Water Conservation in the State of Texas

A Report on Statewide and Regional Water Conservation Efforts and Strategies

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Section 1: Texas Regional Water Conservation Summaries from Water for Texas 2007

Region A: Panhandle
The Panhandle Planning Group recommended water management strategies focused on conservation, groundwater development, and direct reuse. It also recommended connecting to the Palo Duro Reservoir. In all, the strategies would provide 412,146 acre-feet of additional water supply by the year 2060. (14)

Conservation strategies represent 70% of the total volume of water associated with all recommended strategies. Water conservation was recommended for every municipal and manufacturing need and for all irrigation water user groups in the region. Municipal reductions are capped at 5% in 2060. Irrigation conservation is achieved through irrigation equipment improvements, conservation tillage practices, use of the North Plans Evapotranspiration Network, and precipitation enhancement. (15-16)

Select Major Water Management Strategies:
-Irrigation conservation strategy by regional agricultural producers would provide a total of 282,549 acre-feet per year—Implementation by: 2010, Capital Cost: $145 million
-Direct reuse for manufacturing needs in Hutchinson and Moore Counties would produce 2,700 acre-feet per year—Implementation by: 2010; Capital Cost: $2 million (18)

Region B:
The Region B Planning Group recommended water management strategies ranging from groundwater development to direct reuse to reservoir system operation changes. In all, the strategies would provide 81,021 acre-feet of additional water supply by the year 2060. (20)

Conservation strategies for municipal and irrigation water users represent 20% of the total volume of water associated with all recommended strategies in 2060. Municipal water conservation was recommended for every municipal and County-other water user group with a need. Irrigation conservation is accomplished through the canal lining strategy. (21-22)

Select Water Management Strategies:
-Direct reuse projects for the cities of Wichita Falls and Bowie would generate 11,134 acre-feet per year—Implementation by: 2020; Capital Cost: $50 million
-Lining of irrigation canals operated by the Wichita County Water Improvement District No. 2 would conserve 14,607 acre-feet per year for producers in Archer, Clay, and Wichita Counties—Implementation by: 2040; Capital Cost: $59 million (24)

Region C:
Region C considered a wide spectrum of water management strategies to meet needs. In all, the strategies provide an additional 2.7 million acre-feet per year by 2060. (26)

Conservation strategies account for approximately 11 percent (297,647 acre-feet) of the total volume of water associated with all recommended strategies. A basic conservation package, including education, water system audits, and plumbing code changes, was recommended for all municipal water user groups in Region C. An expanded

conservation package, including strategies such as pricing structure, water waste prohibitions, and residential water audits, was recommended for some municipal water user groups. (26)

Select Water Management Strategies:
- East Fork Reuse Project would provide a maximum of 102,000 acre-feet per year to the North Texas Municipal Water District—Implementation by: 2010; Capital Cost: $289 million.
- Tarrant Regional Water District Third Pipeline and Reuse would provide up to 188,765 acre-feet per year to the Tarrant Regional Water District—Implementation by: 2010; Capital Cost: $626 million (30)

Region D: North East Texas
Of the 64 identified shortages in the region, 18 are the result of contract expirations. However, the planning group assumed that all contracts would be renewed. For the remaining projected shortages, the planning group recommended two types of water management strategies to meet needs: new groundwater wells and new surface water purchases. If fully implemented, recommended water management strategies would provide an additional 108,742 acre-feet. (32)

The North East Texas Planning Group considered conservation strategies for each water user group with a need and a per capita water use greater than 140 gallons per capita per day. Because costs of conservation strategies were relatively high due to the small size of the entities and amounts of water involved, the region did not recommend conservation as a water management strategy. (32)

Region E Far West Texas:
The Far West Texas Planning Group recommended an integrated water management strategy to meet needs in El Paso. The combined strategies include municipal conservation, direct reuse of reclaimed water, increases from the Rio Grande managed conjunctively with local groundwater, and imports of additional, desalinated groundwater from more remote parts of the planning area. In all, the strategy would provide an additional 137,737 acre-feet of additional water supply by the year 2060. (40)

The city of El Paso has a goal of 140 gallons per capita per day of water use. Total water conservation savings in the plan, including savings from efficient plumbing fixtures, is 29,359 acre-feet in 2010 and 23,437 acre-feet in 2060. (40)

Select Water Management Strategies:
-Reuse (El Paso's purple pipeline project) would provide up to 18,109 acre-feet per year—Implementation by: 2010; Capital Cost: $46 million. (42)

Region F:
Region F recommended a variety of water management strategies to provide slightly more water than is required to meet future needs. In all, the strategies would provide 239,250 acre-feet of additional water supply by the year 2060. (44)

Conservation strategies, including municipal and advanced irrigation, provide the second largest volume of supply for all strategies in the region. By 2060, they account for 81,974 acre-feet (34 percent) of the total volume associated with all recommended strategies. The bulk of conservation savings are provided by advanced irrigation strategies that accrue over 72,247 acre-feet of savings, or 30 percent, of the total volume, by 2060. (46)

Select Water Management Strategies:
- Reuse of treated municipal wastewater by the Colorado River Municipal Water District would provide 12,710 acre-feet by 2060—Implementation by: 2020; Capital Cost: $101 million. (48)

Brazos G:
The Brazos G Planning Group recommended a variety of water management strategies that would provide more water than is required to meet future needs. In all, the strategies would provide 736,032 acre-feet of additional water supply by the year 2060. (52)

Conservation strategies represent 6 percent of the total volume of water associated with all recommended strategies. Water conservation was recommended for every municipal water user group that had both a need and a gallons per capita per day use greater than 140 gallons. The plan recommends that all nonmunicipal water user groups with needs reduce their water use through conservation by 3, 5, and 7 percent in 2010, 2020, and 2030, respectively. (52)

Region H:
Region H Planning Group's recommended 23 water management strategies that would provide 1,300,639 acre-feet of additional water supply to meet all projected needs by the year 2060. (56)

The planning group first considered water conservation strategies for water user groups with water supply needs. Recommended municipal and irrigation water conservation strategies provide for a total of 178,868 acre-feet per year of needs. Municipal conservation accounts for 100,987 acre-feet of savings and irrigation conservation is recommended to save almost 77,881 acre-feet per year by 2060. (56)

Select Water Management Strategies:
-Indirect reuse of wastewater by Houston and the North Harris County Regional Water Authority is recommended at 20 percent of available wastewater effluent to provide 83,925 acre-feet per year—Implementation by 2050; Capital Cost: $0. (60)

Region I East Texas:
Water management strategies recommended for the East Texas Regional Water Plan result in 324,756 acre-feet of additional water supply to meet all projected needs by the year 2060. (62)

Water conservation was evaluated for every municipal water user group with a need and a gallons per capita per day use of more than 140 gallons. Municipal conservation accounts for 1,916 acre-feet of savings by 2060, and most municipal needs will be partially met through conservation. Water conservation in the East Texas Regional Water Planning Area is driven more by economics than the lack of a readily available supply and is not always the most cost-effective strategy for a water user group with a need. (62)

