicant's Handbook.

Non-Regulatory Efforts

The quantities of water saved through reuse activities in SJRWMD far exceed those that are required by specific permit conditions because of active non-regulatory efforts.

Data Collection and Analysis. SJRWMD maintains a database of wastewater treatment plants and reuse projects within its boundaries and uses its geographic information system (GIS) to map and analyze data. The data, maps, and analyses are used both in the water supply planning process and in the regulatory program to identify feasible opportunities to increase the effective quantity of reuse.

Funding Assistance. SJRWMD provides financial assistance to local governments, utilities, and other major water users through several cost -sharing funds. The sources of these funds include SJRWMD ad valorem tax monies, state appropriations, and special federal appropriations. Approximately $6 million have been allocated through these programs since their inception in 1996. Alternative water supply projects funded through these sources usually involve use of reclaimed water, storm water, or recycled irrigation water (Table G1).

The SJRWMD Alternative Water Supply Construction Cost Sharing Project provides up to 50 percent cost sharing for projects which bring an alternative water supply source into use to replace an existing or potential high-quality water source. This project has provided over $2.5 million to 50 projects since 1996. Thirty-one of those projects have involved the use of reclaimed domestic wastewater. The remaining 19 projects have utilized storm water or recirculated water within their systems. SJRWMD has budgeted $3,616,000 for alternative water supply project cost sharing in FY 2000.

SJRWMD also has funds allocated to share up to 50 percent of the cost of reuse feasibility studies projects. These funds often are used to assist consumptive use permittees to meet requirements for performing reuse feasibility studies (Table G2).

State funds were allocated through the SJRWMD Lower St. Johns River SWIM project for construction of regional reclaimed water distribution. The Florida Forever Act, passed by the 1999 Florida Legislature, provides funds for water supply development. It is anticipated that SJRWMD will use the available funds to implement portions of the *District Water Supply Plan*. Some of these funds will be used to construct reuse projects.

In addition, SJRWMD has pursued and acquired federal funding for alternative water supply development projects through the U.S. Environmental Protection Agency. These funds may be used to pay up to 55 percent of project costs. Most projects financed by SJRWMD through this source have involved reuse (descriptions follow Table G2).

Table G1. Reuse and recycling projects funded by SJRWMD

1996

Brief Project Description	Applicant	SJRWMD $ cost share
Storm and tailwater recovery system	Jon's Nursery	79,000.00
Reclaimed water system extension	New Smyrna Beach Util. Comm.	28,135.00
Reclaimed water system extension	City of Ormond Beach	80,000.00
Reclaimed water system extension	City of Port Orange	13,850.00
Reclaimed water system extension	Bouchelle Island Assoc.	31,215.00
Reclaimed water system extension	City of Port Orange	27,180.00
Reclaimed water system extension	Florida Cities Water Co.	80,000.00
Reclaimed water system extension	City of De Land	50,000.00
Agricultural tailwater recovery pond	Rusty Harper Ferneries	25,000.00
Agricultural tailwater recovery pond	Mark Wickham	60,122.00
Agricultural tailwater recovery pond	T.J. Tolbert	27,208.00
Reclaimed water system extension	City of Sanford	80,000.00
Total		681,710.00

1997

Brief Project Description	Applicant	SJRWMD $ cost share
Upgrade WW treatment to public access	Cape Canaveral, City of	75,000.00
Reclaimed water storage & distribution	Seminole County	75,000.00
Storm water to supplement reuse	Cocoa, City of	60,000.00
Reclaimed water system extension	New Smyrna Beach	75,000.00
Reclaimed water system extension	Rockledge, City of	17,876.80
Agricultural tailwater recovery pond	Harland Fogle	57,949.98
Reclaimed water system extension	Sanford, City of	48,500.00
Plant nursery water recycling system	Robrick Nursery	9,430.00
Agricultural tailwater recovery pond	Jimmy Sowell	29,119.30
Storm water to irrigate golf course	Rolling Hills Golf Club	24,525.50
Agricultural tailwater recovery pond	Jackie Smith	74,631.12
Horizontal wells for irrigation recovery	KHD, LTD	21,140.00
Reclaimed water system extension	New Smyrna Beach	75,000.00
Agricultural tailwater recovery pond	James Warner	59,719.86
Reclaimed water system extension	De Land, City of	75,000.00
Reclaimed water system extension	Brevard County	75,000.00
Golf course conversion reuse	Tomoka Oaks G&C Club	75,000.00
Total		927,892.56

Table G1—*Continued*

1998

Brief Project Description	Applicant	SJRWMD $ Cost Share
Reclaimed water system extension	City of Port Orange	25,120.00
Reclaimed water system extension	City of Port Orange	25,120.00
Storm water to irrigate golf course	Hidden Lakes Golf Course	25,120.00
Install reclaimed water supply system	UF, IFAS, Cent Fla. Res & Ed Cent	69,800.00
Reclaimed water system extension	City Of Sanford	58,000.00
Reclaimed water system extension	City Of Sanford	50,000.00
Ornamental plant nursery recycling	Leesburg Fruit Company, Inc.	50,000.00
Reclaimed water transmission line	City of Lake Mary	9,100.00
Potable water recovery	Palm Coast Utility	25,120.00
Gutter-connect greenhouse construction	Famous & Historic Tree Nursery	37,500.00
Reclaimed water system extension	City of De Land	25,120.00
Reclaimed water system extension	City of Cape Canaveral	50,000.00
Reclaimed water system extension	City of Cape Canaveral	50,000.00
Total		500,000.00

1999

Brief Project Description	Applicant	SJRWMD $ Cost Share
Reclaimed water transmission facilities	Seminole County	100,000.00
Golf course conversion reuse	West Orange Country Club	50,000.00
Upgrade wastewater treatment to public access	Park Manor Waterworks, Inc	100,000.00
Construct reclaimed water lines	Polk County	100,000.00
Reclaimed water system extension	City of Cocoa	100,000.00
Agricultural tailwater recovery pond	Larry L. Loadholtz	35,000.00
Agricultural tailwater recovery pond	George York	15,000.00
Total		500,000.00

Table G2. SJRWMD reuse feasibility study cost sharing, 1996–99

Recipient	SJRWMD Cost-Share
Apopka	15,000
Winter Garden	14,000
Clay County Utility Authority	11,000
Crescent City	10,000
Edgewater	8,000
Fernandina Beach	12,000
Green Cove Springs	10,000
Indian River County	10,000
Jacksonville Beach	10,000
Melbourne	10,000
Ocoee	37,500
Palatka	10,000
Palm Bay	10,000
Port Orange	23,320
Putnam County	24,000
Putnam County	20,000
Rockledge	3,000
Titusville	10,000
Titusville	8,180
Vero Beach	10,000
Winter Garden	10,000
Total	276,000

Federally Funded Alternative Water Supplies Projects. SJRWMD is using federal money to accelerate two major reuse projects that will have regional water supply significance and contribute toward implementation of the *District Water Supply Plan.*

City of Sanford use of surface water to supplement reuse system: Project components include modification of existing wastewater treatment facilities and reversal of an effluent disposal line to take surface water from Lake Monroe to supplement the city's reclaimed water supply by 1 mgd during times of high demand. Future expansion will bring the facility to 3 mgd capacity. This project will help the City of Sanford maximize its use of reclaimed water during low demand times by assuring additional supply to meet peak demand. Use of water from Lake Monroe, along with additional reclaimed water use, will take the place of fresh groundwater withdrawal.

Phase 1 SJRWMD/EPA 1998 Cost Share	Proposed Phase 2 SJRWMD/EPA 1999 Cost Share	Cumulative SJRWMD/EPA (2 phases)	Total Project Cost
$354,334	$1,385,000	$1,739,334	$3,137,467

City of Apopka upgrade of treatment facilities, expansion of reuse system, and use of surface water to supplement reuse system: This project will relieve the use of substantial amounts of groundwater for irrigation in the area which feeds springs in the Wekiva River headwaters. The additional reuse capacity provided by this project also will assure adequate flow to meet peak demands and prevent future shortfalls of reclaimed water supply as experienced by the City of Apopka during dry conditions for the last several years. Project components include the upgrade an existing 2 mgd wastewater treatment facility to public area reuse standards, increased storage, additional pump station capacity, and installation of additional infrastructure to distribute reclaimed water. The current funding proposal is for Phase 2 of a project that was begun in 1998. The current funding proposal is for Phase 2 of a three-phase project begun in 1998.

Phase 1 SJRWMD/EPA 1998 Cost Share	Proposed Phase 2 SJRWMD/EPA 1999 Cost Share	Cumulative SJRWMD/EPA (2 phases)	Total Project Cost
$261,333	$1,511,000	$1,772,333	$4,698,554

Projected Major Reuse Projects

A small number of wastewater utilities with projected available treated wastewater of more than 5 mgd in 2020 account for most of the current and projected available wastewater (Table G3). Development of reuse in the areas of these utilities is an SJRWMD priority. Approximately another 50 wastewater treatment facilities are projected to have an additional 1 to 5 mgd available for reuse through 2020.

Technical Assistance. SJRWMD provides technical assistance to local governments, utilities, and other major water users for assessing reuse needs and opportunities, and for planning the development of reuse programs.

SJRWMD maintains a geographic information system (GIS) database concerning domestic wastewater treatment and reuse. These data are used to identify and assess reuse opportunities and to match potential reclaimed water users with suppliers. Information stored in this GIS database includes treatment facility location, capacity, and flow; existing reuse quantities and types; and locations of reuse distribution

Table G3. Projected 2020 major available reclaimed sources

Utility or Location	Projected 2020 Available Treated Wastewater (mgd)
Jacksonville Electric Authority*	85
Eastern Seminole and Orange Counties Interconnection Project†	20
Gainesville Regional Utilities	20
City of Daytona Beach†	12
City of Melbourne†	10
Brevard County, South Beaches†	8
City of Ocala	6
Clay County Utility Authority	5
City of Leesburg†	5
Orange County, Northwest†	5
Total	176

Note: These quantities are projections of total available additional treated wastewater from these facilities. The amount of potable water demand which can be displaced by using this water will vary with the type of reuse and other factors.
*Partially in priority water resource caution areas
†In priority water resource caution areas

systems and large individual reuse sites. These data are combined with information from other SJRWMD GIS databases for electronic and visual analysis. Information from other databases includes political boundaries; hydrography, roads and highways; and selected land uses and covers, including row and field crops, nursery and ornamental crops, golf courses, and cemeteries.

Coordination. SJRWMD coordinates with local governments, state agencies, and other groups to promote reuse. Such activity includes participation in the State Reuse Coordinating Committee, composed of DEP, PSC, HRS, and the five water management districts; regular meetings with DEP staff to promote reuse opportunities and facilitate reuse; and coordination with DEP, PSC, and HRS staff on specific projects. SJRWMD coordinates with local governments, utilities, and water users through the following listed standing committees and working groups to develop a coordinated regional approach to water supply planning and management. Reuse is a key component in the strategies formulated by the following groups:

- Agricultural Advisory Committee (districtwide)
- Water Utility Advisory Board (districtwide)

- Fern Advisory Committee (Lake, Putnam, and Volusia counties)
- Water 2020 water supply planning work groups (Brevard, Duval, Flagler, Lake, Marion, Orange, Osceola, Polk, Putnam, St. Johns, Seminole, and Volusia counties)

Reclaimed Water Availability

The total permitted treatment capacity for wastewater treatment facilities (WWTFs) of 100,000 gallons per day or more was 470 mgd in 1997. Mean daily treatment flow of wastewater was 288 mgd or 61 percent of permitted capacity. Reclaimed water for reuse, by DEP definitions, was supplied by 126, or 64 percent, of the inventoried WWTFs. These facilities provided about 118 mgd of reclaimed water, 41 percent of the total wastewater flow, for reuse within SJRWMD.

Irrigation uses accounted for 49 mgd, or 42 percent, of all reuse within SJRWMD. Public area uses was the greatest amount of irrigation reuse (19.3 mgd), followed by agriculture (16.5 mgd) and golf course irrigation (12.9 mgd). After irrigation, environmental enhancement (19.6 mgd) and groundwater recharge (14 mgd) were the next largest uses for reclaimed water. Industrial-commercial self-supply, fire protection self-supply, and other uses accounted for relatively minor amounts of reuse.

Availability of reclaimed water varies geographically within SJRWMD (Table G4). Reclaimed water already is utilized very thoroughly in some locations and very little in others. Much of the reclaimed water in the high growth areas of Orange and Seminole counties is already committed, and some systems in these areas are supplemented with storm water or groundwater.

Effects of Reclaimed Water Use on Potable Demand

It should not be assumed that the use of reclaimed water would offset use of potable water at a one-to-one ratio, particularly for lawn and landscape irrigation. Actual replaceability of potable water with reclaimed water may be at a rate as small as 50%. Reclaimed water frequently is wasted because of low utility rates, generally a flat monthly rate for an unlimited quantity. Because of that, total water use may increase significantly when reclaimed water becomes available. Metering and use-based rates may be useful in averting such waste.

Seasonal variations in both supply and demand of reclaimed water also affect utilization. A system that is designed to utilize all available reclaimed water during low demand times will require augmentation from other sources during high demand times. A system which is designed to handle peak demand without augmentation will have to discharge a high percentage of the available water during low demand times.

