Projection Methodology – Draft Population and Municipal Water Demands

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2 Population

The population projection methodology takes place in two steps: first, projections at the county level and then projections at the city/utility level.

2.1.1 County Population Projections

Draft county population projections are based on Texas State Data Center (TSDC)/ Office of the State Demographer county-level population projections. Such projections are based on recent and projected demographic trends, including the birth rates, survival rates, and net migration rates of population groups defined by age, gender and race/ethnicity.

The TSDC develops county-level population projections from 2011 to 2050 under three migration scenarios:

1) no net migration (natural growth only),
2) net migration rates of 2000-2010 ("full-migration scenario"), and
3) 2000-2010 migration rates halved ("half-migration scenario").

The State Data Center strongly recommends use of the half-migration scenario for long-term-planning. For each county, the draft projection is based on the half-migration scenario as the default, but alternatives (full-migration scenario or a composite of the scenarios) were chosen in select instances where a different scenario was more reflective of anticipated growth patterns.

While the TSDC's projections extend to 2050, the 2017 State Water Plan will require projections to 2070. TWDB staff has extended the projections to 2060 and 2070 by using the trend of average annual growth rates of the 2011-2050 TSDC projections. In 60 counties, the TSDC-projected population show a decline sometime between 2011 and 2050. For these counties, staff held the county population at its highest point prior to the decline for the following reasons:

1) Small Impact - the difference between holding the populations of these 60 counties constant or projecting continued decline in 2050 is 21,987, or 0.05 percent of the state-wide population of over 41 million. The largest county-specific difference between constant population and declining population is 2,030, the smallest is 17, and the average county difference is 366;
2) Constant System Requirements - projected population decline is often a decline in the number of people per household rather than a reduction in the number of connections that a water system must serve. The water systems must continue to have the capability to serve the customer connections regardless of population.

2.1.2 Water User Group Population Projections

The regional and state water plans require population projections for individual Municipal Water User Groups.

Water User Group Criteria

Municipal water user groups in the regional planning process include:

- Cities with a 2010 population greater than 500;
- Select Census Designated Places, such as military bases and in counties with no incorporated cities;

- Utilities (areas outside the places listed above) providing more than 280 acre-feet of municipal water per year;
- Collections of utilities with a common water supplier or water supplies (Collective Reporting Units); and
- Remaining rural, unincorporated population summarized as "County-Other"

The criterion for including only cities with populations greater than 500 has been used throughout the regional planning process, beginning with the 2001 regional water plans and the 2002 state water plan. Smaller cities are included in the aggregated "County-Other" water use, but are not separately delineated because many such small cities may not have a public water system or may not be the owner of the system. Regional planning groups do have the option of combining smaller water systems/cities into a collective water user group when the systems share a similar source or provider and are anticipated to coordinate in meeting their future water needs. In addition, regions may request the inclusion of cities or systems below the threshold criteria as distinct water user groups. This can be accomodataed in the online planning database.

2.1.2.1 Overlapping Boundaries

The previous section noted various criteria for water user groups. In some cases, the boundaries of qualifying water user groups may overlap. Examples and the method of population and water use allocation include:

•**City utility serving beyond city limits** - The service area boundary of a city-owned water utility may extend beyond the city boundaries; in such cases, the population and associated water use outside of the city limits are allocated not to the city but to the County-Other water user group.

•**Non-city utility serving city residents** – A non-city water utility may provide water directly to residents of a city that qualifies as a water user group; in such cases, the population and associated water use in the shared area are attributed to the city rather than the non-city utility in the regional water plan. Additional information regarding these shared populations and demands can be provided to the RWPGs and their technical consultants.

2.1.3 Projection Methodology

Projections for these individual water user groups are developed by allocating growth from the county projections down to the cities, utilities, and rural areas. The methods of allocating future populations from the county to the sub-county areas include:

1) Share of Growth - applying the water use group's historical (2000-2010) share of the county's growth to future growth;
2) Share of Population - applying the water user group's historical (2000-2010) share of the county population to projected county population; and
3) Constant Population - applied to military bases, and other water user groups that had population decline between 2000 and 2010 in a county with overall population growth.

