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Michael F. McNulty

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Michael F. McNulty

Of Counsel
Brown & Bain, P.A.
Palo Alto, Phoenix, Tucson

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I. INTRODUCTION

It has been eleven years since the Arizona Legislature adopted the most systematic, and most rigorous, water conservation statutes that exist outside of the realm of emergency drought measures. But each and every spring since 1980, the Legislature has revisited the Code: to cure dozens of technical problems; to insert additional chapters startling in their complexity; and, perhaps this year, to change the whole emphasis of the Code. This incessant move to "refine" the Groundwater Management Act can fairly be described as an attempt to balance the demand-side orientation of the original legislation with increasingly more creative supply-side options. It is also true that most of the changes of the last decade have been precipitated by a need for flexibility in what began as a tough, almost puritanical, statute. This creativity has kept pace, but barely, with a rising tide of indignation by the regulated community. Protests and requests for administrative hearings concerning AzDWR's conservation requirements now number in the thousands. The speaker supports the growing emphasis on market-based conservation initiatives.

II. WATER RESOURCES BACKGROUND

Like the majority of Western states, Arizona has an agricultural sector that consumes 10 times as much water as all other municipal and industrial uses combined. And still, the Groundwater Management Act of 1980 (the "GMA") put off until the year 2006 any attempt to purchase and retire irrigated lands.

AzDWR's hydrological databases are as sophisticated as can be found in any state. In the author's experience, the Department's understanding of how water is used is not equaled by any other State agency. (For example, see Appendix "A".) The massively complete hydrologic inventory that exists in Arizona only highlights the need to resolve imbalances in supply and demand through institutional means. AzDWR has served, is serving, and will continue to serve as a laboratory for a wide variety of regulatory approaches.

III. AGRICULTURAL CONSERVATION PROGRAM

Introduction

The "grandfathering" process: how tightly can you tailor the present to past agricultural practices? Efficiency requirements: how decisively can you prohibit behavior that has been standard for a century?

A. Statutory Provisions

1. No new irrigated lands (A.R.S. § 45-452)

2. Grandfathered acres (A.R.S. § 45-465)

3. Water Duty (A.R.S. §§ 45-466 and 565)

   a. The quantity of water reasonably required [IR=CU+ON+LA-EP] (see Appendix "B"),
   b. to irrigate the crops historically grown,
   c. on a farm unit,
   d. assuming "the maximum conservation consistent with prudent long-term farm management practices within areas of similar farming conditions, considering the time required to amortize conservation investments and financing costs."
   e. Water Entitlement = Water Duty x Water Duty Acres
   f. Operating Flexibility Accounts/Credits and Debits (A.R.S. § 45-467)

B. Agricultural Conservation Requirements, Modifications, and Adjustments

1. Intermediate targets

2. Conservation requirements when surface water or effluent is used

3. Conservation requirements for irrigation distribution systems

4. Others

C. The Reactions of the Regulated Community (see Appendix "C")

IV. MUNICIPAL CONSERVATION PROGRAM

A. Introduction

1. Municipal Providers

2. Regulation through "Gallons Per Capita Per Day" Limitations (see Appendix "D")

B. Municipal Conservation Requirements

1. Definitions

2. Large Providers - Conservation Programs (see Appendix "E")

3. Large Provider Total Gallons Per Capita Per Day Program

   a. Calculation of Large Provider's Service Area Population. With great perseverance, water utilities are focussing the energies that could be used in water conservation on proving that their service area populations are higher than the number used by AzDWR for setting GPCD limitations. How many people live in a house? What are approved methodologies for deciding?

4. Alternative Conservation Program (see Appendix "F")

   a. Who Would Apply For The Alternative Conservation Program?

   b. Alternative Conservation Program Requirements
      (1) Groundwater Use Limitation Requirement
         (a) Requirements
         (b) Extinguishment of Groundwater Uses Associated with Grandfathered Rights
            i) Applicability
            ii) Annual Credits
            iii) Proof of Extinguishment
      (2) Residential GPCD Requirement
         (a) Requirement
         (b) Compliance with Residential GPCD Requirement
      (3) Non-Residential Requirement
         (a) Conditions for the Establishment of New Service
         (b) Non-Residential User Conservation Programs

5. Total GPCD Program Flexibility Account

6. Conservation Requirements for Small Providers

7. Conservation Requirements for New Large Providers

   a. Total GPCD Program

   b. Alternative Conservation Program
      (1) Application
      (2) Substitute Groundwater Use Limitation Requirement
         (a) Compliance With Groundwater Use Limitation Requirement
      (3) Annual Residential GPCD Requirement
         (a) Requirement
         (b) Conditions for the Establishment of New Service
         (c) New Non-residential Conservation Programs

8. Conservation Requirements for Institutional Providers

9. Individual User Requirements for Municipal Providers and Individual Users

   a. Individual User Requirements

   b. Responsibility for Compliance With Individual User Requirements

   c. Notification of New Individual User by Municipal Provider

10. Conservation Requirements for Municipal Distribution Systems

11. Alternatives (see Appendix "G")

C. Assured Water Supply Program

Less than 2 of the 400 pages of text in the Second Management Plans are given over to discussing assured water supplies. In what is surely one of the most revolutionary of requirements in the GMA, **no land my be subdivided** within an AMA unless it is demonstrated that there is a one hundred year assured water supply available for the uses proposed for the property.