Table G4. Domestic wastewater treatment and reuse, 1998

County	Total Plant		Reuse	
	Capacity (mgd)	Flow (mgd)	Capacity (mgd)	Flow (mgd)
Alachua	20.75	15.63	13.15	9.69
Baker	0.94	0.57	0.00	0.00
Brevard	62.35	37.52	30.82	13.79
Clay	12.44	8.14	0.56	0.47
Duval	122.64	74.31	7.5	5.64
Flagler	6.39	3.2	2.74	2.22
Indian River	11.56	7.27	8.8	4.84
Lake	15.47	9.63	13.21	8.8
Marion	13.73	7.93	11.02	3.25
Nassau	5.76	3.95	1.46	0.91
Orange	39.28	19.17	28.82	17.18
Putnam	3.25	3.12	0.03	0.03
St. Johns	15.4	9.52	7.5	3.37
Seminole	78.2	48.93	49.96	35.06
Volusia	61.77	39.09	48.26	12.81
SJRWMD Total	469.93	287.98	223.83	118.06

The need to dispose of treated wastewater during low demand periods also leads to excessive irrigation by large users who have contracts to take specific amounts of water regardless of their immediate need. Thus, many golf courses and recreational fields tend to be over irrigated when reclaimed water is used.

Alternative Water Supply Investigations

SJRWMD has performed studies of various reuse alternatives as part of its *Water 2020* long-term water supply planning project. Those investigations concern the following topics.

Cost of supplying reclaimed water to areas of high agricultural withdrawals. The costs of replacing water withdrawn from the Floridan aquifer with reclaimed water for agricultural irrigation on citrus grown in Orange and Lake counties and ferns grown in Volusia and Putnam counties were studied. This study provided cost data for comparison with other water supply options. Study report: *Water Supply Needs and*

Sources Assessment: Alternative Water Supply Strategies Investigation: Assessment of the Cost of Supplying Reclaimed Water to Areas of High Agricultural Withdrawals, by PBSJ. Special Publication SJ98-SP1 (St. Johns River Water Management District).

Elimination of potable quality water for residential landscape irrigation. The cost of replacing potable quality water with reclaimed water and individual private irrigation wells was calculated for 25 utilities in priority water resource caution areas. The purpose of this study was to determine the economic feasibility of relieving demand on public water supply facilities and thereby reducing the need for facility expansion by shifting to an alternative supply source. This study provided cost data for comparison with other water supply options. Study report: *Water Supply Needs and Sources Assessment: Alternative Water Supply Strategies Investigation: Replacement of Potable Quality Water for Landscape Irrigation,* by PBSJ. Special Publication SJ98-SP2 (St. Johns River Water Management District).

Using reclaimed water for aquifer recharge. Groundwater modeling was performed to determine the effects on groundwater levels of artificially recharging reclaimed water. This practice was evaluated as a possible means of offsetting the effects of groundwater withdrawals. Although artificial recharge tends to raise groundwater levels, modeling showed that gains achieved through this practice were less than the reductions to groundwater levels that could be prevented by making direct use of reclaimed water and avoiding additional groundwater withdrawals. Draft report: Technical Feasibility of Artificial Recharge of Reclaimed Wastewater and Its Impacts on the Regional Groundwater System, by Ghulam Rabbani and Doug Munch (St. Johns River Water Management District).

Golf course water use. The actual amounts of water from various sources used to irrigate golf courses were studied. Sources included groundwater, reclaimed water, surface water, and storm water. This information will be used to refine the withdrawal quantities used in groundwater models and to optimize the use of reclaimed water. This information also may be applied in the consumptive use permitting process. Study report, in progress: Monitoring Golf Course Water Use for Source and Amount.

Interconnection of reclaimed water systems. Several studies of the costs and benefits of interconnecting various reclaimed water systems have been performed, including systems in Brevard, Indian River, Orange, Seminole, and Volusia counties. These studies provided cost data for comparison with other water supply options. Study reports:

Water Supply Needs and Sources Assessment: Alternative Water Supply Strategies Investigation: Systems Interconnection Methodology, by Law Engineering and

Environmental Services. Special Publication SJ96-SP6 (St. Johns River Water Management District).

Water Supply Needs and Sources Assessment: Alternative Water Supply Strategies Investigation: Planning Level Assessment of the Feasibility of a Regionally Interconnected Reuse System in Brevard and Indian River Counties, by Law Engineering and Environmental Services. Special Publication SJ97-SP17 (St. Johns River Water Management District).

Water Supply Needs and Sources Assessment: Alternative Water Supply Strategies Investigation: Evaluation of Interconnection Strategies in Water Resource Caution Areas, draft, by Law Engineering and Environmental Services.

Daytona Beach-Port Orange-Duke Power Plant Reclaimed Water Interconnections, by PBSJ. Unpublished.

Cost Assessment of Regional Reuse Alternatives in Eastern Seminole and Orange Counties, by PBSJ. In progress.

Appendix H

Guidance for Prioritizing the Distribution of State or Water Management District Funds for Water Supply Development Projects, Subparagraph 373.0831(4)(a)(b), *Florida Statutes*

Florida Statute **373.0831 Water resource development; water supply development**

Subparagraph 373.0831(4)(a)(b)

(4)(a) Water supply development projects which are consistent with the relevant regional water supply plans and which meet one or more of the following criteria shall receive priority consideration for state or water management district funding assistance:

1. The project supports establishment of a dependable, sustainable supply of water which is not otherwise financially feasible;

2. The project provides substantial environmental benefits by preventing or limiting adverse water resource impacts, but requires funding assistance to be economically competitive with other options; or

3. The project significantly implements reuse, storage, recharge, or conservation of water in a manner that contributes to the sustainability of regional water sources.

(b) Water supply development projects which meet the criteria in paragraph (a) and also bring about replacement of existing sources in order to help implement a minimum flow or level shall be given first consideration for state or water management district funding assistance.

Appendix I

Public/Private Partnerships for Water Resources Facilities

DRAFT

Public/Private Partnerships for Water Resources Facilities
Discussion of Principles

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As we enter the 21st century, Florida is facing critical challenges in continuing to supply its population with our most precious resource, water. Our long used source of supply, the Floridan aquifer, simply cannot continue to withstand the increasing demands being placed upon it by our growing population.

However, like many natural resource problems, many people do not believe that the problem is critical until it directly affects them through unavailability or higher prices or both. Fortunately, our water management districts are currently identifying alternative sources of supply, because in the foreseeable future, the Floridan aquifer will not be adequate to meet all projected water needs.

One alternative being seriously considered by the St. Johns River Water Management District is a surface water plant on the St. Johns River in central Florida. A significant challenge will be to structure the ownership and funding of such a facility. This paper discusses this challenge in the following paragraphs.

1.0 PUBLIC/PRIVATE OWNERSHIP, OPERATION AND FUNDING

When considering public and/or private ownership, operation and funding of a water resources facility, it is first useful to examine each independently of the other and to then explore the possibilities of public/private partnerships that might incorporate the advantages of both. Therefore, the following subsections discuss the advantages and disadvantages of exclusively public ownership, operation and funding and of exclusively private ownership, operation and funding. However, it is first necessary to state some assumptions that will apply to the discussion of each case.

- The water resources facility will serve existing and new public and private utilities in its service area on a wholesale basis.

- The cash needs basis of rate making is assumed for public ownership and the utility basis of rate making as regulated by the Florida Public Service Commission (FPSC) is assumed for private ownership.

There are several components of ownership, operation and funding of a major water resources facility that are important to evaluate for both the public and private options. These components are as follows:

- Design
- Construction
- Ownership
- Financing
- Operation
- Rates

Each of these components of ownership, operation and funding are evaluated in the discussions of the advantages and disadvantages of public and private ownership, operation and funding presented in the following subsections.

1.1 EXCLUSIVELY PUBLIC OWNERSHIP, OPERATION AND FUNDING

Because the service area of the surface water treatment facility will be large and the facility will serve a number of existing utilities, most of which are public utilities, on a wholesale basis, public ownership, operation and funding of the facility seems to be the most logical structure to consider initially. Therefore, this section discusses the advantages and disadvantages of public ownership, operation and funding.

1.1.1 Components of Public Ownership, Operation and Funding

With regard to the components of ownership, operation and funding discussed in the previous section, the following analysis is applicable to public ownership, operation and funding.

- Ownership - A public entity will be the owner of record for the facility and will be organized as a public utility.

- Design - A public owner could design the facility with internal resources or contract with a private engineering/design firm for design of the facility. Most large public utilities contract for the design of major infrastructure, therefore, it is assumed that a public owner of this facility will contract for its design.

- Construction - As with design, a public owner could construct, or build, the facility with internal resources or contract with a private firm for construction of the facility. Because most large public utilities contract for the construction of major infrastructure, it is assumed that a public owner of this facility will contract for its construction.

- Financing - Financing will be accomplished by the issuance of tax exempt revenue bonds that will be supported by the revenues of the new utility.

- Operation - The new public utility will operate the facility with its own personnel and other resources. As with most large public utilities, the new utility may contract for specialized services such as lab analyses.

- Rates - The new public utility will be self regulating with regard to rates and will use the cash need basis of rate making. The FPSC will have no regulatory control under the public ownership option. Most publically owned water utilities use the cash need basis of rate making. Under this approach, all of the cash requirements of the utility are included in its rates, including operations and maintenance costs, annual renewal and replacement costs, minor capital outlay requirements and annual debt service. Annual debt service includes the principal and interest payments for long term tax exempt debt issued to finance design and construction of the facility and other major capital items.

1.1.2 Advantages and Disadvantages of Public Ownership, Operation and Funding

The advantages of public ownership, operation and funding are as follows:

Advantages

- Low rate, tax exempt financing
- Rates match rate revenue with cash requirements
- No profit in rates
- Subsidies could be made from other governmental sources if necessary for financial viability

Disadvantages

- Limited competition to minimize costs
- Cumbersome procurement process
- All risks are born by the public owner
- "Profit" can appear as transfers to other funds of the public owner

1.2 EXCLUSIVELY PRIVATE OWNERSHIP, OPERATION AND FUNDING

As an alternative to public ownership, operation and funding, this section discusses the advantages and disadvantages of exclusively private ownership, operation and funding.

1.2.1 Components of Private Ownership, Operation and Funding

With regard to the previously identified components of ownership, operation and funding, the following analysis is applicable to exclusively private ownership, operation and funding.

- Ownership - A private entity will be the owner of record for the facility and will be organized as a public utility, regulated by the Florida Public Service Commission (FPSC).

- Design - A private owner could design the facility with internal resources or contract with a private engineering/design firm for design of the facility.

- Construction - As with design, a private owner could construct, or build, the facility with internal resources or contract with a private firm for construction of the facility.

- Financing - Financing will be accomplished by the infusion of equity from the private owner and debt incurred by the private owner at available taxable market rates. Some level of tax exempt financing may be available through special programs, however, it is considered that this source of funding will be minimal.

- Operation - The new private utility will operate the facility with its own personnel and other resources. As with most large utilities, the new utility may contract for specialized services such as lab analyses.

- Rates - The new private utility will be regulated with regard to rates by the FPSC and will use the utility basis of rate making. Under this approach, the private utility is allowed to recover its operations and maintenance costs, including an allowance for depreciation, plus a return on rate base. Rate base represents the utility's net investment in utility plant in service that is considered to be used and useful in the service of current customers.

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1.2.2 Advantages and Disadvantages of Private Ownership, Operation and Funding

The advantages of private ownership, operation and funding are as follows:

Advantages

- Competition can minimize costs
- All risks are born by the private owner
- Less cumbersome procurement process

Disadvantages

- Higher cost of financing
- Rates do not match rate revenue with cash requirements
- There is profit in the rates

2.0 THE FINANCIAL DYNAMICS OF PRIVATE VS. PUBLIC RATES

The area that is most critical to the financial viability of either the public or private option for ownership, operation and funding is rate making. Rates provide the revenue stream that will support the financial requirements of either the public or private option. However, the financial dynamics of the rate making process are different for each.

The one aspect of rate making that is the same for public and private ownership is that operations and maintenance costs other than depreciation, which is a non cash item, are recovered in the rates for both. However, recovery of investment in plant and recovery of the cost of money relative to that investment is handled quite differently.

A public utility, under the cash needs basis of rate making, is allowed to recover all of the principal and interest associated with financing its investment in plant, regardless of how much of the capacity of the utility is used and useful in service to current customers. On the other hand, a private utility, under regulation by the FPSC, is allowed to recover 1) only the portion of depreciation on its investment in plant that is used and useful in service to current customers and 2) a return on rate base to represent its cost of money used in its investment. Rate base represents the utility's net investment in utility plant in service, after subtracting accumulated depreciation, which is used and useful in service to current customers.

Therefore, a public utility is able to recover all of its cash requirements in all years of operation, whereas, a private utility will suffer cash flow deficits relative to its actual cash costs in the later years of the life of the plant. This is because, absent future investment for expansion, growth, etc., the rate base derived from the initial investment is continually eroded by increasing accumulated depreciation so that in the later years of the plant financing, cash payments for principal and interest exceed the cash received in the rates from annual depreciation and return, because the allowed return is being calculated based upon a diminishing rate base each year.

The charts included on pages 4 and 5 of the attached Discussion of Principles demonstrates this effect. The first chart on page 4, Investment in Plant, shows how rate base associated with the construction of the surface water plant erodes over the life of the investment, assuming no additional investments in plant over the period.