The sum of all water user group populations within a county is reconciled to the total county projection prior to the finalization of draft projections.

3 Municipal Water Demands:

Draft municipal water demand projections utilize the population projections and a per-person water use volume for each city, water utility and rural area (County-Other). The draft projections will include 2011 per-person water use values (Gallons Per Capita Daily or GPCD) as the initial 'dry-year' water use estimate. Staff then applies future anticipated reductions in water use due to natural replacement rates for adoption of water-efficient fixtures and appliances required by law.

For each municipal water user group, the 2011 GPCD, minus the incremental anticipated savings for each future decade due to water-efficient fixtures/appliances, is multiplied by the projected population to develop the municipal water demand projections.

3.1.1 2011 Gallons Per Capita Daily (GPCD)

The 2011 GPCD for each water user group is calculated by:

- Calculating the net water use of each water system surveyed annually by the TWDB (total intake volume minus sales to large industrial facilities and to other public water suppliers),
- Allocating all or portions of the system net use and applicable estimates of non-system municipal water use (private groundwater) to the planning water user groups (city boundaries or water utility service areas), and
- Dividing the total water use allocated to a water user group by 365 and by the 2011 population estimate.

For city water user groups, the 2011 population estimates from the U.S. Census Bureau were used. Historically, the July 1st population estimates from the Texas State Data Center (TSDC) have been used in GPCD calculation, however because the TSDC had not released their 2011 population estimates by January 2013, staff used the available Census Bureau estimates. For non-city utility water user groups (Districts, Water Supply Corporations, and Investor Owned Utilities), the population reported in the annual water use survey was utilized, with an alternative calculation based on the reported number of connections if necessary.

3.1.2 Minimum GPCD Values

When calculating the base (2011) or projected GPCD values, TWDB staff applied a minimum of 60 GPCD. The minimum value of 60 GPCD is based upon several recent studies: *Analysis of Water Use in New Single-Family Homes*[1] and an internal TWDB report, *The Grass Is Always Greener...Outdoor Residential Water Use In Texas*, analyzing the percentage of Texas residential water used outside of the home.[2] The single-family home study studied the average per-person water use for:

1) Pre-1995 Homes (62.18 GPCD),
2) Standard New Homes built after 2001 (44.15 GPCD),
3) Standard new homes retrofitted with high-water-efficient fixtures and appliances (39.0 GPCD), and
4) New WaterSense Homes built with the best available technology for water conservation (35.6 GPCD).

[1] *Analysis of Water Use in New Single Family Homes*, Prepared by William B. DeOreo of Aquacraft Water Engineering & Management for The Salt Lake City Corporation and the U.S. Environmental Protection Agency, 2011
[2] *The Grass Is Always Greener...Outdoor Residential Water Use In Texas*, Sam Marie Hermitte and Robert Mace, Technical Note 12-01, 2012

With the assumed replacement of fixtures and appliances over the next 50 years, the indoor per-person water use of the Standard New Home Retrofitted (39.0 GPCD) can be expected under existing standards. However, this is only indoor use and the single-family home study found that there was no statistical difference in outdoor water use between types of housing.

The TWDB study of outdoor water use in Texas estimated that on average 31 percent of total residential water use is outdoor water use. Utilizing this average outdoor water use percentage (31 percent) and the indoor water use (69 percent) of 39 GPCD for retrofitted new homes produces a total residential GPCD of 56.5 GPCD. While some municipal water user groups may remain primarily residential, any water use by the local government or commercial water users will contribute some to the water user groups average GPCD. For this reason, staff rounded the minimum GPCD to 60.

3.1.3 Water Efficiency Savings

Federal standards on plumbing fixtures, dish washers, and clothes washers sold in the U.S. have recently been upgraded with potential savings due to installation of more water efficient units comprising a small, although significant, portion of total water use. Table 1 summarizes the expected savings from adoption of the standards, which apply by Federal Law to the fixtures and appliances sold in the U.S. for each of the effective date years shown. Years shown in Table 1 for each type of fixture/washer are the legislated beginning of sales of those items, with the associated water savings levels mandated by law.