The reason for conservation, surely, is shortages of supply (although there are those who believe in conservation for its own sake). The assured water supply program should dovetail in some meaningful way with the Management Plans. For now, they do not.

1. Assured Water Supply Criteria Rules

It has now been 8 years since AzDWR started to promulgate assured supply regulations that would succeed previous "water adequacy" criteria developed some twenty years ago.

2. Permitted drawdown of the groundwater table:

   a. 10'/yr. to a depth of 1200'
   b. Legal and physical availability for 100 years
   c. Financial capability
   d. Consistency with the Management Plans
   e. The waning grace period for municipalities

3. The Helter Skelter Rush By Municipalities To Spend Hundreds of Millions of Dollars on Water Farms: Case Histories

4. Conundrums In The Development of Property

   a. Obtaining a CC&N for a water utility
   b. Obtaining federally-insured mortgages for homes developed on lots in watersheds under adjudication
   c. Trying to read the tea leaves: buying water-rich property and AzDWR's proposed AWS criteria
   d. Other examples

5. Recent Legislation

   a. The Tucson Augmentation Authority

   b. The Replenishment District Approach: The Final Solution? Has Arizona reversed field?

V. INDUSTRIAL CONSERVATION PROGRAM

A. Industrial Users

1. Conservation Requirements for All Industrial Users

a. Conservation Requirements for Exciting Industrial Users
b. Additional Conservation Requirements for New Industrial Users
c. Conservation Requirements for New Large Cooling Users
d. Additional Conservation Requirements for New Large Landscape Users

B. Turf-Related Facilities Sector

1. Turf-Related Facility Water Use Patterns (see Appendix "H")

2. Additional Conservation Requirements for Turf-Related Facilities

a. Definitions

b. Conservation Requirements for Existing Turf-Related Facilities
(1) Maximum Annual Water Allotment
(2) Conservation Plan for First Management Plan New Facilities

c. Conservation Requirements for New Turf-Related Facilities
(1) Maximum Annual Water Allotment
(2) Conservation Plan
(3) Schools, Parks, and Common Areas of Housing Developments
(4) Cemeteries

d. Calculation of Maximum Annual Water Allotment for Turf-Related Facilities
(1) New and Existing Turf-Related Facilities That Are Not Golf Courses
(2) First Management Plan Existing Facilities That Are Golf Courses
(3) First Management Plan New Facilities That Are Golf Courses
(4) New Turf-Related Facilities That Are Golf Courses

(5) Allotment Adjustments
(a) Revegetation Adjustment
(b) Body of Water Fill and Refill Adjustment
(c) Effluent Allotment Adjustment
(d) Leaching Adjustment

C. Dairy Industry Section

D. Cattle Feedlot Sector

E. Sand and Gravel Sector

F. Metal Mining Sector

1. Water Use Characteristics

2. Water Conservation Potential

3. Additional Conservation Requirements for Metal Mining Facilities

a. Definitions

b. Conservation Requirements for Existing Metal Mining Facilities
(1) Tailing Density
(2) Presliming/Interceptor Wells
(3) Management of Water in Tailing Impoundments

c. Conservation Requirements for New Metal Mining Facilities
(1) New Well Placement
(2) New Tailing Impoundments
(3) Tailing Density
(4) Plan for Using Latest Commercially Available Conservation Technology

d. Alternative Conservation Program

G. Electrical Power Sector

VI. AUGMENTATION AND REUSE PROGRAM

A. Storage Location Criteria

B. Recovery Location Criteria

VII. APPENDICES

A. Tucson AMA: Base Year Large Provider Water Use Data

B. Consumptive Use and Other Needs by Crop

C. Concept Paper for Alternatives to Water Duties (Outline)

D. Conservation Potential Analysis and New Development Model -- Single Family

E. Total GPCD Requirements for Large Providers

F. Alternative Conservation Requirements for Large Providers

G. Alternatives to GPCD Requirements (Outline)

H. Conservation Requirements for Turf-Related Facilities

APPENDIX A

ERRATA SHEET
TABLE 5-D

TUCSON AMA: BASE YEAR LARGE PROVIDER WATER USE DATA[1]