The second chart on page 4, Cash Flow, shows 1) net cash flow relative to rate revenue derived from depreciation versus the cash payments that the utility must make to retire the principal on the debt incurred to finance the plant, assuming 100% debt financing, 2) net cash flow relative to rate revenue derived from return on rate base versus the cash payments that the utility must make as interest on the debt incurred to finance the plant, and 3) the net cash flow consequences of 1 and 2.

This chart shows that, although the private utility will experience positive net cash flows in the early years of the investment, after about the mid term of the investment, net cash flows become negative and the negative cash flows get larger through the term of the investment.

The third chart which is on page 5, shows the rate burden of the investment under private ownership compared to public ownership. This chart shows that rates would be higher under private ownership in the early years, assuming operation and maintenance expenses are equal for public and private ownership. If private ownership can achieve operations and maintenance cost savings over public ownership, this difference in rate burden could possibly be mitigated so that expected rates under each option for ownership would be relatively equal during the first half of the investment life of the plant. In the later years, the rate differential swings in the favor of private ownership. However, as shown in the previous chart, the negative cash flow impacts to the private owner would probably preclude private ownership in the later years of the plant investment.

3.0 PUBLIC PRIVATE PARTNERSHIPS

The discussion in the prior section indicates that the financial dynamics of rate regulation upon a private owner for this surface water treatment facility will make exclusive private ownership, operation and funding problematic. However, public/private partnerships offer the possibility of achieving many of the advantages of each option, while eliminating, or at least mitigating the disadvantages.

There are a number of possibilities regarding the structure of public/private partnerships and a number of such arrangements exist today as models. Although, each circumstance is different and a thorough examination of this situation would be required before structuring any public/private partnership approach, the components of ownership, operation and funding of the project can be generally evaluated with regard to a public/private partnership approach. Such an evaluation is presented below.

- Ownership - A public entity could own the facility or it could host a competition where the successful private bidder could own the facility, design it and build it.
- Design/Construction - If a public entity owns the facility, it could host a competition for private design/build.
- Financing - If a structure could be achieved that allowed tax exempt financing through the public entity it would allow for lower costs, with less pressure on rates.
- Operation - A private owner would operate the utility, or if owned by a public entity, a competitive bid process can select the most cost effective private operator, with guarantees regarding cost ceilings.
- Rates - Rates would be established using the cash needs approach if owned by the public entity or using the utility based approach, regulated by the FPSC if owned by a private entity.

If the public/private partnership is structured so that a private entity owns the facility, it will probably be necessary to include a transfer of ownership to a public entity at some point in the future in order to avoid the negative cash flow dynamics under private ownership in the later years of the investment in the plant. Such transfer would include a fair compensation to the private owner for the assets transferred, and could include a long-term operations contract with the private entity and a guarantee of operations and maintenance costs from the private entity as part of the operations and maintenance contract.

Such a transfer of ownership would allow for transition to cash needs rate making to provide the cash flow to retire the principal and interest on the long term debt that the public entity would issue to acquire the utility assets and would also allow the private entity to determine operations and maintenance costs of the facility through experience, thus allowing their inclusion at realistic guarantees in a long term contract. If properly structured in terms of the timing of the transfer, the transition from regulated rates to cash needs rates could have an essentially neutral effect upon the actual rates charged to customers.

4.0 CONCLUSION REGARDING PUBLIC/PRIVATE OWNERSHIP, OPERATION AND FUNDING

Both public and private options have advantages and disadvantages. Models of public/private partnerships exist for similar public utility operations that have had varying degrees of success. An examination of the requirements of this project relative to the structure and success of available public/private partnership models might result in the identification of a public/private partnership model for this project that will facilitate its implementation and its short and long-term cost effective operation.

One or more public/private scenarios could be modeled to determine the comparative impact of the wholesale rate per 1,000 gallons for each year in a 30 year forecast period. The model could be developed to be dynamic and interactive to allow for real time testing of "what if" scenarios. This modeling process could be structured so as to involve the stakeholders in this surface water treatment plant, namely the current utilities in its service area, in a way that they can fully understand the project.

Attachment 1

Discussion of Principles

St. Johns River Water Management District

Burton & Associates Water Resources Economics

Public/Private Partnerships for Water Resources Facilities

Discussion of Principles

Public/Private Options

Public Ownership and Operation

Public - Contract Design
Public - Contract Build
Public - Own
Public - Finance
Public - Operate
Public - Self Regulated Rates

Public/Private Partnership (Numerous Variations Possible)

Public - Host Competition for Private Design/Build
Private - Own
Private - Finance (some tax exempt possible)
Private - Operate
Private - Regulated Rates
Private - Transfer Ownership & Regulation of Rates to Public Entity
Public - Own and Finance Acquisition
Private - Operate under Contract with Fixed Price

Private Ownership and Operation

Private - Design
Private - Build
Private - Own
Private - Finance
Private - Operate
Private - Regulated Rates

Public Ownership and Operation

- Advantages
  - Tax Exempt Financing
  - Cash Needs Rate Making Results in Matching of Rate Revenue with Costs
  - No Profit in Rates
- Disadvantages
  - No Competition to Minimize Costs
  - All Risks Born by Public Owner
  - Profit Often Appears in Rates as Transfers to Other Funds

Private Ownership and Operation

- Advantages
  - Competition can Minimize Costs
  - All Risks Born by Private Owner
  - Less Cumbersome Procurement Process
- Disadvantages
  - Higher Cost of Financing
  - Utility Rate Making Results in Mis-matching of Rate Revenue with Costs
  - Profit in Rates

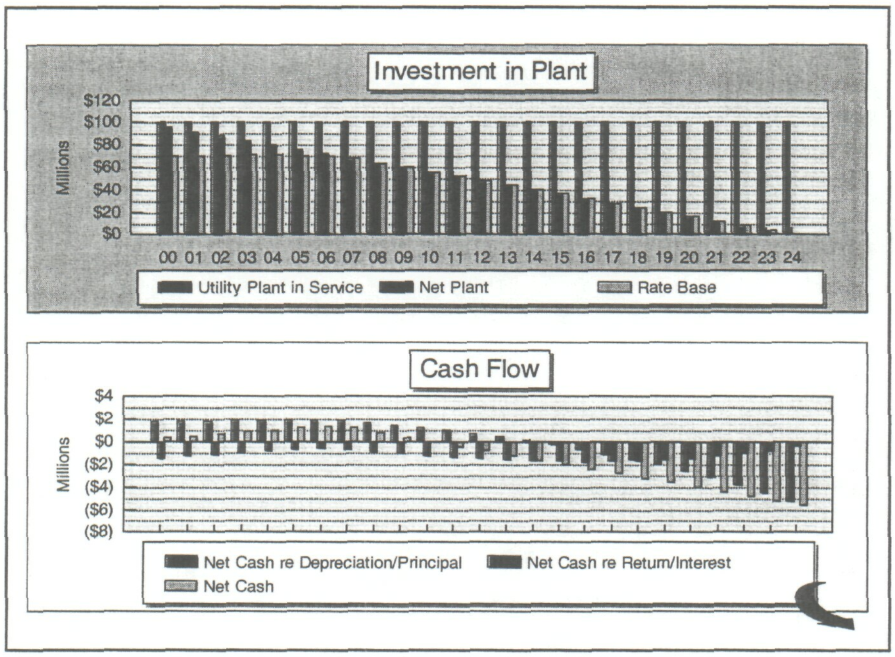
Private vs. Public Rates

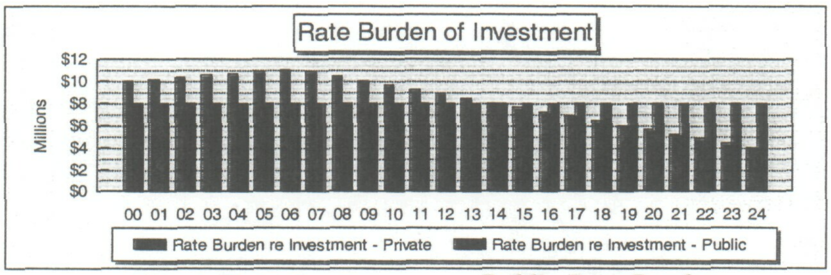
- Private
  - Depreciation
  - Return on Rate Base
  - Used & Useful
- Effects
  - Rate base is eroded by depreciation, reducing return in outer years
  - Depreciation and return not sufficient to cover cash in outer years.
- Public
  - Principal
  - Interest
  - 100% Cash Recovery
- Effects
  - Cash flow matched with principal and interest payments throughout the term of the financing.
  - No deficiencies in cash flow in outer years.

Example of Typical Financial Dynamics of Private Ownership

Assumptions

- $100.0 Million Investment
- 25 Year Depreciation
- 25 Year Financing Term
- 3 Year Margin Reserve Included in Used & Useful Calculation





Private Rate Burden of Investment

- Used & Useful Depreciation, plus
- Return on Rate Base

Public Rate Burden of Investment

- Annual Principal and Interest on Debt

Note: Private savings in operations and maintenance costs may mitigate higher rates in early years. Also, lower private rates as shown in later years are not feasible because without a transfer to a public entity, the negative profitability in the later years for a private owner would make a total private scenario not feasible.

Conclusions

- With private ownership, net cash goes negative at about half way through the depreciable life of the investment.
- Buy-out by a public entity will be necessary at the point where net cash flow goes negative.
- Buyout can be funded by the net income of the utility at that time.

Conclusions (Cont'd)

- Several Public/Private scenarios could be modeled to determine the comparative impact of the wholesale rate per 1,000 gallons for each year in a 30 year forecast period,
- The model could be developed to be dynamic and interactive to allow for real time testing of "what if" scenarios.

End of Presentation

Appendix J

Uncertainty Analysis

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT – WATER SUPPLY PLANNING UNCERTAINTIES

ABSTRACT

Water supply planning requires prediction of future conditions. Included are predictions of future water supply needs, and predictions of the environmental and cost consequences of alternative water supply development scenarios. Any and all attempts to predict future conditions will be imperfect. Therefore, uncertainty is encountered and introduced in each step of the planning process. This paper discusses the sources of uncertainty in the St. Johns River Water Management District Water 2020 planning process, major steps taken to minimize and manage uncertainty, the likely impact of the remaining uncertainty, and decision making implications.

Uncertainty in the Water 2020 planning process is associated with the prediction of future demands, the estimation of water supply deficits, and the estimation of costs for developing water supply options and alternatives.

The recommended approach to address this uncertainty is to; (1) identify sources of uncertainty, (2) define nature and effect of each source, (3) manage each source to minimize its effect to the extent possible, and (4) apply a flexible adaptive management approach to the long term planning and decision process.

WATER SUPPLY PLANNING GOALS AND MAJOR STEPS

The primary goal of water supply planning is to identify acceptable alternative approaches for meeting future water needs, including both human needs and natural system needs. The process requires estimation of all future water needs and the identification and evaluation of alternatives adequate to meet these needs.

In the Water 2020 process, major steps include:

- Estimation of future water supply needs
- Estimation of future water supply deficits
- Alternative development and evaluation
- Plan selection

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Water Supply Needs

Estimation of future water supply needs requires estimation of future population, agricultural activity, and commercial and industrial activities within the planning area, as well as within individual water supply service areas. It also requires estimation of the environmental and hydrologic conditions necessary to maintain healthy natural systems within lakes, rivers, springs, and wetlands.

Water Supply Deficits

Water supply source deficits are the difference between water supply needs and the quantity of water a source can supply. If an existing or preferred source cannot meet all future needs then alternative sources must be identified and evaluated.

Alternatives

Alternative development and evaluation involves identification of alternative sources of supply and alternative resource management and development techniques. Once identified, each alternative is evaluated based on, 1) its ability to meet all, or a portion of, future water supply needs (both human and natural system needs), 2) the total cost of the alternative, and 3) the relative implementability of the alternative.

Plan Selection

Once the alternative evaluation is complete certain alternatives will be identified as technically and environmentally feasible, while others may be identified as infeasible. In the Water 2020 process, all options and alternatives that have been determined to be technically and environmentally feasible will be included in the resulting water supply plan. The plan will be as inclusive as possible. However, the least cost acceptable solution will also be identified to help guide economically sound options development and facilities planning for individual water users.

WATER 2020 PLANNING TOOLS

The St. Johns River Water Management District (SJRWMD) Water 2020 process is an ambitious regional water supply planning initiative. It involves estimation of future water supply needs for one of the fastest growing regions in the State of Florida. It involves development of environmental, hydrologic, and water quality criteria to define natural system needs, and the development and evaluation of complex water supply management alternatives. All planning activities are conducted with public involvement and the participation of all affected and interested parties is actively solicited.

Because of the magnitude and complexity of the task at hand several tools have been developed to assist in the planning process, these include the following:

- Ground water flow models
- Ground water allocation models
- Economic optimization models

Each of these models is designed to help define and evaluate the nearly limitless number of options and alternatives available within the planning area. The ground water flow models provide a particularly important function. These models estimate the hydrologic and water quality response of the aquifer system to ground water withdrawals and provide the basic foundation for all other planning tools.