Select Water Management Strategies:
-Municipal conservation throughout region, composed of education programs, would provide additional 1,916 acre-feet per year—Implementation by: 2010; Capital Cost: $0. (66)

Region J Plateau:
Water management strategies recommended by the Plateau Planning Group would result in 14,869 acre-feet of additional water supply available by the year 2060. (68)

Conservation strategies represent 10 percent of the total volume of water associated with all recommended strategies. All four of the water users with projected needs in 2060 are anticipated to undertake conservation strategies, saving an estimated 1,507 acre-feet of water. (68)

Region K Lower Colorado:
Water management strategies included in the Lower Colorado Regional Water Plan would provide 861,930 acre-feet of additional water supply by the year 2060 (Figure K.5) at a total capital cost of $358,174,068 for the region's portion of the project (Appendix 2.1). The primary recommended water management strategy is the Lower Colorado River Authority/San Antonio Water System Project that consists of off-channel reservoirs, agricultural water conservation, additional groundwater development, and new and/or amended surface water rights. The majority of new surface water will be captured in off-channel reservoirs for use by San Antonio, while the groundwater will remain within the region to meet agricultural needs. The costs associated with this project will be paid for by San Antonio and are included in the 2006 Region L Regional Water Plan. There are no unmet needs in the plan. (74)

Conservation strategies represent 23 percent of the total amount of water resulting from all recommended water management strategies. Water conservation was included as a strategy for every municipal water user group with a need and water use greater than 140 gallons per capita per day. The plan recommends that all nonmunicipal water user groups with needs reduce their water use through conservation by 3, 5, and 7 percent in 2010, 2020, and 2030, respectively. (74)

Select Water Management Strategies:
-Wastewater reuse by Austin and return flows would produce 144,090 acre-feet per year—Implementation by: 2010; Capital Cost: $178 million (78)

Region L South Central Texas:
The South Central Texas Planning Group recommended a variety of water management strategies to meet water supply needs (Figure L.5). Implementing all the water management strategies recommended in the Region L plan would result in 732,779 acre-feet of additional water supplies in 2060 at a total capital cost of $5,222,408,000 (Appendix 2.1). Because there were no economically feasible strategies identified to meet the need, Zavala County has a projected unmet irrigation need (28,130acre-feet in 2060). (80)

Conservation strategies account for 15 percent of the total amount of water that would be provided by the region's recommended water management strategies. Water conservation was recommended in general for all municipal and nonmunicipal water user groups. In instances where the municipal water conservation goals could be achieved through anticipated use of low-flow plumbing fixtures, additional conservation measures were not recommended. (82)

Select Water Management Strategies:
-Expansion of San Antonio Water System recycled water program would provide 36,258 acre-feet by 2060—Implementation by: 2010; Capital Cost: $155 million.
-Edwards Aquifer recharge project would yield an estimated 21,577 acre-feet of additional water per year to multiple users—Implementation by: 2020; Capital Cost: $367 million.
-Lower Colorado River Authority-San Antonio Water System project to provide 150,000 acre-feet per year—Implementation by: 2050; Capital Cost: $2 billion. (84)

Region M Rio Grande:
The Rio Grande Planning Group recommended a variety of water management strategies that would provide water to meet most future needs, including all the needs associated with municipalities. In all, the strategies would provide over 807,587 acre-feet of additional water supply by the year 2060 (Figure M.5) at a total capital cost of $1,086,122,427 (Appendix 2.1). Because economically feasible strategies were not identified to meet some irrigation water supply needs, 29,852 acre-feet of irrigation water supply needs are unmet in 2060. (88)

The Rio Grande Planning Group recommends region wide implementation of municipal water conservation programs. The combined water savings is estimated to yield a savings of 24,412 acre-feet per year by 2060. (88)

Select Water Management Strategies:
-Agricultural conveyance system improvements would supply over 218,783 acre-feet per year of surface water for irrigation and would help transport Rio Grande water to its customer cities—Implementation by: 2010; Capital Cost: $131 million. (90)

Region N Coastal Bend:
The Coastal Bend Planning Group recommended a variety of water management strategies to meet future needs. Implementing all the recommended water management

strategies in the Coastal Bend plan would result in 149,496 acre-feet of additional water supplies in 2060 (Figure N.5) at a total capital cost of $789,515,000 (Appendix 2.1). In 2060, there are 3,876 acre-feet of water supply needs for mining that are unmet. (92)

Conservation strategies represent approximately 5 percent of the total amount of water that would be provided by all recommended water management strategies. The Coastal Bend Region made a general recommendation that conservation practices be implemented by all municipal and nonmunicipal water user groups regardless of gallons per capita per day usage, as well as by entities without any identified water need. Conservation water management strategies were recommended for municipal, irrigation, manufacturing, and mining water users. (92)

Region O Llano Estacado:
The Llano Estacado Planning Group recommended a variety of water management strategies, providing 441,511 acre-feet of additional water supply by the year 2060 (Figure O.5) at a total capital cost of $818,630,071 (Appendix 2.1). The primary recommended water management strategy for the region is irrigation water conservation, which generates 74 percent of the volume of water from strategies in 2060. The planning group determined there were approximately 909,000 acres of irrigated crop land that did not have efficient irrigation systems. Because there were no economically feasible strategies identified to meet their needs, 19 counties in the region have unmet irrigation needs (2,027,680 acre-feet). (98, 100)

Conservation strategies represent 77 percent of the total volume of water associated with all recommended water management strategies. Water conservation was recommended for every municipal water user group that had both a need and a water use greater than 172 gallons per capita per day (the regional average). The planning group adopted a municipal water conservation goal of reducing per capita water use by 1 percent per year until 172 gallons per capita per day is achieved. (100)

Select Water Management Strategies:
-Irrigation conservation strategy for most of region would provide 554,396 acre-feet in 2010, decreasing to 327,366 acre-feet by 2060—Implementation by: 2010; Capital Cost: $354 million. (102)

Region P Lavaca:
The Lavaca Planning Group analyzed various strategies to meet needs, but the only one determined to be economically feasible was temporarily overdrafting the Gulf Coast Aquifer to provide additional irrigation water during drought. This strategy produces 32,468 acre-feet of water which is sufficient to meet the region's needs (Figure P.5). **There is no capital cost associated with this strategy** because all necessary infrastructure is assumed to already be in place. (104)

Water conservation was not recommended as a strategy because it was not the most cost-effective method to meet irrigation needs, which are the only needs in the region. Since there were no municipal needs, no municipal conservation was recommended. However,

the planning group did recommend that all municipal water user groups implement water conservation measures. The Lavaca Planning Group did recommend continued agricultural water conservation practices as one of its policy recommendations. The region also supports state and federal programs that provide financial and technical assistance to agricultural producers and result in increased irrigation efficiency and overall water conservation. (104)