Provider	Total Use[4] (AF)	Population	FMP Target[5] (GPCD)	Total Use[4] (GPCD)	Total Res Use[6] (GPCD)	Int Res Use[6] (GPCD)	Ext Res Use[6] (GPCD)	Non Res Use[7] (GPCD)	Lost[8] (%)
ADOC Wilmot Prison	155	531	292	193	-	-	-	-	-
Arizona WC	265	3,488	140	68	52	39	13	9	10
Avra Water Co-op	258	2,068	140	111	102	62	40	0	9
Beznos Management[2]	284	910	154	278	278	140	138	0	-
Canada Hills WC[2]	1,953	4,528	SP	385	105	58	47	259	6
Citizens - Rio Rico	415	1,606	201	231	120	84	36	107	2
Citizens - Tubac Valley	169	798	180	190	148	80	68	34	4
City of Nogales	2,821	14,398	183	183	117	80	37	45	8
City of Tucson	90,285	499,850	155	161	104	72	32	41	11
Community WC of GV	1,579	10,675	143	132	101	74	27	21	7
Cortaro Wtr Users Assn[2]	659	1,313	195	448	101	65	36	342	1
Davis-Monthan AFB[2]	2,264	6,800	SP	297	86	71	15	211	1
E & T WC	86	631	140	121	116	66	50	0	4
Evergreen Air Center	117	0	SP	-	-	-	-	-	-
Far Horizons East	190	749	161	226	226	138	88	0	-
Farmers WC[3]	169	365	SP	414	283	128	155	116	4
Flowing Wells ID	2,709	16,179	183	150	117	71	46	30	1
Forty-Niner WC[2]	658	676	545	869	268	123	145	587	2
Green Valley WC	1,226	1,990	SP	550	100	83	17	438	2
Halcyon Acres WUA	104	209	375	444	444	162	282	0	-
Hub WC	790	4,065	154	173	162	95	67	6	3
K & V WC[2]	138	963	190	128	119	65	54	6	2
Lago Del Oro WC[3]	259	1,685	140	137	116	75	41	7	10
Lakewood WC	108	663	152	145	110	62	48	9	18
Las Quintas Serenas WC	191	1,076	177	159	131	77	54	20	5
Los Cerros WC[2]	130	667	140	175	102	71	31	0	42
Marana Water Service	261	2,030	156	115	113	56	57	0	1
Metropolitan WC[2]	6,160	27,568	191	199	163	104	59	26	5
New Pueblo WC	84	598	140	125	92	69	23	30	2
Rancho Vistoso WC[3]	1,222	4,480	SP	244	113	61	52	108	9
Ray WC	586	3,592	149	146	103	68	35	24	13
Town & Country Estates[2]	108	795	121	121	121	81	40	0	-
Town & Country Terrace	146	770	140	169	169	103	66	0	-
Tucson Meadows MHP	95	641	140	133	133	99	34	0	-
University of Arizona	1,765	5,721	SP	275	71	-	-	204	10
Valle Verde WC	241	1,613	140	133	99	78	21	11	17
VA Medical Center	222	53	SP	3,744	-	-	-	-	-
Vista Del Norte MHP[2]	189	849	140	198	198	88	110	0	-
Winterhaven W & D Co.	283	837	333	301	301	113	188	0	-
TOTALS/AVERAGES	119,304	626,430	153	170	108	74	35	43	11

[1] 1985 unless noted otherwise.
[2] 1986 base year.
[3] 1987 base year.
[4] All water pumped, diverted or received. Effluent and deliveries to other service area or irrigation Grandfathered Rights not included.
[5] First Management Plan target.
[6] Residential use: total, interior and exterior.
[7] Non-residential use.
[8] Lost and unaccounted for water.
SP Special Provider status.
- Delivery data necessary to calculate values was not available.

APPENDIX B

TABLE 1: CONSUMPTIVE USE AND OTHER NEEDS BY CROP[1]

TUCSON AMA

	CONSUMPTIVE USE (acre-feet /acre)		OTHER NEEDS (acre-feet/acre)
	ASFC[2] 1-6	ASFC 7	ALL ASFCs
GRAIN CROPS			
Barley	1.83	1.83	----
Corn, Grain	2.67	2.50	----
Maize (Sorghum)	2.67	2.17	----
Oats, Grain	1.83	1.83	----
Rye	1.83	1.83	----
Sorghum, Grain	2.67	2.17	----
Wheat	1.83	1.83	----
FIELD CROPS			
Castor Beans	3.70	3.70	----
Cotton	3.08	2.58	----
Peanuts	2.75	----	----
Pinto Beans	----	1.17	----
Safflower	3.33	----	----
Soybeans	1.85	----	----
FORAGE CROPS			
Alfalfa[3]	4.08	3.42	----
Bermuda Grass	3.50	3.42	----
Hay, Annual (Non-Alfalfa)	2.25	1.50	----
Native Pasture	1.75	1.75	----
Permanent Pasture (Fescue)	5.75	4.67	----
Sudan Grass	2.25	1.50	----
NUTS			
Pecans, w/o Groundcover	4.33	3.58	----
Pecans, with Groundcover	5.67	----	----
Pistachios	4.17	3.50	----
VEGETABLE CROPS			
Carrots	1.38	----	.75
Chili Peppers	----	2.33	.50
Corn, Sweet	1.63	1.42	.87
Lettuce, All	.71	.71	2.44
Onions, Dry	1.94	----	.75
Tomatoes, All	2.00	----	.50
Vegetables, Mixed	2.00	----	.50

	CONSUMPTIVE USE (acre-feet/acre)		OTHER NEEDS (acre-feet/acre)
	ASFC[2] 1-6	ASFC 7	ALL ASFCs
FRUIT			
Apricots	3.92	3.00	----
Cantaloupe, Late	----	1.33	.50
Citrus, All	3.75	----	----
Grapes	----	2.50	.50
Peaches	3.92	----	----
Plums	3.92	----	----
Watermelons	1.75	----	.50
MISCELLANEOUS			
Jojoba	3.00	----	----
Christmas Trees	2.50	2.25	----
Nursery Stock	3.00	----	----

1 Based on crops that were reported in the 1975-1979 history.

2 Areas of Similar Farming Conditions. (See Chapter 4.)

3 Based on the average historical high yield of alfalfa in Pima County of 6.5 tons per acre and a consumptive use (CU) rate of 7.5 acre-inches per acre per ton of production, rounded to the nearest acre-inch. Farm units that demonstrated historic yields above this average were assigned higher CU rates accordingly, not to exceed a high CU value of 5.67 acre feet per acre. ASFC #7 was based on an average historical high yield for Santa Cruz County 5.5 tons per acre.