SOURCES OF UNCERTAINTY

Water Supply Needs (Future Demand Projections)

Projections of demand for water are typically based on knowledge of historical use and assumptions about the future. This is equally true for both complex demand models and for simple demand equations. In areas or times of stable growth, historical use has been found to be a reliable indicator of aggregate future demand. In the public water supply use category, areas which are "built-out" to their permitted or physical capacity are typical of this group. There are numerous examples of such areas in the District, particularly in municipalities located near the center cores of heavily urbanized metropolitan areas, as well as in mobile home parks or older planned developments. Knowledge of historical use is also found to be fairly reliable for the other major use categories, in areas or among crops which are well established.

Recently however, urban and commercial development in key counties within the District has occurred at such a rapid pace that it is difficult to predict with any great level of certainty when the rate of development will level off. In these areas, the uncertainty associated with demand projections for water is high, compared to the more stable, urbanized areas. However, projections must be made so that strategies can be develop to preserve the continued viability of water related resources while meeting the growing demands for water. Projections are made by SJRWMD using the best available information, but are recognized as having inherent uncertainty.

There are multiple issues of uncertainty associated with demand projections, many of which are interrelated. For instance, in the public supply category, there is uncertainty over the extent of geographic area that will fall within a given utility's service area. There is uncertainty over whether the composition of the aggregate demand will be altered significantly in favor of one or another sector (i.e., single vs. multi-family residential, commercial vs. residential). This uncertainty could impact total demand estimates and ratios of average day demand to maximum day demand made with current information. There is the unknown element of where or when new developments will occur, or even whether growth in known planned developments will progress as scheduled. In some areas, large planned developments have taken considerably longer to get off the ground, impacting the timing of increases in demand. Other uncertainties in the public supply category relate to the potential impact of water conserving technologies at both the utility and the user level, and the extent to which reuse of reclaimed water can diminish demand for potable water.

Public Supply

SJRWMD presented two sets of demand projections for public supply use in the 1998 Water Supply Assessment (WSA) (Vergara, 1998). One set, referred to as the *utility-based* projections, was developed by the public water supply utilities using methodologies similar to those used in the development of facility master plans. These include expectations of expansion into new service areas and planned development areas, growth in percent of population served within current service boundaries, and expectations of increased demand in other sectors such as the commercial and industrial sectors. SJRWMD developed a separate set of demand projections, referred to as the *population-based* projections, calculated using projections of population growth published by the Bureau of Economic and Business Research and historic estimates of per capita use. The District's projections assumed a constant per capita use throughout the planning period and no change in the composition of the aggregate demand.

The rate of growth in demand in the utility-based projections tends to be greater than in the population-based projections. This difference is interpreted by SJRWMD as an estimate of the range of uncertainty in demand projections. District-wide public supply use totaled 455 mgd in 1995. The 2020 utility-based projections total 863 mgd, and the population-based projections total 719 mgd; a difference of 144 mgd, or 20 percent.

Considering just the growth component of the 2020 public supply needs, the overall average ratio of utility to population based projection is 1.54, meaning that district-wide, utility-based growth projections are on average 54% higher than population-based projections. However, the ratios vary considerably among counties, ranging from a high of 3.4 in Volusia County to low of 0.8 in Duval County. The utility-based projections tend to be highest in the counties experiencing the most rapid and recent growth, such as in Flagler, Volusia, Lake, St. Johns, and Marion counties.

Agricultural Irrigation

In the agricultural use category, uncertainty is related more to the question of how much acreage will be in production than to crop irrigation requirements. District-wide agricultural water use is expected to change little during the planning period. Agricultural irrigation use totaled 587 mgd in 1995 and is projected to total 589 mgd in 2020, an insignificant difference. The major change will be redistribution of the irrigation demands as agricultural land use and cropping patterns change.

Agriculture has made great advances in the development and adoption of more efficient irrigation practices, and it is unlikely that significant changes in demand will occur in response to better irrigation management practices. There is some question over which of the several methods for estimating irrigation demand should be used in demand calculations, especially for citrus crops, which represent almost 45% of the total agricultural demand. Water use permit allocations issued by SJRWMD are based on 30-year mean Blaney-Criddle estimates of supplemental irrigation requirements. These tend to be high compared to measurements of actual use. For example, the Blaney-Criddle estimate for citrus supplemental irrigation requirements is roughly 60% higher on average than measurements of actual use. However, out of deference to the agricultural community, SJRWMD agreed to use the Blaney-Criddle estimates in the WSA for all crops except fern and potatoes. The irrigation requirements for the latter two crops were obtained from the District Benchmark Farms Project, with the approval of the agricultural community.

On average over all the crops and counties, the Blaney-Criddle estimates were approximately 20% higher than estimates of actual use reported in the District Annual Water Use Survey, which use measurements of actual rainfall for the year. This range is interpreted by SJRWMD as the range of uncertainty in estimates of crop supplemental irrigation requirements.

However, SJRWMD believes the greatest uncertainty in projecting agricultural demand lies in how much acreage will be in production, where production will occur, and which crops will be grown. Urbanization has taken a toll on agriculture, and is likely to continue to encroach on agricultural land found on the fringes of major urban centers. Increased market competition and erratic, damaging climate have also combined to make agriculture a less stable economic venture than in the past. An abrupt decline in a competitive market could stimulate interest in certain crops, or new higher value crops could be introduced. Higher value crops tend to require more reliable water sources, which would increase demand for irrigation water. Nothing on the horizon points to these events, however one can not rule them out.

Recreation (Golf Course Irrigation)

While it is certain that the golf course industry will continue to grow, it is difficult to determine how much of their irrigation needs will be obtained from ground or surface water sources as opposed to being obtained from reuse of reclaimed water or above ground retention ponds. District-wide golf course irrigation totaled 99 mgd in 1995, and is expected to increase to 156 mgd by 2020, a significant increase. Estimates of future demands for the golf course industry are acknowledged in the Water Supply Assessment to be among the less reliable of the demand categories, because of the uncertainty associated with the source. There is also uncertainty associated with the calculation of irrigation demand. The golf course industry has made significant progress in the adoption of better irrigation management, and many of the larger, more affluent courses now use computers to manage their irrigation. Greens are irrigated at a different rate than are roughs and fairways. Without knowing the ratio of greens to roughs and fairways, it is difficult to correctly assess the irrigation demand of an entire system.

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Commercial and Industrial

The historic trend in the commercial/industrial/institutional category has been one of relatively insignificant growth compared to growth in the public supply sector. However, there is evidence of considerable new activity in the commercial sector, again on the fringes of larger metropolitan areas. The uncertainty lies in how much or how long this rapid growth phase will last, and what its ultimate impact on demand will be. Currently these demands are expected to grow district-wide from 134 mgd (1995) to 147 mgd by 2020.

Thermoelectric Power Generation

Deregulation of the electric power utilities, expected to occur within a few years, has lead to significant uncertainty in projections of demand by thermoelectric power plants. No one has a clear understanding of how deregulation will change the current industry. However, the large majority of water used in this industry is saline surface water. It is unlikely that even significant changes in demand for electric power will impact demand for ground water by these few utilities.

Natural Systems Needs (Withdrawal Constraints)

Water withdrawal constraints applied in the Water 2020 planning process are of three types.

- Minimum flows and levels (MFLs)
- Native vegetation (primarily wetlands drawdown)
- Ground water quality

In aggregate the water withdrawal constraints define natural systems needs. That is, the purpose of the withdrawal constraints is to insure that a proposed ground water withdrawal scenario will protect natural systems, including the aquifer, and will not cause unacceptable harm. The water withdrawal constraints are designed to parallel consumptive use permitting criteria, as much as practical at a regional planning scale. The constraints applied in the Water 2020 planning process are described in detail in the *Water 2020 Constraints Handbook* (SJRWMD and CH2M HILL, 1998).

Minimum Flows and Levels (MFLs)

Minimum flows and levels are flow values or water levels below which significant harm to the water resource or ecology of the region would occur. MFLs are established for specific waterbodies by the SJRWMD Governing Board; based on results of site-specific investigations. The waterbodies are selected, and the MFLs are established, from a priority list also approved by the Governing Board.

Within the Water 2020 planning area, MFLs have been established for a number of lakes and certain streams including the Wekiva River. As a result, specific minimum mean flow values have been established for the major springs within the Wekiva River basin. These values are used as constraints in the ground water allocation and decision models to evaluate various water supply withdrawal scenarios and water supply alternatives. Where established, by the SJRWMD Governing Board, there is no institutional uncertainty associated with actual MFL values. That is, these values have been defined by Governing Board action. However, there can be some uncertainty that adopted MFLs do indeed adequately protect the intended resource. The District addresses this concern through monitoring of hydrologic and ecological conditions.

To protect lakes with established MFLs, the adopted minimum average lake level is used as a planning constraint. Using this constraint, the allowable change in average lake level is used as the maximum allowable change in the surficial aquifer water level, as determined by application of the regional ground water flow model. This approach implies that eventually a reduction in the average surficial aquifer level adjacent to a lake will result in an equal reduction in the average lake level.

Many lakes exist within the Water 2020 planning area and only a small sub-set has adopted MFLs at this time. SJRWMD plans to adopt MFLs for many additional lakes. For that reason, a generalized constraint, set equal to 0.5 feet of reduction in average lake level, was assumed for selected lakes not currently covered by adopted MFLs.

Similarly, many significant springs exist within the planning area that do not have adopted MLFs at this time. In order to protect these springs, and to provide for future MFLs determinations, a maximum reduction of 15 percent of historic median spring flow is used as the constraint for springs not currently covered by adopted MFLs.

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There is some uncertainty introduced by this procedure because actual adopted MFLs, for individual waterbodies, may vary from the assumed values. However, these surrogate planning values have been set based on experience in setting MFLs for lakes and springs, and the associated level of uncertainty, on a regional basis, should be rather small.

Native Vegetation

Changes in a wetland's hydrologic regime, including a lowering of the average water level, may affect the structure and species composition of the vegetative community. Changes in the basic vegetative community within a wetland is considered significant harm, according to current SJRWMD consumptive use permitting criteria, and is to be avoided. The wetland constraint establishes maximum drawdown values for specific wetland community types, which if exceeded are likely to result in the replacement of dominant vegetative species by those characteristic of drier community types.

Ten wetland types were identified and a specific maximum allowable drawdown limit was established for each. These limits range from 0.35 feet to 1.20 feet. This approach is very similar to the lake level MFLs approach and implies that eventually a reduction in the average surficial aquifer level adjacent to a wetland will result in an equal reduction in the average wetland water level.

Uncertainty Associated With Prediction of Lake Level and Wetlands Water Level Reductions

Uncertainty associated with prediction of lake level and wetland water level reductions is associated with the ability to accurately predict changes in surficial aquifer water levels and in the hydrologic linkage of the surface water feature (lake or wetland) with the surficial aquifer. Uncertainty associated with prediction of surficial aquifer water level changes is discussed in the ground water flow models section of this paper. This discussion focuses on uncertainty associated with the hydrologic linkage between lakes and wetlands and the surficial aquifer.

In the Water 2020 analysis, a change in average surficial aquifer water level is assumed to result in an equal change in average lake or wetland water level. This will be true only if there is a hydraulic connection between the surface water feature and the surficial aquifer, and where surface water inflow into the lake or wetland is negligible. The lake and wetlands drawdown constraint actually identifies areas where significant harm may occur, or has the opportunity to occur. Drawdown constraints can help identify areas where significant harm will likely occur, when care is taken in identification of lake and wetland control points most vulnerable to changes in surficial aquifer levels.

In general terms, lakes and wetlands can be divided into two types, based on tributary area characteristics. These are, *isolated* lakes and wetlands, and *flow through* lakes and wetlands, as illustrated in Figure 1. Isolated lakes and wetlands have little or no tributary area. The major source of inflow is direct rainfall and the major source of outflow is evapotranspiration and seepage to ground water (recharge to the surficial aquifer). Water levels in isolated systems that are hydraulically connected to the surficial aquifer, are likely to respond as assumed in the Water 2020 analysis. That is, a change in the average surficial aquifer water level will result in an equal change in the average lake or wetland water level.

Flow through lakes and wetlands, on the other hand, are part of larger surface water systems. They receive significant inflow from upstream tributary areas and discharge, or spillover, to downstream hydrologic systems. In this case, reduction in the surficial aquifer water levels beneath the wetland is unlikely to influence water levels within the wetland. Even if the rate of ground water seepage (i.e. recharge) is increased, it is likely that this effect will be reflected in reduced spillover volume rather than reduced water levels.

In summary, the uncertainty associated with changes in lake or wetlands water levels, resulting from changes in surficial aquifer water levels results primarily from uncertainty related to the quantity of direct surface water inflow received from upstream tributary area and the degree of hydraulic connection with the surficial aquifer.

Ground Water Quality

The Floridan aquifer was formed as a result of marine deposits and is composed of limestone and dolomites, with varying hydraulic properties. The uppermost parts of the aquifer generally contain fresh water and with depth water quality deteriorates, with concentration of chlorides and other dissolved constituents approaching that of seawater. Conceptually, fresh water exists as a lens that is underlain by denser highly mineralized brackish to saline water.