Details concerning each of the pertinent pieces of legislation may be found at the websites noted in Table 2.

Anticipated savings due to water-efficient fixtures/appliances include:

1) Toilets and Showerheads – savings of 16 GPCD;
2) High-Efficiency Toilets – savings of 1.63 GPCD;
3) Dishwashers – savings of 1.61 to 1.90 GPCD; and
4) Clothes Washers – 6.45 GPCD

Table 1. Summary of Water Efficiency Savings and Implementation Years

	1995	2007	2010	2013	2015	2018
Item						
Plumbing Fixtures, 1991 (toilets, showerheads)	***Combined savings:*** **16 GPCD**					
High-Efficiency Toilet, 2009			***Savings:*** **0.32 gal/flush or 1.63 GPCD**			
Dishwashers			***Standard:*** **6.5 gal/cycle** ***Savings*:*** **7.5 gal/cycle or 1.83 GPCD**	***Standard:*** **5 gal/cycle** ***Savings:*** **9 gal/cycle or 1.93 GPCD**		
Front Load Clothes Washers		***Standard:*** **9.5 gal/cycle** ***Savings:*** **17.5 gal/cycle or 5.23 GPCD**			***Standard:*** **4.7 gal/cycle** ***Savings:*** **22.3 gal/cycle or 6.67. GPCD**	
Top Load Clothes Washers		***Standard:*** **9.5 gal/cycle** ***Savings:*** **17.5 gal/cycle or 5.23 GPCD**			***Standard:*** **8.4 gal/cycle** ***Savings:*** **18.6 gal/cycle or 5.56 GPCD**	***Standard:*** **6.5 gal/cycle** ***Savings:*** **20.5 gal/cycle or 6.13 GPCD**

*Savings for dishwashers and clothes washers are calculated versus historical average usage noted below: Dishwashers: 14 gal/cycle, Clothes Washers: 27 gal/cycle (minor use of front load clothes washer previous to 2007). GPCD savings based on assumed 2.75 people per household, 215 dishwasher loads/yr, and 300 clothes washer loads/yr.

Table 2. Background Information on Federal Standards on Water/Energy Efficiency

Item	Effective Year	Website
Plumbing Fixtures	1995	http://www.gao.gov/new.items/rc00232.pdf
High-Efficiency Toilets	2010-2014	www.capitol.state.tx.us (search House Bill 2667, 81st Legislature (Regular) 2009)
Dishwashers	2010	http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/74fr16040.pdf
Dishwashers	2013	http://www1.eere.energy.gov/buildings/appliance_standards/residential/dishwashers.html (see section on Energy Conservation Standards)
Clothes Washers	2007	http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/rcw_dfr_tsd_ch3.pdf (see section 3.7.2)
Clothes Washers	2015, 2018	http://www1.eere.energy.gov/buildings/appliance_standards/residential/clothes_washers.html (see section on Energy Conservation Standards)

3.1.4 Plumbing Fixtures Efficiency Savings, 1991 ("Plumbing Code Savings")

The suggested water savings that accompanied the water demand projections represent an estimation of the amount of water (average per-person) that will be saved by the conversion to more water-efficient fixtures as described in the State Water-Efficient Plumbing Act passed in 1991. Those housing units built before the law came into effect will, over time, replace their old fixtures with the new water-efficient fixtures. TWDB is providing a suggested schedule at which the fixture replacements will take place, and the effect that the replacement will have on the city or utility's average Gallons Per Capita Daily (GPCD).

3.1.4.1 Water Savings

From the a recent study of water conservation, it is estimated that the average savings of replacing higher water-use fixtures with more efficient fixtures mandated by state and federal laws would be 16 gallons per person, per day (10.5 gallons for toilets and 5.5 gallons for showerheads).