Section 2: Texas Regional Water Conservation Strategies

Data compiled from the 2006 Regional Water Plans

2.1 Region A

- Advanced municipal conservation – 1% annual demand reduction until a goal of 140 gpcd consumption is achieved
- Implementation of water efficient clothes washers for current populations, education and public awareness programs, reduction of unaccounted for water through water audits and system maintenance, and water rate structures that discourage water waste
- Wastewater reuse for manufacturing water needs
- Steam electric power generation in the region is on schedule to implement full utilization of reuse wastewater for supply generation by 2010
- For irrigated agriculture, the primary strategies identified to address irrigation shortages are demand reduction strategies (conservation)- NPET to schedule irrigation, irrigation equipment efficiency improvements, implementation of conservation tillage methods and precipitation enhancement
- No identified strategies for livestock water use
- Strategies for Municipal Shortages
    - Amarillo- water conservation
    - Cactus- water conservation
    - Canyon- Water conservation through implementation of water conservation plan, water conservation pricing and system water audit
    - Dalhart- Water conservation through implementation of water conservation plan, water conservation pricing and system water audit
    - Dumas
    - Stratford- Water conservation through implementation of water conservation plan, water conservation pricing and system water audit
    - Sunray- Water conservation through implementation of water conservation plan, water conservation pricing and system water audit
    - County- Other, Dallam County- Water conservation through implementation of water conservation plan, water conservation pricing and system water audit
    - County- Other, Hartley County- Water conservation through implementation of water conservation plan, water conservation pricing and system water audit
    - County- Other, Moore County- Water conservation through implementation of water conservation plan, water conservation pricing and system water audit
    - County- Other, Potter County- Water conservation through implementation of water conservation plan, water conservation pricing and system water audit
    - County- Other, Randall County- Water conservation through implementation of water conservation plan, water conservation pricing and system water audit
    - County- Other, Sherman County- Water conservation through implementation of water conservation plan, water conservation pricing and system water audit

- Manufacturing shortages- water conservation strategies include system water audit and water waste reduction
- Steam electric power generation will achieve future conservation savings through the implementation and construction of more efficient generating facilities. In addition, steam electric power generation will practice conservation by utilizing reuse supplies for future demands.
- The biggest water savings in the agricultural sector in the foreseeable future will be achieved through the application of five major on-farm irrigation water conservation practices. These five practices include: (1) Low Elevation Precision Application (LEPA) sprinklers, (2) surge flow furrow irrigation valves, (3) drip irrigation, (4) soil moisture measurement and irrigation scheduling, and (5) the use of on-farm underground water distribution pipelines.
- The PWPA has contracted with Texas Agricultural Experiment Station and using local experts determined that the following conservation strategies be implemented in the area: (1) Use of North Plains Evapotranspiration Network (NPET), (2) Change in crop variety, (3) Irrigation Equipment Efficiency Improvements, (4) Change in crop type. (5) Implementation of Conservation Tillage Methods, (6) Precipitation Enhancement, and (7) Conversion from irrigated to dryland.
- Conservation for agricultural practices is summarized according to water management strategies. Assuming water savings is the primary criteria for prioritizing water conservation strategies, the strategies of changing crop variety and increased conservation tillage should be either dropped from consideration or assigned a low priority. Neither strategy generated significant water savings; in addition, the change in crop varieties was detrimental to gross crop receipts. It should be noted that the analysis of crop varieties is based on current available varieties. Research currently underway may provide improved varieties that are more water efficient with little negative effect on yield. If these improvements develop, the feasibility of this strategy would need to be reevaluated. Prioritizing the other five strategies will depend on the various decision variables, i.e., water savings, implementation costs and Regional impacts. The two strategies that yield the largest water savings, changing crop type and conversion to dryland, are projected to generate a significant negative impact to the Regional economy, -$235.85 and -$78.72 per ac-ft of water saved, respectively. The third leading water saving strategy, i.e., changing to more efficient irrigation systems, comes with the highest estimated implementation cost, $41.12 per ac-ft of water saved. The remaining strategies of precipitation enhancement and irrigation scheduling appear to provide the potential of significant water savings while positively impacting the Regional economy.
- The focus of the conservation activities for municipal water users in the PWPG are: Education and public awareness programs, Reduction of unaccounted for water through water audits and maintenance of water systems, and Water rate structures that discourage water waste.
- The focus of the conservation activities for industrial users is: Evaluation of water saving equipment and processes, and Water rate structures that discourage water waste.

2.2 Region B

- Generally water conservation was not included in the projected demands for non-municipal water uses in Region B. An expected level of conservation is included in the municipal demand projections due to the natural replacement of inefficient plumbing fixtures with low flow fixtures, as mandated under the State Plumbing Code. For Region B, the total municipal water savings associated with plumbing fixtures is approximately 14.3 percent of the projected demand if no conservation occurred.
- Additional conservation savings can potentially be achieved in the region through the implementation of conservation best management practices. It is assumed that entities with low per capita water use will have minimal reductions in water use through conservation. In Region B there are ten municipal water user groups with identified safe supply shortages. Of these entities, Byers, Lakeside City and Montague County-Other have per capita water use below the screening criteria of 140 gallons per person per day
- Conservation strategies appropriate for Region B were evaluated based on the best management practices identified through the State Water Conservation Implementation Task Force. The Task Force identified 21 municipal conservation strategies and 15 strategies for industrial water users. In addition there are new Federal regulations that require new clothes washers to be energy efficient by 2007, which may reduce water use. After review and consideration of these strategies, the recommended municipal conservation package consists of four management practices:
    - Public and School Education
    - Reduction of Unaccounted for Water through Water Audits
    - Water Conservation pricing
    - Passive Clothes Washer Rules
- No industrial conservation strategies were evaluated because there are insufficient data to evaluate these strategies for the manufacturing safe needs in Wilbarger County. For the irrigation and steam electric power needs associated with shortages in Lake Kemp, conservation through reductions in transmission losses in the irrigation canal system will be considered.
- Water conservation is a potentially feasible water savings strategy that can be used to preserve the supplies of existing water resources. Some of the demand projections developed for Senate Bill 1 planning incorporate an expected level of conservation to be implemented over the planning period. For municipal use, the assumed reductions in per capita water use are the result of the implementation of the State Water-Efficiency Plumbing Act. On a regional basis, this is about a 5.4 percent reduction in municipal water use by year 2060 (from a regional per capita use of 165 gallons per person per day to 156 gallons per person per day). Additional municipal water savings may be expected as the federal mandate for energy efficient clothes washing machines takes effect in 2007
- The Region B Water Planning Group also recognizes that advanced water conservation measures (i.e. savings associated with active conservation