If fresh water is withdrawn at too great a rate, the underlying mineralized water can replace the fresh water and the aquifer water

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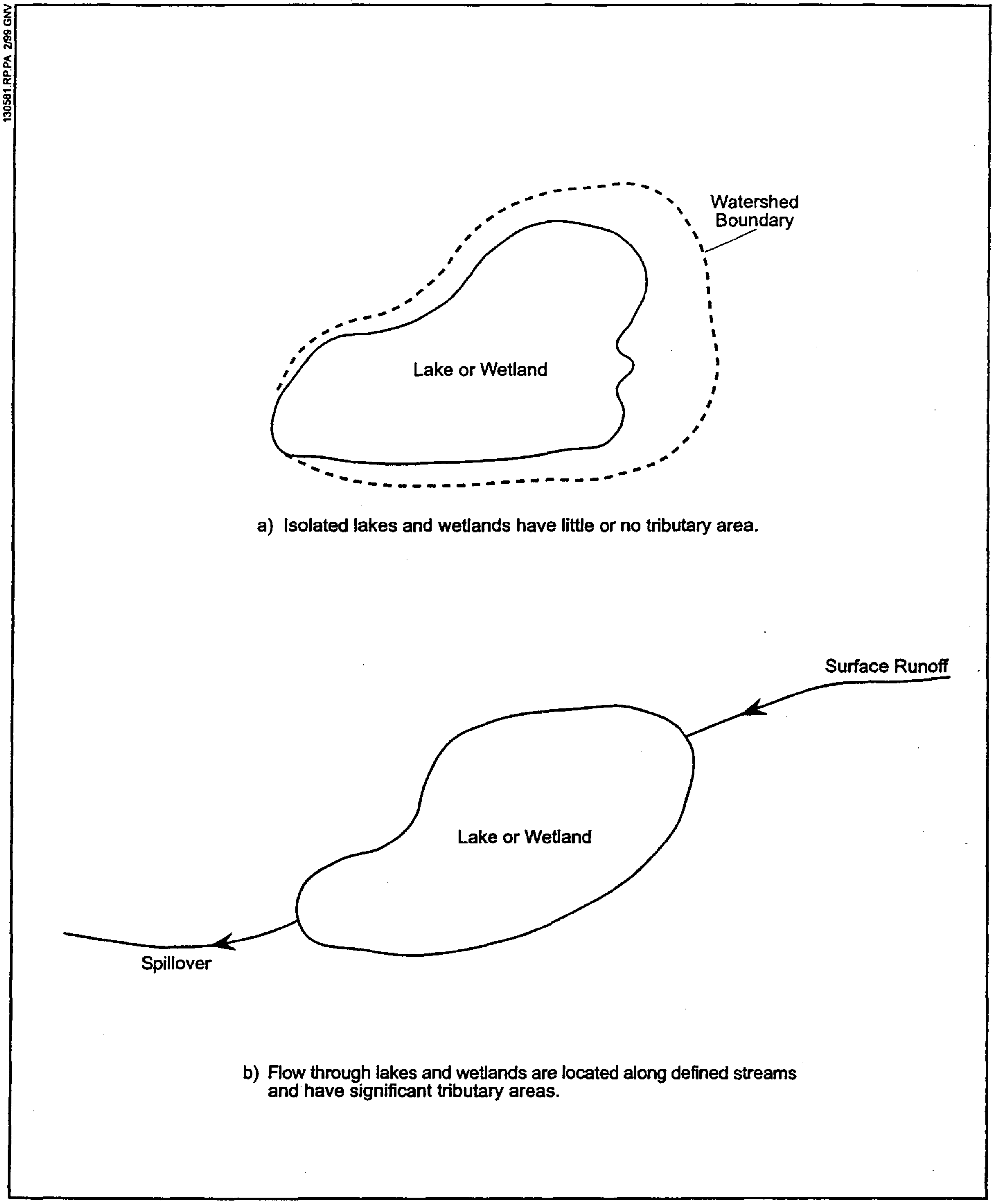

Figure 1. Isolated and Flow Through Lakes and Wetlands.

quality will deteriorate. The purpose of the water quality constraint is to protect the fresh water portion of the Floridan aquifer and to prevent deterioration in water quality that would result in exceedence of primary and/or secondary drinking water standards for dissolved constituents.

The water quality constraint used in the Water 2020 analysis is to allow increased withdrawals as long as the quality of the water withdrawn does not exceed the current drinking water standard of 250 parts per million (ppm) chloride concentration, or the existing chloride concentration if it is currently greater than 250 ppm.

Uncertainty associated with the application of this criterion is associated with the accuracy of the water quality data for the Floridan aquifer, and with prediction of water quality changes as a function of pumping rate and duration.

Ground Water Flow Models

Introduction

Ground water flow models are used to predict the long term response of the aquifer system to water supply withdrawal. Under natural conditions aquifers exist in a state of dynamic equilibrium. That is, over long periods of time recharge and discharge virtually balance. Water supply withdrawals upset the natural balance, and, if operated at near steady state conditions, will eventually generate a new balance. In the short term, water is withdrawn from storage. In the long term, this water is replaced in the aquifer by increased recharge, or a decrease in natural discharge, or a combination of both.

Ground water flow models are used to quantify these recharge/discharge/water supply withdrawal relationships for a given aquifer system and water supply withdrawal scenario. These models are mathematical representations of the physical system. As such, they produce estimates of aquifer response to water supply withdrawal, expressed in terms of changes in Floridan aquifer pressure (potentiometric surface elevation), surficial aquifer water levels, recharge rates, and spring flow discharges.

For the Water 2020 planning process, the important variables are those that significantly impact water supply withdrawal decision making. These are the change in surficial aquifer water levels beneath sensitive wetlands and changes in spring flow. The ground water flow models have been developed by SJRWMD to

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provide the best predictions currently available of the response of the Floridan and surficial aquifers to various water supply withdrawal scenarios.

There are several sources of model uncertainty including: limitations inherent in the available model computer codes; horizontal and vertical resolution (discretization) of the model framework; uncertainty in the model input data; and uncertainty in model calibration.

Ground Water Model Peer Review

Technical peer reviews of the SJRWMD East-Central, Volusia, and Northeast Florida ground water flow models were conducted in July 1998 and again in May 1999. Bob Faye (lead reviewer, recently retired USGS Southeast Region Ground Water Specialist), and other per review team members, found no major errors in model construction, assumptions, calibration, or execution. Generally, only minor improvements were suggested. Peer review findings were based on how accurately the models would be able to predict steady-state aquifer responses in the Upper and Lower Floridan aquifers – the pumped aquifers. Impacts on the surficial aquifer system and how net recharge to the surficial might be computed were discussed and reviewed but not to the same level of detail applied in the Floridan aquifer review. The focus of the peer review was primarily upon the Floridan aquifer system in the steady-state condition.

Soon after the peer reviews, SJRWMD found that the Decision/Optimization Model's determinations of source deficits would be driven almost entirely by surficial aquifer responses (projected water level declines in wetlands) to Floridan aquifer pumping in the year 2020. In some cases projected wetlands declines of only 0.35 feet will trigger a wetland constraint exceedance. It is problematic as to whether the ground water flow models, in their present formulation, are capable of accurately computing such a small change in water level in the surficial aquifer, especially projected that far out in time. Uncertainty in determining the upper confining bed leakance and surficial aquifer net recharge on a cell-by-cell basis are likely the largest sources of uncertainty in computing projected drawdown in wetlands.

Limitations in Model Computer Codes

A model computer code is used by the modeler to construct a ground water flow simulation model that is unique to a given area

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by inputting that area's relevant hydrologic parameters. The hydrologic parameters that describe the "real" system are applied within the framework of the model computer code and thereby result in a ground-water flow model.

The model code used in the Water 2020 models is MODFLOW -- a published, long-accepted, peer-reviewed, set of computer-coded instructions authored by Michael McDonald and Arlen Harbaugh (U.S. Geological Survey) that has been used throughout the United States for more than 10 years.

The ground water flow models will do a good job of predicting 2020 Floridan aquifer drawdowns and spring flows and will do a reasonably good job of identifying potential Floridan water quality trouble spots. However, the models' abilities to accurately predict 2020 drawdown in the surficial aquifer and in wetlands is hampered, in part, by limitations inherent in MODFLOW.

MODFLOW's governing equations accurately describe the ground water hydrology but only the Floridan spring flow and evapotranspiration (ET) portions of the surface-water hydrology can be explicitly computed in a reasonably straight forward manner. MODFLOW allows "capture" of water due to reduced Floridan spring flows caused by drawdown in the Floridan. Similarly, MODFLOW allows capture of water due to reduced ET as a result of water-table drawdown in the surficial aquifer. ET capture tends to offset water table drawdown as does surface water capture. However, MODFLOW's equations do not adequately describe "capture" of runoff (surface and subsurface) in response to drawdown in the surficial aquifer caused by changes in leakage rates through the confining beds that overlie the Upper Floridan aquifer.

MODFLOW's DRAIN or RIVER functions can compute changes in surface discharge from the surficial, but only if composite "fixed heads" and composite "DRAIN or RIVER coefficients" can be determined for individual model grid-cells. Those parameters are difficult to accurately determine, especially in grid cells that contain more than one ditch, stream, or river.

MODFLOW does not account for hydrologic connectivity of wetlands with other wetlands, streams, or with upland drainage, where such connectivity exists. Hence surface water routing is not simulated or quantified from one grid cell to another. This factor alone causes MODFLOW to overestimate drawdown in the surficial because it doesn't allow for surface water inflow to help offset the effects of local drawdown caused by increased downward leakage. MODFLOW's inability to adequately describe surface water capture (discussed previously) exacerbates the problem.

Horizontal and Vertical Discretization

Model horizontal grid discretization is large (2500 feet on each side) with respect to the size of certain types wetlands. For example, in the coastal zone of the District, many wetlands are elongate and coast-parallel, and, in many cases, their narrow dimensions are considerably smaller than 2500 feet. The geometry of wetlands (size, shape, grid-cell overlap) cannot be explicitly described in MODFLOW. Storage coefficients for the surficial aquifer must therefore be a composite value of that part of the grid cell that represents free-water surfaces and that which represents land surfaces. It is important to recognize that storage coefficient considerations will not affect the current steady-state models but it will have an effect on future transient simulations.

Horizontal grid discretization can affect the areal extent of the "deficits" computed by the Decision/Optimization model. For example, the deficit amount for a large grid cell will likely be larger than that for a smaller grid cell because it will likely contain more pumping sites. It is possible that the sheer number of affected deficit small grid cells might account for the same amount of deficit in a larger cell of the same equivalent area contained in the small cells. In a more highly discretized model, the tendency will be for a smaller total area to be included in deficit areas, hence some pumping cells could escape being labeled as deficit cells.

Vertical discretization refers to the number of aquifer and confining bed layers simulated. Aquifers simulated with only 1 layer cannot account for vertical anisotropy, that is, the tendency for horizontal aquifer hydraulic conductivities to be greater than their vertical hydraulic conductivities. Such anisotropy tends to allow water within the aquifer itself to more easily flow horizontally than vertically. Subdividing the aquifer vertically into several layers can account for vertical anisotropy by incorporating quasi-confining beds that couple the individual layers and offer resistance to vertical flow between the aquifer layers. Confining beds can be similarly discretized.

Vertical discretization of vertically anisotropic aquifers tends to simulate Floridan pumping cones of depression that are shallower and of larger aerial extent than would be the case if that aquifer was simulated as only one layer. Shallower, broader Floridan cones of depression would tend to reduce downward leakage from the surficial aquifer in the areas nearest the pumping centers but would tend to increase downward leakage near the outermost edges of the cone.

More highly discretized models result in models with more grid cells, sometimes many multiples of those contained in the current SJRWMD models. This presents data and computational problems that are beyond the scope of this discussion, but they are substantial.

Errors in Model Input Data

Bias and Random Errors

All model input data are subject to errors. There are essentially two types of error, bias error and random error. Bias error occurs when data are collected in such a manner that measurements are "biased" toward values that are consistently too high or too low. Bias error typically occurs when the measurement technique is flawed. Random error occurs when some of the measurements are too high while others are too low. Random errors are inherent in all measurements to one degree or another but tend to cancel out over a series of many measurements.

Measured model input data are carefully collected to eliminate bias errors and to minimize random errors to the extent possible. The following discussion lists major sources of random error in model input data.

Spring Flow Measurements

The accuracy of USGS measured Floridan aquifer spring flows are typically rated as "good," meaning the gaging technician believes the measurement is accurate to within 10% of its actual value. In recent years, springs in the District have been measured from 6 to 12 times per year. Prior to that time, most springs were measured only twice per year with Blue Spring (8 times/yr.) and Silver Spring (8 times/yr. and computed daily discharge) being the exceptions. The errors in discharge measurements are random errors and are not believed to contain bias error. Therefore, over a period of a year which contains 8 time-weighted discharge measurements, the random errors should tend to balance out and thus leave a reasonably accurate determination of the average discharge for that year. Multi-year average discharges are even more accurate.

Rainfall Measurements

Rainfall in Florida is highly variable, both temporally and spatially. SJRWMD must assume that the gauged rainfall data are accurate. Theissen polygons or other methods are used to interpolate between stations.

Land Surface Elevations

Land-surface altitudes are gleaned from USGS topographic maps or from the USGS topographic databases. In either case, those data might be considered the "gold" standard for data derived by indirect means such as photogrammetry augmented by known control points such as surveyed benchmarks. Even so, the USGS rates their interpolated topographic data as accurate to within plus or minus one-half a contour interval (+- 2.5 feet for 1:24,000, 7.5' quadrangle map sheets). It is believed that the USGS understates the accuracy of their maps. Nevertheless, some error exists even here.