Sources: Consumptive Use of Water by Major Crops in Southwestern United States, Conservation Research Report #29, Agricultural Research Service, United States Department of Agriculture (1982).

FAO Irrigation and Drainage Paper #24, Food and Agriculture Organization of the United Nations (revised 1977).

APPENDIX C

OUTLINE

ALTERNATIVE CALCULATION METHODOLOGIES FOR WATER DUTY AND ALLOTMENTS
(Draft AzDWR Concept Paper)

I. INTRODUCTION

II. DESCRIPTION OF WATER DUTIES AND ALLOTMENTS

* * *

I. STATEMENT OF PROBLEMS WITH CURRENT WATER DUTY CALCULATIONS

- A. General Over-Allotment of Groundwater
- B. Some Allotments Are Too Low
- C. Water Cannot be Transferred to More Economically Efficient Users
- D. Flexibility Account Rules are Complicated
- E. Safe-Yield Concerns

II. POSSIBLE POSITIVE BENEFITS OF CURRENT WATER DUTY CALCULATIONS

III. CRITERIA TO EVALUATE ALTERNATIVE WATER DUTY CONCEPTS

- A. Effectiveness
- B. Equity
- C. Impact on the Quantity of the Groundwater Rights
- D. Flexibility to Allow Reallocation of Groundwater Rights
- E. Administrative Efficiency

IV. ALTERNATIVE NO. 1 -- GROUNDWATER DUTIES

V. ALTERNATIVE NO. 2 -- IRRIGATION ACRE WATER DUTY

VI. ALTERNATIVE NO. 3 -- UNIFORM WATER DUTY

VII. ALTERNATIVE NO. 4 -- WATER RIGHTS MARKET

VIII. ALTERNATIVE NO. 5 -- TECHNICAL SOLUTION

IX. ALTERNATIVE NO. 6 -- SAFE-YIELD WATER DUTIES

X. ALTERNATIVE NO. 7 -- DISTRICT ALLOTMENTS

XI. ALTERNATIVE NO. 8 -- DEREGULATION OF ALL FARMS UNDER 10 ACRES

APPENDIX D

CONSERVATION POTENTIAL ANALYSIS FOR EXAMPLE PROVIDER

TUCSON AMA

An analysis of conservation potential for an example water provider is discussed in this section. The analysis indicates that total per capita water use in this service area could be reduced from 150 to 132 GPCD through the implementation of certain conservation measures. The analysis assumes that existing users (those served prior to January 1, 1990) can reduce consumption through conservation, and that new users can be added to the service area at per capita use rates that reflect highly efficient water use devices and practices.

The total GPCD requirement for the service area was determined by adding the target rate for projected new residential and non-residential users to the target rate for existing users. Each target rate was weighted according to the user category's contribution to overall water use within the service area.

The conservation potential analysis is based on existing and projected water use and demographic data for each service area. This data for the example provider is shown in Tables 5-1 and 5-2.

The interior and exterior water use rates for the example provider fall into the moderate conservation potential category as described in Chapter 5, Section E.3.c and Table 5-E. Conservation measures assigned to this category are: 1) a depot pick-up retrofit program of interior plumbing fixtures, applicable to all pre-plumbing code housing units, 2) an interior water use education program at a moderate level, 3) a provider sponsored program of free landscape watering advice including guides and workshops, and 4) an exterior water audit/upgrade program available through the provider and performed on a voluntary basis. (Descriptions of these measures are available at the Tucson AMA office. A complete description of a depot pick-up retrofit program is presented in Appendix 5-F). Application of these measures to existing water use rates results in the savings shown in Table 5-3.

Interior savings depends on the number of pre-plumbing code housing units in the service area and exterior savings on the percentage of lawns and high water-using landscapes. Included in the savings calculations are anticipated installation rates, fixture use rates, and levels of market penetration. This analysis of existing users is then combined with the model use rates for new users (see Chapter 5, Section E.3.c, and Tables 5-F and 5-G.) The model per capita rates are shown in Table 5-4.

These use rates for new residential users were applied to the projected population and housing unit figures for 1990, 1995, and 2000. The results were then prorated with the per capita rates for existing users depending on the proportions of new and existing users in the service area. In addition, the per capita water use rates (GPCD) of single family and multi-family housing units were prorated to yield a total residential GPCD for existing and new residential units. The residential rates were combined with the projected non-residential per capita rate and with the lost and unaccounted for water per capita rate, assuming the proportions of both would remain unchanged from the base year until 2000. The 1990, 1995, and 2000 projected use rates are shown in Table 5. The 1992 and 1995 intermediate total GPCD targets would be 148 and 140, respectively, for the example provider, and the 2000 target would be 132 GPCD.