- Acknowledging the importance of water conservation to meet future water needs in Region B, this water plan recommends several water conservation strategies for users with identified needs:
    - Municipal Conservation
    - Municipal Reuse
    - Irrigation conveyance loss reduction
- Municipal Water Strategies:
    - Archer County (Other) - With no known dependable groundwater supply in Archer County, the only potentially feasible strategy considered, in addition to conservation, was additional supply from an existing local provider. (4-21)
    - Clay County (Other) - With a very limited groundwater supply in Clay County, the only potentially feasible strategy considered, in addition to conservation, was additional supply from an existing local provider. (4-22)
    - Montague County (Other)- no conservation recommended
    - City of Bowie- In addition to conservation, two potentially feasible strategies were considered for the City of Bowie. (4-26)
    - City of Byers- Since Byers has a water usage below 140 gpcd, only conservation associated with the Federal Clothes Washer Standards was considered as a strategy (4-28)
    - City of Electra- Therefore in addition to conservation, the only potentially feasible strategy evaluated for the City of Electra was to purchase treated water from the City of Wichita Falls. (4-30)
    - City of Iowa Park- Therefore in addition to conservation, the only potentially feasible strategy evaluated for the City of Iowa Park was to purchase additional treated water from the City of Wichita Falls. (4-31)
    - City of Lakeside City- Since Lakeside City has a water usage below 140 gpcd, conservation savings are limited. With the relatively small amount of water needed, the only strategy evaluated for Lakeside City was to purchase additional treated water from Wichita Falls. (4-33) – no conservation recommended
    - City of Vernon- Having conferred with the City of Vernon officials, in addition to conservation, the only strategy evaluated for Vernon was to develop additional groundwater supply wells and continue to utilize their nitrate removal treatment facility. (4-43)
    - City of Wichita Falls- no conservation recommended
    - Charlie Water Supply Corporation- no conservation recommended (quality issue)

    - Hinds-Wildcat and Lockett Water Systems- no conservation recommended (quality issue)
- Steam Electric Power and Irrigation Water Strategies:
    - The management strategies that are proposed for Region B to meet the combined steam electric power and irrigation shortage of 36,557 ac-ft per year, are to increase the conservation storage capacity of Lake Kemp, provide for a seasonal conservation pool (April to October) and also make the necessary improvements in the Wichita County Water Improvement District conveyance system to substantially reduce water losses in the canal laterals.
- Selection of Preferred Water Management Strategies by County:
    - Archer County- Municipal Conservation, Increase water conservation elevation at Lake Kemp (4-59)
    - Baylor County- no conservation recommended
    - Clay County- Municipal Conservation, Increase water conservation elevation at Lake Kemp, seasonal conservation pool April- October
    - Cottle County- There are no projected water shortages in Cottle County of Region B.
    - Foard County- There are no projected water shortages in Foard County of Region B.
    - Hardeman County- There are no projected water shortages in Hardeman County of Region B.
    - King County- There are no projected water shortages in King County of Region B.
    - Montague County- Municipal Conservation, Wastewater reuse
    - Wichita County- Municipal Conservation, Increase water conservation elevation at Lake Kemp, seasonal conservation pool April- October
    - Wilbarger County- Municipal Conservation, Increase water conservation elevation at Lake Kemp, seasonal conservation pool April- October
    - Young County- There are no projected water shortages in Young County of Region B
- The Region B Water Planning Group is proposing five preferred water management strategies. These strategies are as follows:
    - Increase Lake Kemp Conservation Pool
    - Purchase water from local providers
    - Wastewater reuse
    - Expanded use of groundwater
    - Nitrate removal
    - Water Conservation
- **Wastewater Reuse**: Wastewater reuse is proposed as a strategy for the cities of Wichita Falls and Bowie. Treated wastewater effluent will be used for irrigation on non-agricultural, municipal properties. The proposed project includes the reuse of 11,000 acre-feet per year of treated effluent. This project could have positive impacts on key water quality parameters downstream of the current discharge. The project will result in a decrease to the volume of

- Some of the conservation activities for municipal water users in Region B include:
    - Education and public awareness programs
    - Reduction of unaccounted for water through water audits and maintenance of water systems
    - Water rate structures that discourage water waste
- The focus of conservation activities for industrial users should be:
    - Evaluation of water saving equipment and processes
    - Water rate structures that discourage water waste
- Appropriate conservation activities for large irrigators in the Region B area include:
    - Reduction in operational losses and losses associated with conveyance systems
    - Coordination of irrigation deliveries to maximize efficiencies
    - Encourage water saving irrigation equipment and land practices for customers
- Legislative comment relating to conservation:
  "Region B supports the efforts of the state-appointed Water Conservation Task Force, and encourages the practices of water conservation within the region and state. The Regional Water Planning Group also recognizes the differences in water use and needs among water users and different regions. Region B encourages the Legislature to allow each region to establish realistic, appropriate, and voluntary water conservation goals for the region. These goals should only be established after sufficient data have been collected on water use using consistent data reporting. The use of the measurement of gallons per capita per day is appropriate only for residential water use or as a guideline for historical trends for a single entity. Region B does not support state mandated requirements or goals." (8-9 Region B 2006 Water Plan)

2.3 Region C

- During the evaluation process, the potentially feasible water conservation strategies for municipal water user groups were divided into groups based on potential water savings, opinions of probable cost, and likelihood and difficulty of implementation. The basic package is recommended for all municipal water user groups. All or part of the expanded conservation package is recommended for 129 out of 271 municipal water user groups. The less cost-effective strategies are not recommended for any municipal water user groups. The packages are as follows:
    - The basic package consists of the following water conservation strategies:
        - Low-flow plumbing fixture rules (included in water demand projections)
        - Public and school education
        - Water use reduction due to increasing water prices
        - Water system audit, lead detection and repair, and pressure control
        - Federal residential clothes washer standards
    - The expanded package consists of one or more of the following water conservation strategies:
        - Water conservation pricing structure
        - Water waste prohibition
        - Coin-operated clothes washer rebate
        - Residential customer audit
        - Industrial, commercial, and institutional ICI rebate
        - ICI water audit, water waste reduction, and site-specific conservation program
        - Reuse of treated wastewater effluent (for selected providers)
- The recommended water conservation strategies for non-municipal water user groups are:
    - Efficient new steam electric power plants (included in demand projections)
    - Reuse of treated wastewater (manufacturing, irrigation, and steam electric power)
    - Golf course conservation
    - Manufacturing general rebate
    - Recycling of process water for mining
- Reuse has been a source of water supply in Region C for a number of years. Currently Region C is reusing nearly 100,000 acre-feet per year of wastewater return flows for water supplies. Under current permits and infrastructure, this use is expected to increase to 103,400 acre-feet per year by 2060.
- The Region C plan proposes to reuse over 330,000 acre-feet of return flows in 2010 through both direct and indirect reuse projects, with most of this additional reuse occurring in the Trinity River Basin. By 2060, the proposed reuse in the region is expected to reach nearly 800,000 acre-feet per year.
- By 2060, the projected water supplies and/or savings from water conservation are expected to be over one million acre-feet per year.
- The recommended strategies for the regional wholesale water providers include conservation, reuse, connections to existing sources already under contract,

connection to other existing sources, and the development of new reservoirs. The total amount of supply from these strategies is 2.6 million acre-feet per year in 2060, bringing the total supply for the regional providers to 3.8 million acre-feet per year.