Water Level Measurements

Water-level measurements in Floridan aquifer wells are used to develop potentiometric surface data points from which potentiometric maps are constructed. Almost all water-level measurements are collected with an accuracy of 0.01 foot. Potentiometric map data points are fixed in space and time but the potentiometric maps are constructed from numerous data that were not all collected at the same time. Thus, the maps represent a "snapshot" in time that may actually span 1 or more weeks. Further, the data at the data points are interpolated in space by either an experienced hydrologist or by a computer. Regardless of which does the best job, there is some error inherent in the potentiometric maps.

Thickness of Geologic Strata

There is uncertainty in determining aquifer and confining bed thicknesses. Such information is obtained from geologic data gathered from individual wells or test holes and then, by interpolation, rendered into areal maps.

Transmissivity and Leakance

Floridan aquifer transmissivity (T) and upper confining bed leakance (L) are typically first rough-estimated using available aquifer-test data and are then fine-tuned as part of the iterative calibration process. This process is aided in spring basins where the actual ground-water flux is known in terms of gaged spring flow. Calibrated T's and L's are typically within +- 20% to 30%.

Recharge

Uncertainty in net recharge to the surficial aquifer is derived from uncertainties in: rainfall data; estimates of run-off (surface and sub-surface) to streams and ditches; evapotranspiration rates; and estimates of recharge from septic systems, rapid infiltration basins, recharge due to lawn and agricultural irrigation, and other types of surface and subsurface applications.

Model Calibration Errors

In brief, the steady-state model calibration process consists of adjusting the "soft" input parameters of Floridan aquifer Transmissivities (T) and upper confining bed leakance coefficients (L) so the model output response due to pumping or other imposed hydraulic stresses matches the "hard" data such as observed aquifer heads and spring flows. An important aspect of the initial calibration effort consists of determining the proper boundary conditions for the model.

Nonsteady-state calibration typically occurs after steady-state calibration is accomplished. Here, the previously determined boundary condition coefficients, T's, and L's are held unchanged and aquifer and confining bed storage coefficients are adjusted to match aquifer responses due to pumping or other hydraulic stresses observed over a given period of time.

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The steady-state calibration process typically yields non-unique "working" combinations of T and L for individual grid cells. These working combinations can yield calibrated Floridan aquifer responses within a few percent even though the individual T's and L's may be considerably less accurate. This is adequate for predicting steady-state aquifer responses in the Floridan but the errors in L directly affect the leakage rates to and from the surficial and, hence, can cause errors in the computed drawdowns in the surficial.

Models are typically considered calibrated if the computed Floridan aquifer heads match observed heads within approximately 2 feet (+,-), whereas the wetland drawdown constraint can be as small as 0.35 foot. It is unlikely that the accuracy of the computed wetlands drawdown in the less well calibrated surficial aquifer exceeds the calibration criterion for the calibrated Floridan aquifer where fluxes are reasonably well known.

There may be considerable lag between the time that 2020 drawdowns are seen in the Upper Floridan and when they are seen in the surficial aquifer. Where Upper Floridan confining beds are thin or permeable, drawdowns in the surficial will be reasonably contemporaneous with those in the Upper Floridan. Where confining beds are thick or less permeable, drawdowns in the surficial can lag those in the Upper Floridan by several years. The steady-state versions of the models will not account for lag but the transient versions will be able to simulate drawdown in wetlands as a function of time.

Water Allocation and Economic Optimization Models

The water allocation model and the decision model are closely related linear programming applications. These models are based on proven mathematical optimization algorithms. The water allocation model duplicates the hydrologic response predicted by the ground water flow models and is designed to optimize ground water withdrawals given aquifer response and water withdrawal constraints. The decision model is an extension of the ground water allocation model and is designed to identify least cost alternative water sources to meet the identified water supply deficits.

The water allocation and decision models rely on input data provided by other aspects of the planning process, including ground water flow model results and the withdrawal constraints. All uncertainties associated with these planning steps are carried forward, but no new significant sources of uncertainty are introduced by proper application of the ground water allocation model. With accurate input data these models will always provide accurate results.

The decision model does require life cycle cost estimates associated with development of the alternative water supplies considered. Cost estimates are developed at the cost curve or conceptual planning level of accuracy. As such there is a significant degree of uncertainty associated with any individual facility cost estimate. For example, the estimated cost of a surface water treatment plant located on Lake Griffin, or a given water transmission main could be in error as much as 50 percent. This is because at this regional planning scale, exact sites or routes have not been identified and site specific conditions cannot be accounted for. At this level of planning it is important that the relative differences in cost among alternatives be accurately represented, and that the costs for all alternatives be developed on a consistent and comparable basis.

UNCERTAINTY MANAGEMENT

Uncertainty cannot be avoided, but to a great extent it can be managed. Major areas of uncertainty, previously discussed, include the accuracy of future water supply needs projections, uncertainties associated with the application of lake and wetland drawdown constraints, and the accuracy of predicted surficial aquifer water level changes using existing models and hydrogeologic data.

Water Use Projections

The major area of uncertainty associated with the 2020 water used projection is the accuracy of the projected growth in public supply demand. Growth in public supply demands represents the vast majority of the expected growth in water use by 2020. Two methods were used to develop 2020 public supply needs estimates; the first is based on projections supplied by the individual public supply utilities; and the second is based on expected population growth, using growth estimates published by the Bureau of Economic and Business Research (BEBR) and historic per capita use. The first set of estimates is referred to as the *utility-based projections* and the second set is referred to as the *population-based projections*.

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There is considerable variance between the two sets of water use projections. District-wide, actual 1995 public supply use totaled 455 mgd. Projected 2020 public supply needs total 863 mgd, using the utility-based projections, and 719 mgd using the population-based projections, a difference of 144 mgd, or 20 percent. This difference is a measure of the uncertainty associated with 2020 public supply demands within SJRWMD.

Although this level of public supply demand uncertainty is significant, its impact on the planning process relates primarily to the planning horizon. It has no impact on the water supply alternatives available to meet future needs.

The relationship between water use projections and the planning horizon is illustrated in Figure 2. Basically two choices are available. The first, (A), is to base the water supply plan on meeting the utility-based 2020 needs projections, and the second, (B), is to base the water supply plan on meeting the population-based 2020 needs projections.

If we chose A, and are correct, then the water supply plan and the planning horizon will match. That is, the facilities identified in the Water 2020 plan will be needed to meet 2020 demands. If we chose A and B is correct, then the water supply plan will not match the planning horizon. In this case, the facilities identified in the plan would not be fully needed until approximately 2034. This means that additional time would be available for plan implementation.

Also, if we chose B and are correct, the water supply plan and the planning horizon will again match. However, if we chose B and A is correct, then the water supply plan will not match the planning horizon and the facilities identified in the plan would not be sufficient to meet 2020 needs. In fact, the identified facilities would need to be operational by approximately 2011, and an additional 144 mgd of water supply, treatment and transport system capacity would need to identified and constructed to meet the actual 2020 needs.

Clearly the best choice is to base this initial water supply plan on the larger utility-based demand projections. The worst case scenario is that the facilities identified in the plan would not be fully needed in 2020 and some additional time would be available to implement the plan. If on the other hand we chose to base the initial water supply plan on the population-based estimates and

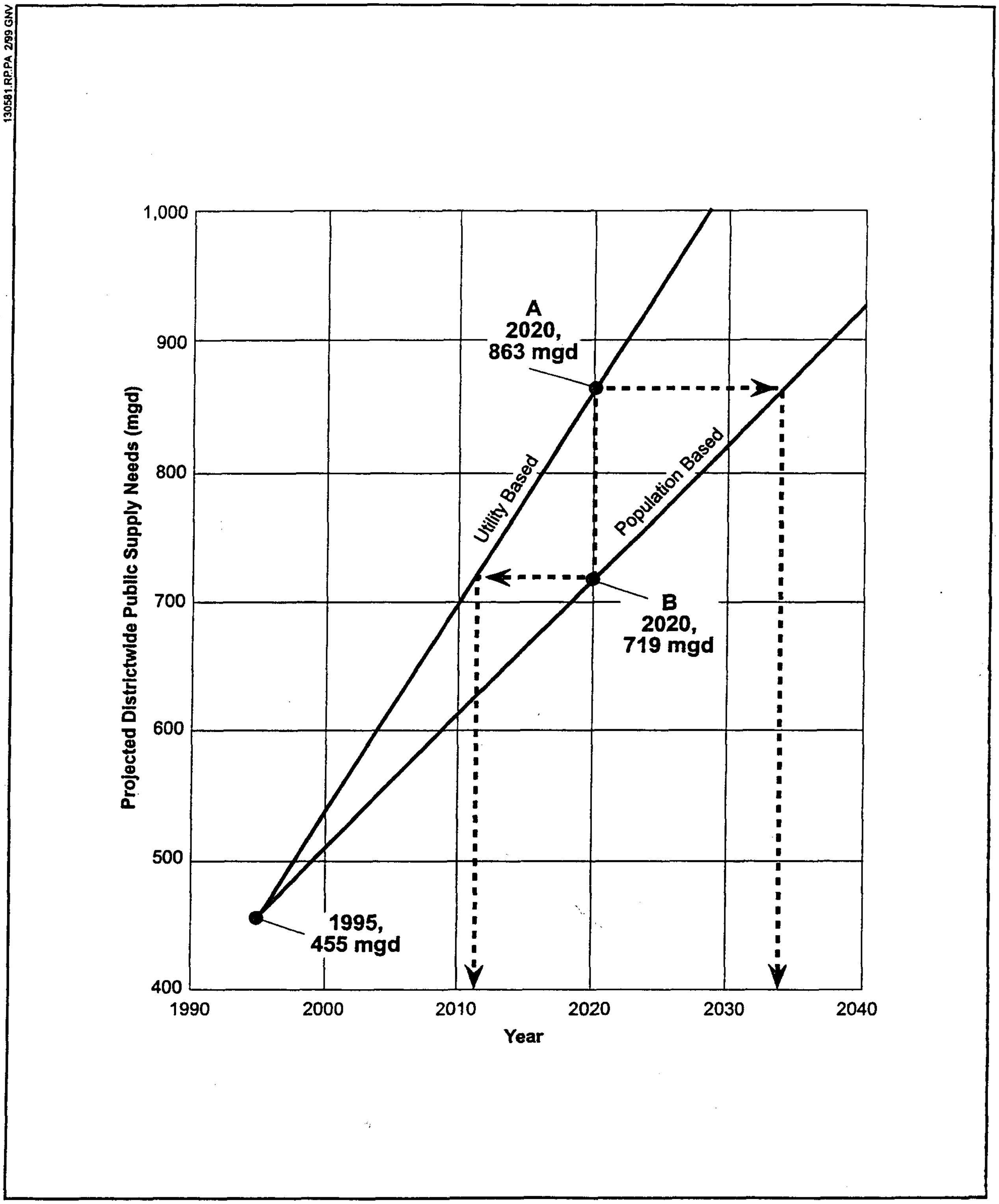

Figure 2. Effect of Public Supply Uncertainty on Planning Horizon.

these projections proved to be in error, identified facilities would be inadequate to meet the 2020 need, and little time would be available to plan, design, and construct adequate facilities to meet the shortfall.

Future iterations of the water supply plan should strive to identify the exact source of difference between the utility-based and population-based water use projections in an effort to narrow the range of uncertainty. It is likely that some differences will always exist and it is also likely that planning for the higher estimates will be the most prudent choice.

Application of Lake and Wetlands Drawdown Constraints

If the average water level of lakes and wetlands are reduced sufficiently, dominant vegetative patterns will change and such change is consider significant harm under current SJRWMD water use permitting criteria. The relationship between reduction in long term average water levels and changes in vegetation type is fairly well known. However, water levels in lakes and wetlands respond to many variables and only one, surficial aquifer water level, is effected by ground water pumping. Other important hydrologic variables include the lake or wetlands tributary area size, soils type, land use, and other characteristics that may influence the lake or wetland water budget. Therefore, a level of uncertainty exists related to the cause and effect relationship between reduction in surficial aquifer water levels and resulting reduction in water levels in nearby lakes and wetlands as previously discussed. This uncertainty is managed, in the planning process, by careful selection of the lakes and wetlands used as control points in the decision model.

The control points used in the decision model were chosen to geographically cover the entire planning area and to represent those lakes and wetlands most likely to be affected by reductions in surficial aquifer water levels. The selected control points are primarily isolated lakes and wetlands as illustrated on Figure 1. Lakes or wetlands that are directly connected to larger surface water hydrologic systems were not chosen as control points because reduction in surficial aquifer water levels near these flow through systems is unlikely to result in reduction in the lake or wetland water levels. That is, only sensitive isolated lakes and wetlands were used as water supply withdrawal control points in the application of the decision model.

Because the response of individual lakes or wetlands cannot be accurately predicted at this regional planning scale the results of the ground water allocation and decision models are open to some interpretation. Specifically, an exceedance of the drawdown constraint at a given lake or wetland control point does not necessarily mean that the lake or wetland drawdown limit will be exceeded, it means that the limit may be exceeded, depending on effects of other hydrologic variables not directly included in the analysis. Without a doubt, a decrease in the surficial aquifer level beneath a lake or wetland will increase the potential for seepage (i.e. recharge) from the surface water body to the aquifer. However, the actual magnitude of the increased seepage will depend on the degree of hydraulic connection between the two hydrologic systems, and surface water inflow, as well as the magnitude of surficial aquifer drawdown.