3.1.4.2 Replacement Schedule

The TWDB compiles population data rather than housing data, so in calculating the number of houses and the less-efficient fixtures, the Board staff used population as a proxy for the number of houses at the time the law took effect and the projection of future houses. The July 1995 population estimate is used as a benchmark to determine the potential average per-capita water savings of a city or utility. The 1995 population (as a proxy for housing and fixtures) is assumed to have less-efficient fixtures, which can be replaced, lowering their GPCD and the city's or utility's average GPCD. Any population growth after 1995 is expected to inhabit new housing that was built with the more efficient water fixtures. No additional water savings can be expected on the basis of fixture replacement for the post-1995 population. Fixture standards have not changes since the initial law was implemented.

The July 1995 population estimate was chosen as a starting point for adoption of the more efficient fixtures for several reasons. First, in both the state and federal laws affecting plumbing codes, retailers were allowed to continue selling the less-efficient fixtures that they had in stock. Second, in any areas, whether a city or a subdivision served by a utility, there are vacant housing units which will eventually be

occupied. Although there was no population in the house, there were less-efficient fixtures that will be used, and replaced, by residents eventually. Third, because we are using a proxy for the number of fixtures and the proxy (population estimate) can have varying degrees of accuracy, the July 1995 estimate was felt to be a good, conservative number.

The annual rate of fixture replacement was estimated to be 2 percent of the 1995 population, implying a 50 year adoption period for the 1995 population of housing. By the year 2045, 100 percent of the 1995 population would have the new water-efficient plumbing fixtures.

STEPS IN CALCULATING THE WATER SAVINGS DUE TO FIXTURE REPLACEMENT

A) Establish the Base 'Dry-Year' and Associated GPCD. Due to the extreme drought experience in 2011, it was decided that the year 2011 GPCD would act as the default 'dry-year' water use figure for all municipal water user groups. However, the base year for the population projections was 2010, so the dry-year GPCD (2011) will be applied to the 2010 base year. All potential water saving calculations are therefore subtracted from this reference GPCD (year 2011, assigned as the year 2010 value) to calculate the expected GPCD for each water user group over time as adoption of the various water saving technologies (fixtures, clothes and dish washers) proceed.

B) Calculate the estimated savings due to replacement between 1995 and 2010. Some fixture replacement took place between the passage of the law and the year 2010. The savings that result decrease the potential water savings available after the year 2010. Using the estimate that 2% of the 1995 population will replace the fixtures each year, 30% of the 1995 replaced their fixtures by the year 2010.

EQ. 1: PCS2010 = ((***POP1995*** * 30%) + ***G1995-10***) / ***POP2010***) * 16 GPCD

Calculates the percentage of the 2010 population that has water-efficient fixtures.

The per-person amount saved per replaced toilet and showerhead.

GPCD2010	Per-person, per-day water use in 2010 (GPCD)
G1995-10	Population growth between 1995 and 2010
PCS2010	The city/utility's average GPCD savings due to plumbing code changes (fixture replacement) between 1995 and 2010.
PCS2020	The city/utility's average GPCD savings due to plumbing code changes (fixture replacement) between 2010 and 2020
POP1995	July 1995 population estimate
POP2010	Census 2010 population (cities) or Year 2010 population estimate (utilities

Note: The per-person savings for each toilet and showerhead replaced is 16 gallons, however this change in GPCD applies for the portion of the 1995 population that replaced fixtures up to the point in time under consideration plus the new housing units in the water use group service area. The average GPCD savings for the entire city or utility will be considerably less than the maximum possible 16 GPCD due to non-replacement of plumbing fixtures by the majority of 1995 housing units. As noted in the calculation

above (EQ 1.), the estimated water savings are a combination of the accrued savings due to 30 percent of the 1995 level housing units, plus all of the growth from 1995 to the year 2010.

C) Calculate the remaining savings that will become available in each decade.