- Dallas Water Utilities (DWU) Recommended Water Management Strategies Related to Conservation:
    - Conservation- Not including savings from low-flow plumbing fixtures (which are built into the demand projections) and not including reuse, conservation by DWU retail and wholesale customers is projected to reach 105,299 acre-feet per year by 2060.
    - Direct Non-potable reuse (2010) - DWU plans to develop a direct non-potable reuse system by 2010. The system will supply an additional 20,458 acre-feet per year of direct reuse for landscaping and industrial use by 2060
    - Indirect reuse through Lake Ray Hubbard (2012)- The 2001 Region C Water Plan included development of a 60 mgd indirect reuse project through lake Ray Hubbard. This project is also in DWU's current plan, scheduled to be in service in 2012 with a supply of 67, 253 acre feet per year.
    - Indirect reuse through Lewisville Lake (2022) - DWU plans to develop a 60 mgd indirect reuse project through Lewisville Lake by 2022. This project would provide a supply of 67,253 acre feet per year.
- Tarrant Region Water District (TRWD) Recommended Water Management Strategies Related to Conservation:
    - Conservation and Reuse
        - Water conservation by customers- Not including savings from low-flow plumbing fixtures (which amount to about 5 percent of demand and are built into the demand projections) and not including reuse, conservation by TRWD customers is projected to reach 79,793 acre-feet per year by 2060.
        - Third pipeline and reuse project- TRWD recently received a permit from the Texas Commission on Environmental Quality allowing the diversion of return flows of treated wastewater from the Trinity River. The water will be pumped from the river into constructed wetlands for treatment and then pumped into Richland-Chambers Reservoir and Cedar Creek Reservoir. The wetlands project will increase the safe yield of the two lakes to the permitted amounts (increasing the total 2060 TRWD system safe yield by 73,265 acre-feet per year) and provide an additional 115,500 acre-feet per year of new supply. Thus, the total supply made available by the reuse project is 188,765 acre-feet per year in 2060. In order to deliver the currently available supplies and the supplies developed from the reuse project, the TRWD will need to build a third pipeline from Richland – Chambers Lake and Cedar Creek Reservoir to Tarrant County. The Richland-Chambers Reservoir reuse project has the river pump station on the Trinity River and a

15 mgd treatment train in operation. The pump station to move the water to Richland-Chambers Reservoir and a second 15 mgd treatment train are under design now and will be constructed in 2006. Final build-out for Richland-Chambers Reuse will be around 2010. The Cedar Creek Reservoir reuse project and the third pipeline will be needed around 2018.

  - The total projected 2060 supply from conservation and reuse for TRWD is 268,580 acre-feet per year. This does not include conservation from low-flow fixtures, which is built into TWDB demand projections.

- North Texas Municipal Water District (NTMWD) Recommended Water Management Strategies Related to Conservation:
  - Conservation- Not including savings from low-flow plumbing fixtures (which amount to about 5 percent of demand and are built into the demand projections) and not including reuse, conservation by NTMWD customers is projected to reach 86,114 acre-feet per year by 2060.
  - Additional Wilson Creek Reuse Project
  - East For Reuse Project
- City of Fort Worth Recommended Water Management Strategies Related to Conservation:
  - Conservation- Not including savings from low-flow plumbing fixtures (which are built into the demand projections), conservation by Fort Worth and its customers is projected to reach 49,405 acre-feet per year by 2060
  - Direct reuse for steam electric power/ Direct reuse for irrigation
    - Fort Worth plans to implement four direct reuse projects.
      1. Mary's Creek Direct Reuse: A satellite wastewater treatment plant and conveyance facilities would be constructed to provide a supply for non-potable water needs for the Walsh Ranch development and other nearby areas
      2. Central Business District Reuse: A satellite wastewater treatment plant and conveyance facilities would be constructed to provide supply for non-potable water needs in the Central Business District.
      3. Village Creek Direct Reuse: Effluent from the Village Creek Wastewater Treatment Plant would be used to meet non-potable water needs in the general vicinity of the wastewater treatment plant. Conveyance facilities would be constructed to transport the water to user delivery points.
      4. Alliance Corridor Direct Reuse: A satellite wastewater treatment plant and conveyance facilities would be constructed to provide supply for non-potable water needs in the Alliance Corridor area
- Trinity River Authority Recommended Water Management Strategies Related to Conservation:
  - Conservation- Not including savings from low-flow plumbing fixtures (which are built into the demand projections) and not including reuse,

conservation by TRA customers is projected to reach 9,758 acre-feet per year by 2060

- Reuse
  - Development of Reuse for Steam Electric Power Generation in Dallas County- Dallas County Steam Electric Power has a need for about 6,000 acre-feet per year of additional water supply by 2060. It is assumed that TRA will supply reuse water for 3,000 acre-feet per year for part of that need. The project cost is based on delivery of the water from the TRA Central Wastewater Treatment Plant to Mountain Creek Lake using a portion of the delivery capacity for the Johnson County SUD Reuse project. It is assumed that the project will be developed by 2020. (TRA reuse projects may be located elsewhere in Dallas County, depending on the development of steam electric power generation facilities and/or the occurrence of other opportunities to meet water needs with reuse water. If that were to occur, then costs for the project may differ.)
  - Development of Reuse for Steam Electric Power Generation in Ellis County- Ellis County Steam Electric Power has a need for about 40,000 acre-feet per year of additional water supply by 2060. It is assumed that TRA will supply 40,000 acre-feet per year of direct and indirect reuse water for that need. The project cost is based on four 10,000 acre-foot per year phases, each delivering water about 20 miles. (A similar, though smaller, reuse project for Ellis County was included in the 2001 *Region C Water Plan* (4).) (TRA reuse projects may be located elsewhere in Ellis County, depending on the development of steam electric power generation facilities and/or the occurrence of other opportunities to meet water needs with reuse water. If that were to occur, then costs for the project may differ.)
  - Development of Reuse for Steam Electric Power Generation in Freestone County- Freestone County Steam Electric Power has a need for about 20,000 acre-feet per year of additional water supply by 2060 (beyond the planned supply of 6,602 acre-feet per year from Richland-Chambers Reservoir and other existing supplies). It is assumed that TRA will supply 20,000 acre-feet per year of indirect reuse water for that need. The project cost is based on two 10,000 acre-foot per year phases, each diverting TRA treated return flows from the Trinity River and delivering the water about 15 miles. (TRA reuse projects may be located elsewhere in Freestone County, depending on the development of steam electric power generation facilities and/or the occurrence of other opportunities to meet water needs with reuse water. If that were to occur, then costs for the project may differ.)
  - Development of Reuse for Steam Electric Power Generation in Kaufman County- Kaufman County Steam Electric Power has a need for about 20,000 acre-feet per year of additional water supply

by 2060. It is assumed that TRA will supply 15,000 acre-feet per year of indirect reuse water for that need (with the remainder coming from North Texas Municipal Water District). The project cost is based on two 7,500 acre-foot per year phases, each diverting TRA treated return flows from the Trinity River and delivering the water about 15 miles. (TRA reuse projects may be located elsewhere in Kaufman County, depending on the development of steam electric power generation facilities and/or the occurrence of other opportunities to meet water needs with reuse water. If that were to occur, then costs for the project may differ.)