Ground Water Flow Models

The most significant uncertainty associated with application of the ground water flow models is the accuracy of predicted of surficial aquifer water levels. Although many ground water modeling uncertainties exist, as previously discussed, this is the most important for two reasons. First, water supply deficits are controlled, for the most part, by the wetlands drawdown constraint. That is, wetland drawdown considerations control the total volume of water that can be withdrawn from the aquifer without causing unacceptable harm. This constraint is more important to limiting water supply withdrawal from the Floridan aquifer, than the MFLs constraints (including springflow concerns), and the Floridan aquifer water quality constraint. Second, prediction of surficial aquifer water levels is one of the least accurate of the parameters predicted by the ground water flow models.

The uncertainty associated with the surficial aquifer water level projections is mitigated somewhat by the fact that the absolute accuracy of the projected surficial aquifer water levels is not as important as the predicted change in water levels due to an increase in water supply withdrawal. That is, the important variable, for water supply decision making, is the change in predicted water levels, rather that the exact value of the predicted water level. It is generally believed that the range of uncertainty associated with prediction of surficial water level change is

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considerably less than the uncertainty associated with prediction of exact surficial water level elevations.

Although many factors influence surficial aquifer drawdown resulting from a given Floridan aquifer drawdown, the most important, currently included in the model, is likely the leakance value (L), which is an indicator of the degree of hydraulic connection between the surficial aquifer and the Floridan aquifer. Very high leakance indicates a well connected system and a very low leakance indicates nearly independent hydrologic systems. Therefore, where leakance is high the change in surficial aquifer levels, due to increased Floridan aquifer withdrawals, will be greater than where leakance is low, all else being equal.

As previously discussed leakance is a calibration parameter. Reasonable leakance (L) and transmissivity (T) values are assumed and these values are adjusted until predicted potentiometric elevations match observed potentiometric elevations, within an allowable range. Under theses conditions, the model is considered *calibrated*. There is however, a range of leakance values that could be used in the model and still meet calibration criteria.

In an effort to quantify the degree of uncertainty associated with predicted change in surficial aquifer water levels, the leakance values were adjusted, within the range of model calibration, to determine the resulting change in predicted surficial aquifer water levels and in estimated 2020 water supply deficits. The adjustment was a one-way adjustment, assessing only the effects of decreasing the leakance. This analysis was carried through the entire water supply plan alternative analysis for Work Groups I and II, to determine the sensitivity of the water supply alternatives to uncertainty associated with surficial aquifer leakance. In each case, the water supply alternative was evaluated based on the unadjusted wetlands constraints. Also in each case, the water supply alternative was evaluated based on the wetland constraint plus an allowance to account for the uncertainty in over-estimating the surficial water level response resulting from uncertainty in aquifer leakance. Results for both cases are presented and discussed for each alternative evaluated.

It has also been noted that there is uncertainty related to the response time or lag involved between the time a water supply withdrawal occurs and the time a response is observed in the surficial aquifer and affected wetlands. This lag time is important for interpretation of monitoring results but it has no impact on water supply planning or decision making. This is because eventually, given sufficient time, the surficial aquifer will respond to lowered Floridan aquifer potentiometric pressure and sensitive wetlands will be impacted. Because the Water 2020 planning effort strives to prevent these adverse impacts from occurring, the uncertainty in lag time does not impact the decision making process.

Planning Level Cost Estimates

All cost estimates used in the decision model, and developed in the Water 2020 plan, are conceptual planning level cost estimates. As such any individual estimate, for a given treatment plant or transport facility for example, may be in error by as much as 50 percent. This is essentially true for all regional planning activities not just Water 2020.

The accuracy of the individual cost estimates are however not as important to the decision process as the relative life cycle cost among the alternative water supply sources. That is, it is important for the costs associated with various water supply sources such as fresh ground water, brackish ground water, and surface water from the St. Johns River, to be accurate relative to each other. That is, if all life cycle cost estimates are say 25 percent high or 25 percent low, the same solution will be identified by the optimization analysis and therefore this uncertainty is not important to the decision process.

Steps were take to ensure that all conceptual planning level life cycle cost estimates used in the Water 2020 planning process were compatible and comparable. Early in the process a consistent set of cost estimating and economic criteria were established so that all cost estimates were based on the same set of assumptions. In this manner the uncertainty associated with conceptual planning level cost estimates was minimized.

DECISION MAKING IMPLICATIONS

It is acknowledged that there are considerable areas of uncertainty in the regional water supply planning process. Each source of uncertainty has relative degrees of importance and can often be minimized, or at least managed.

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Planning uncertainty will never be fully eliminated. Therefore, waiting until all is known is not an option. The best decisions possible must be made based on our current understanding, recognizing that this understanding may change in the future.

Water supply planning and decision making must proceed on a regional scale. Individual (user-by-user) decision making is no longer a valid approach to long term water supply decision making, and resource management, for large portions of SJRWMD. This is definitely true for Work Groups Areas I, II and V. For example, considering the East-Central Florida area (Work Group I) the Floridan aquifer currently provides a single source water supply with approximately 1,000 public supply wells in operation. Regional interactions of the individual withdrawals must be considered in both planning and permitting. Individual wellfields cannot be examined in isolation if adverse impacts are to be avoided, and adequate affordable water supplies are to be developed.

Although not perfect, the water supply planning tools and procedures developed by SJRWMD for the Water 2020 planning process are the best water supply planning tools currently available for the planning area. These tools and procedures provide the most comprehensive regional scale water supply planning approach currently available.

We must recognize and acknowledge the limits of the current analysis. An exact upper limit on Floridan aquifer withdrawal cannot be established at this time. However, water supply alternatives based on the lower end of the maximum withdrawal estimates will present less resource impact risk than will water supply alternatives based on the higher end of the maximum withdrawal estimates. Cost follows an inverse relationship. The lower risk alternatives, that involve development of alternative water supplies involve higher costs. Therefore decision making will involve a risk versus cost assessment.

New institutional relationships may be needed to implement regional solutions. At the very least a significant level of cooperation will be needed among the individual public supply utilities currently operating within the priority water resource caution area.

This is the first SJRWMD regional water supply planning initiative. It is a beginning, not an end. This water supply plan will be updated at least every 5 years, possibly more often, and continuous

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upgrades and revisions to the planning tools will be necessary to improve the accuracy and reduce the uncertainty in future updates. Therefore, it is important to maintain flexibility in the process and to the greatest extent possible maximize choices available and to characterize the choices in terms of relative cost and risk. The worst case scenario of course is to construct high risk water supply facilities that later have to be abandoned because of unacceptable environmental impacts.

It is clear that an adaptive management approach will be needed both for long term resource monitoring and management and to provide the new information necessary to improve future prediction and to decrease uncertainty.

REFERENCES

St. Johns River Water Management District and CH2M HILL. 1998. *Water 2020 Constraints Handbook.* CH2M HILL . Gainesville, FL.

Vergara, B.A. 1998. *Water Supply Assessment 1998 St. Johns River Water Management District.* Technical Publication SJ98-2. St. Johns River Water Management District. Palatka, FL.

Appendix K

Memorandum of Understanding Between the St. Johns River Water Management District, the South Florida Water Management District, and the Southwest Florida Water Management District

MEMORANDUM OF UNDERSTANDING
BETWEEN
ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
AND
SOUTH FLORIDA WATER MANAGEMENT DISTRICT
AND
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

The *St. Johns River Water Management District* ("St. Johns"), the *South Florida Water Management District* ("South Florida"), and the *Southwest Florida Water Management District* ("Southwest Florida"), enter into this *Memorandum of Understanding* to accomplish the goals and purposes stated below.

Whereas St. Johns, South Florida, and Southwest Florida are legislatively created regional agencies of the state with abutting geographic boundaries;

Whereas St. Johns, South Florida, and Southwest Florida each have existing programs to assess hydrologic conditions, to plan for future water supply needs, to regulate consumptive uses of water, and to declare water shortages within their boundaries;

Whereas St. Johns, South Florida, and Southwest Florida desire to cooperate in the areas of water resource investigation, water supply planning, water use regulation, and water shortage management where such cooperation is prudent and efficient;

Whereas St. Johns, South Florida, and Southwest Florida find that cooperation in the areas of water resource investigation, planning, water use regulation and water shortage management is prudent and efficient in situations arising outside the context of Section 373.2295, Florida Statutes, (F.S.) *Interdistrict transfers of groundwater*,

Now therefore, St. Johns, South Florida, and Southwest Florida (collectively referred to hereinafter as the Districts), agree as follows:

This Memorandum of Understanding addresses interdistrict coordination in five subject areas, including:

Part I - Water Resource Investigations,
Part II - Water Supply Planning,
Part III - Water Use Regulation,
Part IV - Water Shortage Management, and
Part V - General Provisions.

For each subject area, a geographic area within which coordination will be applicable is described and coordination procedures are outlined.

I. Water Resource Investigations

Geographic Area: The area to be considered for water resource investigation coordination is the entirety of each of the Districts.

Coordination between districts will involve: (A) collection and management of hydrologic data and (B) data modeling.

A. Data Collection and Management - each of the districts has ongoing hydrologic data collection and management programs. These programs collect data on rainfall, evapotranspiration, surface water levels and flows, ground water levels, aquifer characteristics, water quality and water use, among other parameters. By improving consistency and exploring areas for improved efficiency and effectiveness, coordination between the districts can be beneficial to each district, as well as third parties which utilize district hydrologic data.

In order to increase efficiency and avoid unnecessary duplication of efforts, the Districts agree to cooperate as follows:

1. Coordination will be accomplished by a team of personnel from the Districts. The team shall cooperate closely with the Interdistrict Data Collection Focus Group and shall include technical staff from each district familiar with hydrologic data collection, databases, and GIS development, including at least one Data Collection Focus Group member from each district.

2. Hydrologic data contained within existing and/or future databases will be organized and sufficiently documented so that data can be easily shared by personnel of the Districts. Specific examples are listed below:

- Hydrologic, geologic, and water use permit information will be stored in databases that are available for access by appropriate district personnel.
- Geographic Information System (GIS) coverages will be shared.

Development and extension of hydrologic databases and networks will be coordinated by personnel of the Districts', with the goal being the development of a comprehensive water resources observation network.

3. Each of the districts has a number of hydrologic investigations and modeling efforts which extend beyond the boundaries of that particular district in order to encompass the entire water resource unit (e.g., an entire aquifer system) and/or to address factors which may have impacts upon the resource under investigation (e.g., water withdrawals outside of, but

influencing, a ground or surface water resource). The Districts agree to share all available existing hydrologic data, including but not limited to permitted withdrawal locations, amounts, water use types, and other related information in a form compatible with model requirements, as well as to coordinate in the collection of additional hydrologic data determined to be necessary for specific modeling purposes, for such hydrologic investigations which cross district boundaries.

4. The Districts will coordinate in the acquisition of data collection equipment and services in an effort to ensure compatibility and achieve monetary savings.

B. Hydrologic Modeling - A number of modeling efforts initiated by a particular district may transcend that district's boundaries and encompass a part of an adjacent district. It is necessary in such cases for the Districts to coordinate their respective hydrologic modeling efforts. Coordination will be aimed at assuring consistency in model development, data sets and results where model boundaries coincide or overlap.

In order to accomplish this coordination, the Districts agree to cooperate as follows:

1. Coordination will be accomplished by a team of personnel from the Districts comprised of staff members who are knowledgeable of the modeling efforts at their respective districts. The team shall meet at a minimum twice per year to review progress on specific modeling efforts and to seek input from other district team members. This coordination is in addition to coordination that may be ongoing between respective district staff involved in specific modeling efforts.

2. Coordination will include model conceptualization, selection of data points and parameters, review of calibration runs, and review of preliminary and final results, as appropriate. The Districts agree to subject each applicable modeling effort to peer review by appropriate staff from each district prior to finalization, with the common goal of a uniform interpretation. This coordination may include methodologies used to produce rainfall intensity/frequency/duration maps. Where differences result in discrepancies between model results in the vicinity of the Districts' common boundaries, the Districts shall seek to achieve consistency.

II. Water Supply Planning

Pursuant to Section 373.036(2), F.S., the Districts must, as a part of their District Water Management Plans, identify one or more water supply planning regions that singly or together encompass the entire district and prepare a Districtwide Water Supply Assessment. As part of the planning effort, the Districts are initiating water supply planning for their entire district or based upon the results of the assessments, limiting the planning area to areas where " *sources of water are not adequate for the planning period to supply water for all existing and projected reasonable-beneficial uses and to sustain the water resources and related natural systems*" subsection (373.0361(1), F.S.).

The purpose of this section is to seek consistency and coordination, as appropriate, among the Districts in these respective water supply planning initiatives. This consistency is particularly important within those local governments encompassed by more than one district as well as in other common boundary areas.

Geographic Area: The areas within which water supply planning coordination will be considered include all appropriate water supply planning regions or portions thereof within the Districts.

A. Coordination will be accomplished by a team of personnel from the Districts comprised of staff members who are knowledgeable of the water supply planning efforts at their respective district. The team shall meet at a minimum twice per year to review progress on water supply planning efforts and to seek input from other district team members.