EQ. 2: PCS2020 =

$$\left[\left(\left(\underbrace{\textbf{\textit{POP1995}} * 50\%}_{\text{Calculates the percentage of the 2010 population that has water-efficient fixtures (30\% of the 1995 pop plus the growth between 2010 and 1995, divided by the 2010 total population).}}\right) + (\textbf{\textit{POP2020}} - \textbf{\textit{P1995}})\right) / \textbf{\textit{POP2020}}\right) * 16 \text{ GPCD}\right] \text{ minus } \underbrace{\textbf{\textit{PCS2010}}}_{\text{These water-use savings took place before the water-use base year (2000) and cannot be subtracted from the base}}$$

Similar water savings calculations (a point estimate for the year 2020 (EQ 2)) combine water savings from 50 percent of the 1995 housing population plus all of the population growth since 1995. Water savings estimated to be in place by 2010 (PCS2010), already implicit in the year 2010 estimated GPCD, are then subtracted from the potential savings to avoid double counting the potential savings.

Estimated GPCD for the year 2020 is then the baseline Dry Year GPCD (***GPCD2010***) less the water savings accumulated up to that point in time.

EQ 3: 2020 Per-Person Water Use (GPCD) =

2010 Per-Person Water Use (*GPCD2000)* MINUS Fixture Efficiency Savings (*PCS2020)*

Note: A formula similar to EQ. 3 would apply for each decade through 2070. By 2060 and 2070 all of the fixture replacements would have taken place and no additional water savings (and GPCD reductions) will occur.

3.1.5 High-Efficiency Toilet Savings, 2009

House Bill 2667 of the 81st Texas Legislature (2009) mandated that all toilets installed in residential and commercial buildings, with limited exemptions be High-Efficiency Toilet, using no more than 1.28 gallons per flush. The act also addressed water efficiency standards for showerheads, urinals, and faucet flow.

3.1.5.1 Water Savings

The 2009 law required that by January 2014, all toilets use no more than 1.28 gallons per flush. This is a 20% savings from the 1.6 gallons per flush standard set in the 1991 Texas law. Based upon an average frequency of per-person toilet use in households of 5.1 and a per-use savings of 0.32 gallons per use the estimated saving of adopting high-efficiency toilets is 1.63 GPCD. The act also required changes to standards for showerheads, from 2.75 gallons per minute to 2.5 gallons per minute, and standards for urinals and faucets, however at the regional water planning level such savings become too detailed and cumbersome to incorporate.

3.1.5.2 Replacement Schedule

To provide toilet manufacturers time to shift production to high-efficiency toilets, the 2009 law allowed a phasing in period by the percent of models offered for sale meeting the 1.28 gallons per flush standard:

- January 1, 2010 – 50% of the models offered for sale
- January 1, 2011 – 67% of the models offered for sale
- January 1, 2012 – 75% of the models offered for sale
- January 1, 2013 – 85% of the models offered for sale
- January 1, 2014 – 100% of the models offered for sale

Similar to the replacement of water-efficient fixtures required by the 1991 law, the replacement of pre-high-efficiency toilet was assumed to be 2 percent per year, with adjustments for the 2010-2014 time period as the high-efficiency toilets are being phased in.

3.1.6 Dishwasher Savings Efficiency Savings

3.1.6.1 Water Savings

The baseline water use per load of dishwashers prior to mandatory efficiency standards was 14 gallons per load. Beginning in 2010, dishwashers were required to use no more than 6.5 gallons per cycle. By 2013 the maximum water use is set at 5 gallons per cycle for all dishwashers produced or sold in the country. Thus, the savings per load for the 2010 machine standards is 7.5 gallons per load (14 gallons – 6.5 gallons) and 9 gallons for the 2013 standards (14 gallons – 5 gallons).

The water efficiency saving for the 2010 – 2020 period is a weighted average of the 2010 and 2013 standards (3 years at 7.5 gal/load plus 7 years at 9 gal/load): 8.55 gallons per load. Water savings after 2020 is the full implementation of the 2013 standards of 5 gallons per load, or a savings of 9 gallons per load.