- Development of Reuse for Irrigation and Municipal Use in Denton and Tarrant Counties- the Trinity River Authority has been in discussions with potential water users regarding the development of up to 15,000 acre-feet per year of reuse water from TRA's Denton Creek WWTP for irrigation and municipal use in Denton and Tarrant Counties. Costs for this strategy are based on 7,500 acre-feet per year direct reuse for irrigation and 7,500 acre-feet per year as indirect reuse through Grapevine Lake. This is similar to two management strategies in the 2001 *Region C Water Plan* (4).
- Development of a Reuse Project for Johnson County SUD in Johnson County- The Trinity River Authority has been in discussions with representatives of Johnson County SUD regarding the development of a project to supply up to 20,000 acre-feet per year of indirect reuse water through Joe Pool Lake for use in Johnson County. This project is assumed to be developed by 2020 in conjunction with the Dallas County Reuse Project for steam electric power. It is assumed that Johnson County SUD will develop transmission and treatment facilities to use the water from Joe Pool Lake.
- Development of a Reuse Project for Joe Pool Lake- The Trinity River Authority has applied for a reuse permit for 3.9 mgd from a new wastewater treatment plant in the watershed of Joe Pool Lake. Water would be discharged upstream of the lake for subsequent use from Joe Pool Lake. This project is assumed to be developed by 2020.
- Development of a Reuse Project from the Ten Mile Creek WWTP for Irrigation in Dallas and Ellis Counties- The Trinity River Authority has a contract to supply 250 acre-feet per year of treated reuse water from TRA's Ten Mile Creek WWTP for irrigation use in Dallas and Ellis Counties. Facilities to implement this project are assumed to be developed by 2010.
- Contracting with Irving to allow reuse of wastewater discharged from TRA's Central Wastewater Treatment Plant- TRA and Irving have entered into a contract to allow Irving to reuse wastewater

discharged from TRA's Central Wastewater Treatment Plant. Irving will develop facilities to implement this strategy.

- Upper Trinity Regional Water District (UTRWD) Recommended Water Management Strategies Related to Conservation:
    - Conservation- Not including savings from low-flow plumbing fixtures and not including reuse, conservation by UTRWD customers is projected to reach 11,762 acre-feet per year by 2060.
    - Lake Chapman Indirect Reuse- UTRWD is seeking a permit for indirect reuse of return flows originating from water supplied from Lake Chapman. UTRWD, DWU, and Denton have agreed that UTRWD would be able to reuse up to 60 percent of the Lake Chapman supply. This is part of the DWU return flows above DWU lakes that are used by UTRWD.
    - Indirect reuse of return flows from Lake Ralph Hall- UTRWD plans to apply for the right to reuse return flows from the Lake Ralph Hall project, which are assumed to be 60 percent of the supply from the project, or 17,800 acre-feet per year.
    - Water treatment plant and distribution system improvements
- Greater Texoma Utility Authority (GTUA) Recommended Water Management Strategies Related to Conservation:
    - Conservation- Conservation is the projected conservation savings for the GTUA's existing and potential customers, based on the recommended Region C water conservation program. Water savings by the GTUA and customers is projected to reach 5,843 acre-feet per year by 2060.
- Dallas County Park Cities Municipal Utility District- . The proposed strategy is to implement water conservation measures by the respective water customers. The water savings and costs for conservation were determined by water user group and are shown for Highland Park and University Park in Appendix U of the Region C 2006 Regional Water Plan.
- City of Corsicana) Recommended Water Management Strategies Related to Conservation:
    - Conservation- Not including savings from low-flow plumbing fixtures (which are built into the demand projections), conservation by Corsicana and its customers is projected to reach 1,165 acre-feet per year by 2060
- Sabine River Authority- no conservation recommended
- Recommended Strategies for Local Wholesale Water Providers
    - Athens Municipal Water Authority
        - Conservation- Not including savings from low-flow plumbing fixtures (already built into the projected demands) conservation by AMWA is projected to reach 811 acre-feet per year by 2060
        - Indirect Reuse- This strategy would include the infrastructure to move treated wastewater effluent from the City of Athens wastewater treatment plants to an outfall location upstream of Lake Athens. This would supplement existing supplies in Lake Athens and would be available for rediversion by AMWA. The total amount of this supply would be 2,677 acre-feet per year.
    - City of Cedar Hill- conservation

- Denton- water conservation measures
- Ennis- conservation
- Forney- conservation
- Gainesville
    - Conservation- Not including savings from low-flow plumbing fixtures (already built into the projected demands) conservation by Gainesville and its customers is projected to reach 654 acre-feet per year by 2060
    - Indirect reuse- By 2020, Gainesville would contract with GTUA to transport treated wastewater effluent from the city's wastewater treatment plant to Moss Lake for blending, storage, and indirect potable reuse. New infrastructure for this project would include advanced treatment facilities at the city's wastewater treatment plant, a reclaimed water transmission pipeline, and a 1 mgd expansion to the city's water treatment plant. After blending and storage, water would be diverted from Moss Lake and transported to the city's water treatment plant using facilities constructed as part of the Cooke County Water Supply Project. This strategy would require a permit to discharge reclaimed water to Moss Lake, and would likely be permitted by the new water right that the city would obtain during implementation of the Cooke County Water Supply Project. However, development of Gainesville's full potential reclaimed water supply may require another new water right to divert water from Moss Lake.
- City of Garland- conservation
- Lake Cities Municipal Utility Authority- conservation
- City of Mansfield- water conservation
- City of Midlothian- conservation
- Mustang Special Utility District- water conservation
- City of North Richland Hills-conservation
- Parker County Utility District #1- water conservation
- City of Rockwall- conservation
- Rockett Special Utility District- conservation
- City of Seagoville- conservation
- City of Terrell- conservation
- Walnut Creek Special Utility District (SUD)- conservation
- Waxahachie
    - Conservation- Not including savings from low-flow plumbing fixtures (which amount to about 5 percent of demand and are built into demand projections) and not including reuse, conservation by Waxahachie and its customers is projected to reach 2,598 acre-feet by 2060
    - Indirect Reuse- By 2010, Waxahachie will begin using additional indirect reuse from Bardwell Lake, making full use of its existing water supply sources and water rights. This will require a 12 mgd expansion to the city's water treatment plant capacity and a 20-

inch diameter pipeline from Lake Waxahachie to the city's water treatment plant. Due to sedimentation in Lake Waxahachie and Bardwell Lake, the additional supply from this strategy will decline over time from approximately 3,112 acre-feet per year in 2010 to approximately 1,846 acre-feet per year in 2060.
    - City of Weatherford- conservation, indirect reuse
    - West Cedar Creek Municipal Utility District- conservation
    - Wise County Water Supply District- conservation
- Recommended Water Management Strategies for Water User Groups by County:
    - Collin County- conservation, reuse
    - Cooke County- conservation
    - Dallas County- conservation, indirect reuse
    - Denton County- conservation
    - Ellis County- conservation, indirect reuse, direct reuse
    - Fannin County- conservation
    - Freestone County- conservation
    - Grayson County- conservation
    - Henderson County- conservation
    - Jack County- conservation
    - Kaufman County- conservation
    - Navarro County- conservation
    - Parker County- conservation, reuse
    - Rockwall County- conservation
    - Tarrant County- conservation, reuse
    - Wise County- conservation, reuse
- Potential applications for water reuse in Region C include:
    - Landscape irrigation (parks, school grounds, freeway medians, golf courses, cemeteries, residential)
    - Agricultural irrigation (crops, commercial nurseries)
    - Industrial and power generation reuse (cooling, boiler feed, process water, heavy construction, mining)
    - Recreational/environmental uses (lakes and ponds, wetlands, stream flow augmentation)
    - Supplementing potable water supplies (surface and groundwater supplies).
- There are a number of benefits associated with water reuse as a water management strategy, including
    - Water reuse represents an effective water conservation measure.
    - Water reuse provides a reliable source that remains available in a drought.
    - Water reuse quantities increase as population increases.
    - Water demands that can be met by reuse are often near reuse sources.
    - Water reuse is a viable way to defer and avoid construction of new surface water impoundments.