B. In order to achieve consistency in water supply planning, the Districts agree to the following:

1. The Districts will make water use projections for their respective areas following the recommendations of the interdistrict Water Planning Coordination Group (created by DEP pursuant to Executive Order 96-297), Water Demand Projections Subcommittee, as reflected in its Final Report, dated April, 1998, as may be amended from time to time by consensus of the Districts. For all local governments divided by the Districts' boundaries, the appropriate districts will agree upon consistent population and water use estimates and projections.

2. The Districts will work together to jointly identify factors for consideration by each district when determining that regional water supply planning must be coordinated within an area and to develop consistent methods to be used to delineate the extent of the area for which planning will be coordinated.

3. When the Districts have determined that regional water supply planning must be coordinated within an area, the Districts agree to coordinate in the identification of water supply options for that area. The Districts will develop a strategy for performance of investigations of traditional and alternative water supply options and shall also cooperate in the development of joint implementation strategies for the identified water supply options.

4. When one of the Districts timely receives a complete application for funding of an alternative water supply project under subsection 373.1961(2), F.S. the district receiving the application shall consider as one factor, under its subsection 373.1961(2), F.S. program guidelines, another district's approval of funding for the same or a related alternative water supply project under its subsection 373.1961(2), F.S. program. This provision shall not obligate either district to provide funding for a water supply project located outside its boundaries.

C. In order to achieve consistency in water supply planning-related technical assistance to local governments, the Districts agree to do the following:

1. The Districts will coordinate with each other in their review of comprehensive plan amendments which involve any water supply issues which could impact another district, as follows:

a. The district receiving notification of a proposed comprehensive plan amendment involving any water supply issues which could impact another district, will notify the other district of receipt of the notice of the proposed change, and if requested, forward a copy of the pertinent information to the other district(s) upon receipt of the proposed amendment.

b. The Districts will coordinate in the preparation of comments to the Florida Department of Community Affairs (DCA) on comprehensive plan amendments of interest to each district. The district in which the change is proposed shall forward preliminary comments to the other district(s) in as timely a manner as possible prior to the date comments are due to the DCA. The district(s) receiving those preliminary comments shall respond with any recommended revisions or additional concerns in as timely a manner as possible.

c. In cases where a proposed amendment to a policy or land use designation directly involves lands which are divided by district boundaries, the appropriate districts will coordinate in developing their comments to the DCA, with each district forwarding their own comments to DCA. The coordination should consist of discussions between the districts and draft comments forwarded to each other in as timely a manner as possible prior to the deadline to send comments to DCA.

2. The Districts will coordinate in the provision of technical assistance to the local governments which are divided by water management district boundaries through the preparation and future updating of the Integrated Plan portions of each district's District Water Management Plan for each such county. Pursuant to this Memorandum of Understanding, the Districts agree to the division of responsibilities for the preparation and updating of these Integrated Plans as shown in Exhibit 1. In addition, the Districts agree to discuss major water resource projects and data with each other prior to delivery of that information to the affected local governments.

III. Water Use Regulation

Geographic Area: The area to be considered for water use regulation coordination purposes generally includes a five mile distance on either side of joint district boundaries (see Exhibit 2). In addition, for purposes of coordination between the SJRWMD and SFWMD, the area shall also include those parts of Osceola and Orange counties that lie within the boundaries of the respective districts.

A. Coordination will be accomplished by a team of personnel from the Districts comprised of staff members who are knowledgeable of the water use regulation efforts at their respective districts. The team shall meet at a minimum twice per year to review progress on water supply planning efforts and to seek input from other district team members.

B. In order to achieve a comprehensive review of proposed withdrawals of water within one water management district which may have impacts within one or more of the other districts, and in an effort to better protect the water resources of the state, within the geographic area defined above and delineated on Exhibit 2 as "water use regulation coordination area", the staff of the Districts will do the following for all proposed uses of groundwater from the Floridan aquifer equal to or greater than 1,000,000 gallons per day:

1. Whenever possible, the Districts shall notify each other prior to pre-application meetings and when requested, shall arrange a joint pre-application meeting between the affected district(s) and the applicant.

2. A copy of the Notice of Receipt of Application shall be provided to the commenting district(s), preferably no later than 7 days following actual receipt of the application. A copy of the application and supporting technical information together with the name and phone number of the reviewing hydrologist shall be included with the Notice.

3. Comments on the application should be provided to the reviewing district no later than 21 days following receipt of the application by the commenting district(s). The comments shall indicate whether a copy of subsequently submitted compliance information required under the permit is desired.

4. A copy of any correspondence between the reviewing district and the applicant should be provided to the commenting district(s) contemporaneously with either mailing or receipt. If any additional comments are necessitated by receipt of such correspondence, the commenting district(s) shall communicate these in as timely a manner as possible.

5. If comments are received from another district, these comments should be incorporated in any subsequent requests for additional information or in the staff report issued by the reviewing district, as appropriate and consistent with the reviewing district's rules.

6. A copy of the Notice of Intended or Proposed Agency Action, whichever is appropriate to the reviewing district, should be provided to the commenting district(s) contemporaneously with its provision to the applicant.

The Districts each agree to forward to the others' designated regulation contact person copies of staff reports or abstracts and actual permits (if substantially different from the staff recommendation) for all appropriate applications requesting uses of water equal to or greater than 100,000 gallons per day on an average annual basis. These documents should be provided contemporaneously with their provision to applicants.

The Districts each agree to forward monthly to the others' designated regulation contact person a copy of the Regulatory agenda, as revised at the Governing Board meeting. The agendas should be provided no later than 30 days after the Governing Board meeting date.

IV. Water Shortage Management

Geographic Area: The area to be included for water shortage management coordination is depicted in Exhibit 3.

In order to enhance the effectiveness of current and future water shortage declarations and to enhance interdistrict efficiency by avoiding unnecessary duplication of related efforts, the Districts agree to cooperate as follows:

A. Coordination will be accomplished by a team of personnel from the Districts who are familiar with each district's respective water shortage programs. This staff team will meet on a regular and as-needed basis.

B. Each district will provide the following information to the two other districts: a detailed description of the factors currently monitored to determine whether to declare a water shortage (i.e., specific hydrologic conditions, water demand, and other data), a schedule which indicates the frequency at which each of these factors is collected and analyzed, and a description of the committee or other staff arrangement which currently conducts the monitoring and analysis efforts.

C. The Districts will identify and implement appropriate means of coordinating these monitoring and analysis efforts. At a minimum, a mechanism for notifying one another of current monitoring and analysis results shall be established. When applicable, databases included or analogous to those described in the "Water Resource Investigations" and "Water Supply Planning" sections of this Memorandum of Understanding will be utilized.

D. The Districts will establish a mechanism for notifying one another of recommended and adopted water shortage orders (declarations, modifications and rescissions). At a minimum, this mechanism should fulfill the following coordination needs:

1. Any recommendation for a Governing Board issued water shortage order or emergency order, notification shall, whenever practicable, occur prior to the applicable Governing Board meeting; and

2. Any adopted Governing Board order or emergency order; timely transmittal of the signed order and samples of related permittee and/or public communication materials as soon as available.

E. The Districts will respond to each notification or transmittal (described in paragraph number 4 above), by providing any comments in as timely a manner as possible.

V. General Provisions

In order to ensure the orderly administration of this MOU, the staff of the Districts will do the following:

A. The Districts' executive directors will each designate in writing one position for each of the four areas of coordination, including Water Resource Investigations, Water Supply Planning, Water Use Regulation and Water Shortage Management, to oversee the administration of this MOU. These staff shall also serve as the principal contact persons for the districts under this MOU.

B. The Districts shall meet in April and October of each year to assess compliance with this MOU and its effectiveness in achieving the above-stated purposes and goals. Any concerns with the language of the MOU or problems with implementation may also be addressed at these meetings.

C. The responsibility for the meeting arrangements shall be rotated annually amongst the Districts, beginning with St. Johns.

D. This MOU may be amended in writing by mutual agreement of the Districts. Any district may terminate its participation in this MOU by providing 60 days written notice to the other.

E. Nothing herein should be construed to conflict with any requirement of Chapter 373, F.S., or water management district rules.

AGREED TO this 28th day of October, 1998.

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT GOVERNING BOARD

BY: ______________________
JAMES DANIEL ROACH
CHAIRMAN

BY: ______________________
OTIS MASON
SECRETARY

SOUTH FLORIDA WATER MANAGEMENT DISTRICT GOVERNING BOARD

BY: ______________________
FRANK WILLIAMSON, JR.
CHAIRMAN

BY: ______________________
SAMUEL E. POOLE, III
SECRETARY

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT GOVERNING BOARD

BY: ______________________
JIM ALLEN
CHAIRMAN

BY: ______________________
SALLY THOMPSON
SECRETARY

MEMORANDUM OF UNDERSTANDING

EXHIBIT 1

RESPONSIBILITIES FOR THE PREPARATION OF DISTRICT WATER MANAGEMENT PLAN INTEGRATED PLANS

COUNTY	LEAD AND SUPPORT DISTRICTS		
	SJRWMD	SFWMD	SWFWMD
Charlotte		Support	Lead
Highlands		Support	Lead
Lake	Lead		Support
Marion	Lead		Support
Okeechobee	Support	Lead	
Orange	Lead	Support	
Osceola	Support	Lead	
Polk	Support	Support	Lead

Exhibit 2
Water Use Regulation Coordination Area

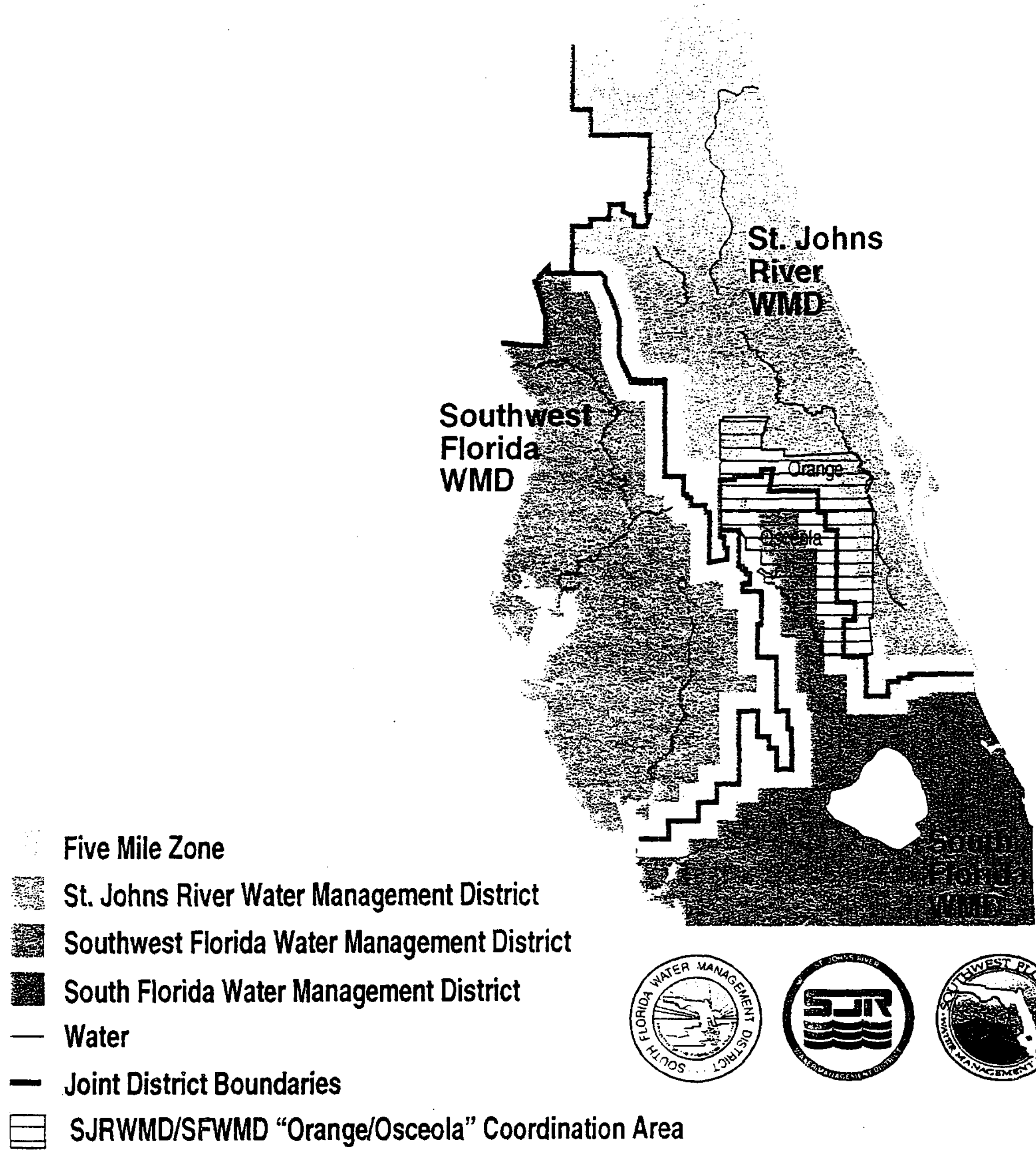

Exhibit 3
Water Shortage Coordination Area