TABLE 5-1

BASE YEAR WATER USE
(gallons per capita per day)

	Residential		Non-Residential	Total
	SF[1]	MF[2]		
Interior Use	81	62	11	90
Exterior Use	54	27	4	50
Lost & Unaccounted for				10
Total Use	135	89	15	150

[1] Single family
[2] Multifamily

TABLE 5-2

DEMOGRAPHIC DATA AND PROJECTIONS

	1982[1]	1985	1990	1995	2000
Population	13,779	15,000	16,499	17,959	19,754
SF Housing Units	4,593	4,737	5,210	5,349	5,884
MF Housing Units	1,148	1,579	1,737	2,293	2,522
SF PPHU[2]	2.5	2.5	2.5	2.5	2.5
MF PPHU[2]	2.0	2.0	2.0	2.0	2.0

[1] Year of enactment of Pima County and City of Tucson low flow plumbing codes.
[2] Persons per housing unit.

TABLE 5-3

WATER SAVINGS FOR EXISTING USERS
(gallons per capita per day)

Measure	Interior		Exterior	
	SF	MF	SF	MF
Retrofit Depot Pick-up	6.5	4.9		
Public Education Moderate	2.8	2.2		
Free Landscape Watering Advice Guides/Workshops			0.4	0.2
Agency Audit/Upgrade Voluntary			1.7	0.6
Total Savings	9.4	7.1	2.2	0.8

TABLE 5-4

MODEL WATER USE FOR NEW USERS
(gallons per capita per day)

Measure	Interior		Exterior	
	SF	MF	SF	MF
Interior Model	61	55		
Exterior Model			31[1]	19

[1] The exterior single family model is 78 gallons per housing unit per day. At 2.50 PPHU for this water provider, the per capita use calculates to 31 GPCD. (78/2.50 = 31)

TABLE 5-5

PROJECTED WATER CONSUMPTION
(gallons per capita per day)

Year	Existing Residential			New Residential			Total Res.	Non-Res.	Lost & Unacct.	Total
	SF	MF	Total	SF	MF	Total				
1990	135	89	125	115	82	108	124	15	10	148
Interior	81	62	77	61	55	60	75			
Exterior	54	27	48	54	27	48	48			
1995	129	85	120	92	74	78	116	15	9	140
Interior	76	58	73	61	55	56	70			
Exterior	53	27	47	31	19	22	45			
2000	123	81	115	92	74	83	109	15	9	132
Interior	72	55	68	61	55	58	66			
Exterior	52	26	46	31	19	25	43			

NEW DEVELOPMENT MODEL — SINGLE FAMILY EXTERIOR

TUCSON AMA

EXTERIOR: 78 GPHUD (gallons per housing unit per day)
78 GPHUD = 27.5 GPCD (for average County household in Pima County of 2.84 people)

EVAPORATIVE COOLING[1]

6,000 gallons per housing unit per year.
6,000 ÷ 365 = 16.4 GPHUD

63.5% have evap. coolers only x 16.4 GPHUD = 10.4 GPHUD
19.5% have air conditioning only
16.1% have both (assume 50% of evap use) x 8.2 GPHUD = 1.3
Total evap. cooling requirement is 11.7 GPHUD
77.8 GPHUD (total exterior) - 11.7 GPHUD = 66.1 GPHUD Available

POOL[2]

400 sq. ft. Pool = 16,291 gal (NET POND EVAPORATION)
1,430 gal (BACKFLUSH)
2,565 gal (REFILL)
20,286 gal/yr = 55.6 GPHUD

Assume Use of Pool Cover 100% (Sept - May) saves 9,853 gal.
Total Pool Use = 10,433 gal/yr = 28.6 GPHUD

With pool cover: 66.1 GPHUD - 28.6 GPHUD = 37.5 GPHUD;
Without pool cover: 66.1 GPHUD - 55.6 GPHUD = 10.5 GPHUD

LANDSCAPING[3]

38 GPHUD available for landscaping = 13,870 gal/yr

HIGH WATER USE	
6 TREES	8,424 gal/yr
11 SHRUBS/GROUNDCOVERS	5,346 gal/yr
	13,770 gal/yr
LOW WATER USE	
10 TREES	7,800 gal/yr
29 SHRUBS/GROUNDCOVERS	6,032 gal/yr
	13,832 gal/yr

ALTERNATIVE MODEL: NO POOL, LUSH XERISCAPE

66 GPHUD Available for Landscaping = 24,090 gal/yr

HIGH WATER USE	
12 TREES	16,848 gal/yr
34 SHRUBS/GROUNDCOVER	7,072 gal/yr
	23,920 gal/yr

LOW WATER USE	
20 TREES	15,600 gal/yr
40 SHRUBS/GROUNDCOVER	8,320 gal/yr
	23,920 gal/yr

ALTERNATIVE MODEL: XERISCAPE WITH LAWN

66 GPHUD Available for Landscaping = 24,090 gal/yr

400 SQ. FT. LAWN = 12,400 GAL/YR; 24,090 - 12,400 = 11,690 gal/yr

HIGH WATER USE	
6 TREES	8,424 gal/yr
6 SHRUBS/GROUNDCOVERS	2,916 gal/yr
	11,340 gal/yr

LOW WATER USE	
10 TREES	7,800 gal/yr
18 SHRUBS/GROUNDCOVERS	3,744 gal/yr
	11,544 gal/yr

1 Information used in this calculation is from Woodard, Gary C. and Rasmussen, Todd C., "Residential Water Demand: a Micro Analysis Using Survey Data," Hydrology and Water Resources in Arizona and the SW, Vol. 14, 1984; and from cooling degree day information from the University of Arizona weather station, with assistance from Gary Woodard. Additional information was collected from Casa Del Agua by Martin Karpiscak.