Table 3. Use and installation assumptions

Metric	Value	Source
People/ household	2.75	Texas State Data Center
Loads/household/yr	215	DOE/EPA estimate
Percentage of new construction installing a new Dishwasher	96.7%	DOE documentation on year 2012 dishwasher standards

Per-person, per day water use saving of the installation of new dishwashers:

Water Savings (2010 to 2020)

= (8.55 gal/load* 215 loads/yr)/(365 days/year * 2.75 people per household)

= 1.83 GPCD max savings for each new dishwasher installed.

Water Savings (2020 to 2070)

= (9 gal/load*215 loads/yr)/(365 days/yr*2.75 people/household)

= 1.93 GPCD max savings for each new dishwasher installed

3.1.6.2 Replacement Schedule and Baseline Adoption Values

A ten year useful life was assumed for dishwashers, with the baseline for dishwashers statewide estimated at 78 percent of existing households for 2010. The latter value is based on metropolitan statistics from the American Housing Survey (http://www.census.gov/housing/ahs/data/metro.html). Therefore, 78 percent of the 2010 population for each water use group was assumed to be the starting point for new, more water efficient dishwasher installation. The ten year useful life implied that ten percent of the 2010 population would install the more water efficient dishwashers each year. It is assumed that all pre-2010 dishwashers have the 14 gal/load water use level, so all benefits of the new standard(s) accrue beginning in 2010, and the updated WUG-specific GPCD values do not have to be adjusted for previous new technology adoption.

3.1.7 Clothes Washer Efficiency Savings

3.1.7.1 Water Savings

The first nationwide standards for residential clothes washers took effect in 2007, requiring both top and front-loading machines to use a maximum of 9.5 gallons per load, compared to a possible use of 27 gallons in pre-efficiency-standard machines. Future efficiency standards will require a maximum usage of 8.4 gallons per load in top-loading machines and 4.7 gallons in front-loading machines in the year 2015. In 2018, the maximum usage for top-loading machines will be reduced further to 6.5 gallons.

Table 4. Parameters for Clothes Washer Savings Calculations

Metric	Value	Source
People Per Household	2.75	Texas State Data Center, 2010 Census
Loads/household/yr	300	DOE/EPA estimate
Proportion of TX households with clothes washers in 2010	75%	American Housing Survey, Metro Stats for 4 major cities in Tx
Percentage of new construction installing a new Clothes Washer	91%	DOE documentation on year 2012 Clothes washer standards
Proportion Top-Loads vs Front-Loads	40% vs 60%	DOE documentation on year 2012 Clothes washer standards
Lifespan of Clothes Washing Machines	Top Load – 14 years, Front Load – 11 years, "Composite" – 12 years	www.bankrate.com/brm/news/pf/20050810c1.asp

Potential Max savings for

- •Both Top Loading and Front Loading Machines (27 gallon -9.5 gallon) = 17.5 gallon for year 2007 standard
- •Top Loading Machines (27 gallon -8.4 gallon) = 18.6 gallon /cycle for year 2015 standard
- •Top Loading Machines (27 gallon -6.5 gallon) = 20.5 gallon /cycle for year 2018 standard
- •Front Loading Machines (27 gallon -4.7 gallon) = 22.3 gallon /cycle for year 2015 standard

3.1.7.2 Replacement Schedule

A twelve year replacement schedule is assumed for the clothes washers. New clothes washer purchases/replacements assume that forty percent of the replacements are top-loading machines and 60

percent are frontloading. A composite machine (i.e., part top-loader and part front-loader) is assumed to ease the water savings calculation process, and a weighted average savings calculation, based upon the respective potential savings of the two types of machines, is performed. The American Housing Survey of 2010 for four major cities in Texas estimated that 75 percent of households have clothes washers. This percentage was applied as a statewide average. In addition, 2012 U.S. Department of Energy studies estimate that 96.7 percent of new residential construction will have clothes washers. These two parameters are used to determine the number of clothes washers eligible for replacement, or will be installed in new constructions as the estimates of potential GPCD savings are calculated for each decade.