2.4 Region D

- The planning group determined that a consumption of 115 gallons per capita per day (gpcd) should be established for all municipal water user groups, and that a reasonable upper municipal level – a goal but not a requirement – should be established at 140 gpcd. The 140 gpcd target was selected to coincide with recommendations of the TWDB's statewide water conservation taskforce. Using these concepts, a decision matrix was developed to guide consideration of water conservation strategies.
- For all municipal use entities, water savings are anticipated in the regional water plan due to plumbing code requirements for low flow fixtures and water saving toilets. Homes built before 1992 should be equipped with low flow toilets and fixtures due to the implementation of the Texas Plumbing Efficiency Standards.
- The Regional Water Planning Group offers the following water conservation and drought management recommendations:
    1. The State Water Conservation Implementation Task Force recommended a statewide goal for municipal use of 140 gpcd. Systems which experience a per capita usage greater than 140 gpcd should perform a water audit to more clearly identify the source of the higher consumption. Among other tasks, the audit should establish record management systems which allow the utility to readily segregate user classes.
    2. Higher per capita consumption figures are often related to "unaccounted-for" water – water which is produced or purchased, but not sold to the end user. Systems with a water "loss" greater than 15% should be encouraged to perform physical and records surveys to identify the sources of this unaccounted-for water.
    3. The planning group encourages funding and implementation of educational water conservation programs and campaigns for the water water-using public; and continued training and technical assistance to enable water utilities to reduce water losses and improve accountability
- The North East Texas Regional Water Planning Group established a goal of 140 gallons/person/day in the approved water demand projections. As such, the advanced water conservation scenario was not considered as a strategy for any municipal water user with per capita use below 140 gallons per capita per day.
- County Recommended Water Management Strategies Related to Conservation- no county recommended conservation, usually for two reasons:
    - Advanced conservation was not selected because the per capita use per day was less than the 140 gpcd threshold set by the water planning group. Reuse is not a feasible option because water supply is mainly used for public consumption. OR
    - Savings from water conservation is minimal and has a higher unit cost.
- Existing Water Conservation:
    - In a survey conducted to obtain data for development of this plan, each WUG was asked if it had a current water conservation or drought management plan. While a substantial number of entities responded positively, there continue to be a number of entities which either do not have a plan, or are not actively pursuing any implementation of their plan.

- Plumbing
    - For all municipal use entities, water savings are anticipated in the regional water plan due to plumbing code requirements for low flow fixtures and water saving toilets. Water saving toilets are toilets that use 1.6 gallons per flush as compared to high volume toilets which use 3.5 to 7 gallons per flush. Low flow fixtures include low flow showerheads and faucet aerators. Homes built before 1992 should be equipped with low flow toilets and fixtures due to the implementation of the Texas Plumbing Efficiency Standards. The savings for these two categories for each WUG are identified and tabulated by entity, and range from 0 to 15 gpcd over the 50 year planning period. These savings increase from decade to decade as less efficient fixtures are continually replaced.
- Water Conservation and Drought Management Recommendations to the Legislature:
  The Regional Water Planning Group offers the following water conservation and drought management recommendations:
  1. The State Water Conservation Implementation Task Force recommended a statewide goal for municipal use of 140 gpcd. Systems which experience a per capita usage greater than 140 gpcd should perform a water audit to more clearly identify the source of the higher consumption. 140 gpcd should not be considered an enforceable limit, but rather a reasonable target which may not be appropriate for all entities. Among other tasks, the audit should establish record management systems which allow the utility to readily segregate user classes.
  2. Higher per capita consumption figures are often related to "unaccounted-for" water – water which is produced or purchased, but not sold to the end user. Systems with a water "loss" greater than 15% should be encouraged to perform physical and records surveys to identify the sources of this unaccounted-for water.
  3. The planning group encourages funding and implementation of educational water conservation programs and campaigns for the water water-using public; and continued training and technical assistance to enable water utilities to reduce water losses and improve accountability.

2.5 Region E

- The potential role of conservation is an important factor in projecting future water supply requirements. In this 2006 regional plan, conservation is only included in the municipal projections as a measure of expected savings based on requirements of the State plumbing code. All other conservation practices are discussed in terms of water supply strategies and as a component of drought management plans.
- Six separate approaches were considered that combined various potential surface water and groundwater sources at variable supply rates and times of implementation. The FWTWPG compared the six integrated strategies and selected the strategy termed the *"Balanced Approach with Moderate Increase in Surface Water"*, which is composed of the following elements:
    - Increased conservation
    - Increased reclaimed water use
    - Increased use from the Rio Grande (developed conjunctively with local groundwater)
    - Importation of groundwater from the Capitan Reef aquifer (Culberson and Hudspeth Counties)
    - Importation of groundwater from the Bone Spring-Victorio Peak aquifer in the Dell City area (Hudspeth County)
- El Paso Water Utilities is the largest supplier of municipal water in Far West Texas, supplying approximately 95 percent of all municipal needs in 2000. The City of El Paso through the El Paso Water Utilities has been implementing an aggressive water conservation program for the past 13 years and has reduced the per capita demand from 200 gpcd in 1990 to 139 gpcd in 2004. The low consumption in recent years occurred because the area was under drought restrictions in 2003 and 2004. The conservation goal for El Paso is 140 gpcd, which would be the lowest large city per capita use in Texas. The continuation of the conservation effort is a key component of the El Paso Integrated Water Management Strategy.
- Since 1989. El Paso has been reducing its pumping from the Hueco. In 2002, EPWU Hueco pumping was 39,151 acre-feet/yr, an amount that was similar to the pumping in 1968. The large reduction in El Paso's dependence on Hueco groundwater can be traced to (1) the City's increasing use of surface water, (2) the adoption of water-conservation programs, (3) the initiation of pricing strategies that discourage excessive water consumption, and (4) an increase in the use of reclaimed water.
- Municipal Conservation
    - Reduction of municipal water consumption may be achieved with the implementation of conservation programs that reduce per capita usage and prevent water waste. EPWU has been implementing an aggressive water conservation program for the last 13 years with actions such as adoption of a rate structure that penalizes high consumption, restrictions on residential watering, rebate programs for replacing appliances and bathroom fixtures for low consumption units, plumbing fixtures to reduce leaks, native