2 Pool usage assumes 65.7 inches of evaporation based on pond evaporation less rainfall for this area (Gary Woodard). Backflushing and refill information from local pool services (assumes one refill every seven years and 55 gpm backflush 26 times per year for one minute).

3 Quantities of water assumed in the high water use calculation are based on a drip irrigation system and a generous irrigation regime: trees 27 gal/week, shrubs and groundcovers 9 gal/week. These amounts have been approved bythe SAWARA Outdoor Conservation Committee. The low water use calculation assumes 15 gal/week for trees and 4 gal/week for shrubs and groundcovers. It should be noted that true low water use species may actually need no additional irrigation after establishment. Xeriscape design normally includes the "zoned irrigation" concept, where thirsty species are grouped in high visibility areas for maximum impact. Thus, the models include significantly more vegetation if this concept is incorporated.

TOTAL GPCD REQUIREMENTS FOR LARGE PROVIDERS

TUCSON AMA

Provider	First Intermediate 1992-1994	Second Intermediate 1995-1999	Final 2000-TMP[1]
Arizona WC	121	121	121
Avra Water Co-op	121	121	121
Beznos Management	238	215	192
Canada Hills WC	314	233	194
Citizens Utilities			
Rio Rico	197	176	164
Tubac	180	167	158
City of Nogales	175	164	156
City of Tucson	155	151	148
Community WC of GV	132	128	125
Cortaro WUA	133	128	126
E & T WC	122	116[2]	111[2]
Far Horizons East MHP	218	208	198
Farmers WC	322	310	298
Flowing Wells ID	153	150	147
Forty-Niner WC	1,023	914	815
Green Valley WC	493	415	366
Halcyon Acres WUA	375	358	356
Hub WC	153	149	144
K & V WC	124	113[2]	112[2]
Lago del Oro WC	289	245	208
Lakewood WC	133	127	122
Las Quintas Serenas WC	155	144	138
Los Cerros WC	140	134	130
Marana Water Service	120	116[2]	114[2]
Metropolitan WC	191	169	153
New Pueblo WC	138	135	132
Rancho Vistoso WC	236	180	154
Ray WC	140	135	131
Town & Country Estates MHP	121	116[2]	110[2]
Town & Country Terrace MHP	162	156	149
Tucson Meadows MHP	132	124	116[2]
Valle Verde WC	123	121	121
Vista del Norte MHP	187	173	160
Winterhaven W & DC	301	268	234

APPENDIX F

ALTERNATIVE CONSERVATION PROGRAM REQUIREMENTS FOR LARGE PROVIDERS

TUCSON AMA

Provider	First Intermediate FCD[1]-1999			Final 2000-TMP[2]		
	Existing	New SF[3]	New MF[4]	Existing	New SF	New MF
Arizona WC	88	89	74	88	89	74
Avra Water Co-op	102	88	74	101	88	74
Beznos Management	215	89	74	192	89	74
Canada Hills	105	89	74	104	89	74
Citizens Utilities						
Rio Rico	105	90	74	100	90	74
Tubac	136	89	74	132	89	74
City of Nogales	111	86	74	105	86	74
City of Tucson	99	88	74	97	88	74
Community WC of GV	98	110	74	96	110	74
Cortaro WUA	99	88	74	97	88	74
E & T WC	111	89	74	107	89	74
Far Horizons East	208	89	74	198	89	74
Farmers WC	254	89	74	233	89	74
Flowing Wells ID	112	97	74	108	97	74
Forty-Niner WC	249	88	74	224	88	74
Green Valley WC	97	105	74	94	105	74
Halcyon Acres WUA	382	85	74	380	85	74
Hub WC	139	85	74	136	85	74
K & V WC	115	89	74	112	89	74
Lago del Oro WC	114	91	74	113	91	74
Lakewood WC	107	90	74	105	90	74
Las Quintas Serenas WC	126	87	74	122	87	74
Los Cerros WC	100	89	74	98	89	74
Marana Water Service	111	88	74	109	88	74
Metropolitan WC	152	90	74	143	90	74
New Pueblo WC	89	88	74	87	88	74
Rancho Vistoso WC	99	92	74	99	92	74
Ray WC	100	85	74	97	85	74
Town & Country Estates MHP	116	89	74	110	89	74
Town & Country Terrace MHP	156	89	74	149	89	74
Tucson Meadows MHP	125	89	74	116	89	74
Valle Verde WC	94	86	74	89	86	74
Vista del Norte MHP	173	89	74	160	89	74
Winterhaven W & DC	268	89	74	234	89	74

APPENDIX G

Alternatives to Municipal Per Capita Water Conservation Requirements
Arizona Department of Water Resources
December 5, 1989

OUTLINE

CONSERVATION REQUIREMENTS FOR INDIVIDUAL USERS THAT ARE TURF-RELATED FACILITIES - CALENDAR YEARS 1990 AND 1991

A. Definitions

In addition to the definitions set forth in Chapters 1 and 2 of Title 45 of the Arizona Revised Statutes, the following words and phrases used in this Appendix, unless the context otherwise requires, shall have the following meanings:

1. "Contiguous" means in contact at any point along a boundary. Two parcels of land are contiguous if they are separated by only one or more of the following: a road, highway, easement or right-of-way.

2. "First Management Plan existing turf-related facility" means:

   a. A turf-related facility that, as of December 26, 1984, was in operation or had obtained all preconstruction permits and approvals required by federal, state or local governments, or for which substantial capital investment had been made in the physical on-site construction of the facility in the 12 months prior to December 26, 1984.

   b. An expansion or modification of a turf-related facility that qualifies as First Management Plan existing turf-related facility under Paragraph a of this definition, if that expansion or modification increased the area of land to which water is applied for turf-related watering purposes and was substantially commenced as of December 26, 1984. An expansion or modification was substantially commenced if the owner or operator of the facility obtained all preconstruction permits or approvals required by federal, state or local governments for that expansion or modification or made a substantial capital investment in the physical on-site construction of the expansion or modification in the twelve months prior to December 26, 1984.

3. "Landscape watering" means the application of water to grow landscaping plants.

4. "Landscaping plant" means any member of the kingdom Plantae, including any tree, shrub, vine, herb, flower, succulent, groundcover or grass species, that grows or has been planted out-of-doors and is used for landscaping purpose.

5. "First Management Plan new turf-related facility" means:

   a. A turf-related facility that does not qualify as a First Management Plan existing turf-related facility.

   b. An expansion or modification of a turf-related facility that qualifies as a First Management Plan new turf-related facility under Paragraph a of this definition, if that expansion or modification increased the area of land to which water is applied for turf-related watering purposes.

c. An expansion or modification of a First Management Plan existing turf-related facility, if that expansion or modification increased the area of land to which water is applied for turf-related watering purposes and was not substantially commenced as of December 26, 1984.

6. "Newly turfed area" means the area of land newly planted during the calendar year in question with a grass species that requires additional water for germination and establishment. Newly turfed area does not include an area covered with a grass species during the preceding calendar year that has been overseeded or reseeded with a grass species during the calendar year in question.

7. "Total landscaped area" means:

   a. With respect to a First Management Plan existing turf-related facility or a First Management Plan new turf-related facility, except as provided in Paragraph b of this definition, the area of land to which water from any source is legally applied for landscape watering purposes during the calendar year in question.

   b. With respect to a First Management Plan existing turf-related facility in operation as of December 26, 1984, whichever of the following is greater:

      1) The largest area of land to which water from any source was legally applied for landscape watering purposes during any one year from January 1, 1980 through December 31, 1984.

      2) The area of land to which water from any source is legally applied for landscape watering purposes during the calendar year in question.

8. "Total water surface area" means the total surface area of all bodies of water from any source, including lakes, ponds and lagoons, that are an integral part of the landscaped area of a turf-related facility. Bodies of water used primarily for swimming purposes are not an integral part of the landscaped area of a turf-related facility.

9. "Turf-related facility" means an industrial user that applies water from any source to ten or more acres of land for turf-related watering purposes.

10. "Turf-related watering" means the application of water from any source to grow landscaping plants on the grounds of a turf-related facility and the use of water from any source to fill or refill any bodies of water, including lakes, ponds or lagoons, that are an integral part of the landscaped area of a turf-related facility. Bodies of water used primarily for swimming purposes are not an integral part of the landscaped area of a turf-related facility.

11. "Turfed acreage" means the total area of land planted with grass species or with plants not listed on the current Low Water Using Plant List for the Tucson Active Management Area for the First Management Period, available upon request from the Tucson AMA office, the Southern Arizona Water Resources Association, or the Department's public information office in Phoenix.

B. **Conservation Requirements for First Management Plan Existing Turf-Related Facilities**

Except as provided in Section F of this Appendix, an individual user that is a First Management Plan existing turf-related facility shall comply with the following conservation requirements:

For the calendar years 1990 and 1991, a First Management Plan existing turf-related facility shall not use an amount of water during a calendar year which exceeds its maximum annual water allotment for the year. The maximum annual water allotment shall be calculated pursuant to Section D of this Appendix, and compliance with the maximum annual water allotment shall be determined pursuant to Section E of this Appendix.

C. **Conservation Requirements for First Management Plan New Turf-Related Facilities**

Except as provided in Section F of this Appendix, an individual user that is a First Management Plan new turf-related facility shall comply with the following conservation requirements:

For the calendar years 1990 and 1991, a First Management Plan new turf-related facility shall not use an amount of water during a calendar year which exceeds its maximum annual water allotment for the calendar year. The maximum annual water allotment for the calendar year shall be calculated pursuant to Section D of this Appendix, and compliance with the maximum annual water allotment shall be determined pursuant to Section E of this Appendix.

D. **Calculation of Maximum Annual Water Allotment**

1. The maximum annual water allotment for a First Management Plan existing turf-related facility for a calendar year shall be calculated as follows:

   a. Determine the total landscaped area of the facility and the newly turfed area of the facility. Subtract the newly turfed area from the total landscaped area. Multiply the result by the water application rate of 5.0 acre-feet per acre.

   b. Multiply the newly turfed area of the facility by the water application rate of 6.0 acre-feet per acre.

   c. Determine the total water surface area of the facility. Multiply the total water surface area by the water application rate of 5.8 acre-feet per acre.

   d. The sum of the results of the calculations in Paragraphs a, b, and c, above, is the maximum annual water allotment for the facility for the calendar year.

2. Except as provided in Section D.3 of this Appendix, the maximum annual water allotment for a First Management Plan new turf-related facility for a calendar year shall be calculated as follows:

   a. Determine the total landscaped area of the facility and the newly turfed area of the facility. Subtract the newly turfed area from the total landscaped area. Multiply the result by the water application rate of 4.8 acre-feet per acre.

b. Multiply the newly turfed area of the facility by the water application rate of 5.8 acre-feet per acre.

c. Determine the total water surface area of the facility and the water surface area of any body or bodies of water filled and refilled with effluent. Subtract the water surface area of any body or bodies of water filled and refilled with effluent from the total water surface area. Multiply the result by the water application rate of 4.8 acre-feet per acre.

d. Multiply the water surface area of any body or bodies of water filled and refilled with effluent by the water application rate of 5.8 acre-feet per acre.

e. The sum of the results of the calculations in Paragraphs a, b, c, and d, above, is the maximum annual water allotment for the facility for the calendar year.

3. The maximum annual water allotment for a golf course that qualifies as a First Management Plan new turf-related facility and that has a total landscaped area in excess of the result obtained by multiplying the number of regulation holes by five acres shall be determined for a calendar year as follows:

a. Multiply the number of regulation holes by five acres. Subtract from that result the newly turfed area of the facility. Multiply the result by the water application rate of 4.8 acre-feet per acre.

b. Multiply the newly turfed area of the facility by the water application rate of 5.8 acre-feet per acre. In no case shall the allotment for the newly turfed area exceed the result obtained by the following formula: Multiply the number of regulation holes by five acres and multiply that result by the water application rate of 5.8 acre-feet per acre.

c. Determine the water surface area of any body or bodies of water filled and refilled with effluent. Multiply that water surface area by the water application rate of 5.8 acre-feet per acre.

d. The sum of the results of the calculations in Paragraphs a, b, and c, above, is the maximum annual water allotment for the golf course for the calendar year.

4. Where a turf-related facility consists of a First Management Plan existing turf-related facility and a First Management Plan new turf-related facility that are contiguous, under one ownership, and operated as one facility, the facility may combine the maximum annual water allotment for the First Management Plan existing turf-related facility and the maximum annual water allotment for the First Management Plan new turf-related facility and may apply all or a portion of the aggregate annual water allotment to any part of the facility.

5. Nothing in this Appendix shall be construed to authorize a turf-related facility to use more water from any source than that facility is entitled to use pursuant to any groundwater or appropriable water right held by the facility. Nor shall this Appendix be construed to authorize a turf-related facility to use water from any source in any manner that violates Chapter 1 or Chapter 2 of Title 45, Arizona Revised Statutes.

E. **Compliance with Maximum Annual Water Allotment**

A turf-related facility is in compliance for the calendar year 1990 or 1991 with its maximum annual water allotment for the year if the Director determines that either of the following applies:

1. The aggregate amount of water from any source used by the facility for turf-related watering purposes during the calendar year does not exceed its maximum annual water allotment for that year, or

2. The aggregate amount of water from any source used by the facility for turf-related watering purposes during that calendar year and the preceding two calendar years does not exceed the sum of the facility's maximum annual water allotments for those three years.

F. **Alternative Conservation Program**

A First Management Plan existing turf-related facility or a First Management Plan new turf-related facility that is or will be using effluent may apply to the Director for a modification of a water application rate. The Director may approve a modification of a water application rate if the owner or operator of the facility demonstrates to the satisfaction of the Director that technical difficulties caused by the use of effluent justify a modification.

G. **Monitoring and Reporting Requirements**

1. For the calendar years 1990 and 1991, each First Management Plan existing turf-related facility and each First Management Plan new turf-related facility shall measure and report in its annual reports required by A.R.S. § 45-632:

   a. The total quantity of water from any source withdrawn, diverted or received annually for turf-related watering purposes. The measurements shall be made with a measuring device in accordance with the Department's measuring device rules, A.A.C. R12-15-901, et seq.

   b. The total landscaped area of the facility.

   c. The newly turfed area of the facility.

   d. The total water surface area of the facility.

2. For the calendar years 1990 and 1991, each First Management Plan new turf-related facility shall measure and report in its annual reports required by A.R.S. § 45-632 the water surface area of any body or bodies of water filled and refilled with effluent.

3. For the calendar years 1990 and 1991, each First Management Plan existing turf-related facility and each First Management Plan new turf-related facility shall estimate and report in its annual reports required by A.R.S. § 45-632 the quantity of water from any source used for each purpose other than turf-related watering purposes.