landscaping programs to reduce landscape irrigation, public education, and enforcement.
    - This conservation program has reduced the per capita demand from 200 gpcd in 1990 to 155 gpcd in 2002. Consumption during 2003 and 2004 was 149 gpcd and 139 gpcd respectively. The lower consumption over the past two years occurred because the region was under drought restrictions in 2003, and in 2004, EPWU had a rate increase along with the incentives programs. The summer of 2004 was also cooler and wetter than normal, which may have further lowered demand.
    - The conservation goal for El Paso County is 140 gpcd, which would be the lowest large city per capita use in Texas.
- Reuse
    - El Paso has nearly 40 miles of reclaimed-water pipelines (purple pipeline) in place in all areas of the City. Reclaimed water serves the landscape irrigation demand of golf courses, parks, schools, and cemeteries, and also provides water supplies for steam electric plants and industries within the City. The supply from the direct reuse program is expected to increase from 5,000 acre-feet per year in 2000 to over 23,000 acre-feet per year by 2060.
    - A portion of the wastewater effluent from the Northwest, Haskell, Bustamante, and Fred Hervey Plants is currently being redirected into a water distribution system (Purple Pipeline) for users of the reclaimed water. Reclaimed water serves the demand of golf courses, parks, schools, steam electric plants, and industries. Currently EPWU is operating three reuse projects that currently provide near 5,000 acre-feet per year. The recommended integrated strategy proposes to expand the reuse supply to 23,109 acre-feet per year (average of 20 mgd) by 2060. This expansion would require capital investment to modify or expand wastewater treatment plants and to expand the distribution of the Purple Pipeline.
    - The current water quality of the treated effluent makes more a reuse project more feasible. The Fred Hervey WWTP is able to produce effluent that meets drinking water quality standards. It currently serves irrigation of ball fields, playgrounds and landscape. Although the effluent has high water quality, reuse for domestic supply may not be feasible due to concerns about the public acceptance of using reclaimed water to serve residential customers. Other WWTPs produce effluent with TDS levels above the drinking water quality standard, but the effluent is acceptable for uses such as irrigation of golf courses or parks. Reuse would have high reliability as water from direct reuse is available all year-round with acceptable quality.
- Irrigation Strategies
    - In some cases, farmers may benefit from Best Management Practices (BMPs) for agricultural water users, which are a mixture of site-specific management, educational, and physical procedures that have proven to be effective and are cost-effective for conserving water. The Texas Water Development Board (TWDB), through the Water Conservation

        - **Agricultural Irrigation Water Use Management**
            - Irrigation Scheduling
            - Volumetric Measurement of Irrigation Water Use
            - Crop Residue Management and Conservation Tillage
            - On-Farm Irrigation Audit (4-30)
        - **Land Management Systems**
            - Land Leveling
        - **On-Farm Water Delivery Systems**
            - Lining of On-Farm Irrigation Ditches
            - Replacement of On-Farm Irrigation Ditches with Pipelines
            - Low Pressure Center Pivot Sprinkler Irrigation Systems
            - Drip/Micro-Irrigation System
            - Gated and Flexible Pipe for Field Water Distribution Systems
            - Surge Flow Irrigation for Field Water Distribution Systems
            - Linear Move Sprinkler Irrigation Systems
        - **Water District Delivery Systems**
            - Lining of District Irrigation Canals
            - Replacement of Irrigation District Canals and Lateral Canals with Pipelines
        - **Miscellaneous Systems**
            - Tailwater Recovery and Reuse System
            - Automation and Telemetry
            - Regulatory Reservoirs
- Groundwater Conservation Districts Management Goals Related to Conservation:
    - Brewster County Groundwater Conservation District
        - Improve the understanding of groundwater in the District
        - Implement rules for drilling, completing, equipping, and operating of water wells
        - Implement strategies that will provide for the most efficient use, long-term sustainability and conservation of groundwater
        - Recommend strategies that will protect and enhance the quality and quantity of water by controlling and preventing waste
        - Minimize the degradation of the aquifers by considering regulations for spacing of wells and production from wells
    - Culberson County Groundwater Conservation District
        - Improve the basic understanding of groundwater conditions in the District
        - Implement management strategies that will provide for the most efficient use of groundwater

        - Strive to prevent the waste of water
        - Minimize the influence of pumping of wells on the degradation of the aquifers by regulating the spacing of wells and by use of a Production Use Measurement Area
    - Hudspeth County Underground Water Conservation District #1
        - Provide for the most efficient use of groundwater
        - Control and prevent the waste of groundwater
        - Address natural-resource issues
        - Curtail permitted withdrawals from the aquifer during periods of extreme drought
        - Promote the efficient application of irrigation water to field crops
    - Jeff Davis County Underground Water Conservation District
        - Provide for the most efficient use of groundwater
        - Control and prevent waste of groundwater
        - Implement management strategies that will promote water conservation
    - Presidio County Underground Water Conservation District
        - Provide for the most efficient use of groundwater
        - Control and prevent waste of groundwater
        - Implement management strategies that will promote water conservation
- City of El Paso Water Conservation Program
    - Mandatory Restrictions included in the Conservation Ordinance are:
        - **Landscape Watering Days:** Before 1991, customers of El Paso Water Utilities could water their yards any time, any day, the water distribution system was always catching up with demand; and then in June 1990, reservoir levels were alarmingly low, just before the evening irrigation peak of 6:00 - 8:00 P.M. Levels at some reservoirs were only three feet high, jeopardizing fire protection in some areas of the city. This experience resulted in the adoption of a three-day per week landscape watering schedule designed to reduce wasteful irrigation practices and to reduce peak demand on the system. The year around schedule allows EVEN numbered addresses to water Tuesday, Thursday and Saturday. ODD numbered addresses are allowed to water Wednesday, Friday and Sundays. There is no residential watering on Mondays. Schools, parks, cemeteries, golf courses and industrial sites are allowed to water Monday, Wednesday and Friday.
        - **Watering Days Times Restrictions:** To extend the conservation efforts, landscape irrigation restriction times were adopted in addition to the watering day's schedule. From April 1 through September 30, outdoor watering is allowed only before 10:00 a.m. or after 6:00 p.m.
        - **Exceptions:** If a customer desires a change in irrigation days and hours, it is the customer's responsibility to apply for a variance and demonstrate hardship. A Review Board can modify established

schedules or approve requests for variances. Variances are based on the Review Board's recommendations and are usually granted to customers that, because of age or health or depend on someone else to do yard work, or for those out-dated irrigation systems that cannot irrigate within the allotted time. Landscape Watering Permits are issued for thirty days for the establishment of new lawns and landscapes or for one day for the application of either chemicals or fertilizer.

- **Car Washing:** Is only allowed using a bucket and/or a hand-held hose equipped with a positive shutoff nozzle. All "fund-raising" car wash events must be held at commercial establishments. During different drought management stages, washing of vehicles will only be permitted at commercial establishments approved by the El Paso Water Utilities. (6A-2)
- **Water Waste:** Any activity that causes water to spray or flow into the street or public right-of-way is prohibited and considered a violation. Violations are class C misdemeanor in nature. Although El Paso Water Conservation Ordinance does not require written warnings before a citation is given, the Conservation Department introduced the ordinance via warnings as part of their public education campaign. Washing of sidewalks, driveways, patios and other nonporous surfaces with a hose is prohibited except to eliminate dangerous conditions.
- **Leak Repair:** After Inspectors notification, leaks must be repaired within five working days. Failure to do so might result in a citation.
- **Enforcement:** The enforcement of the conservation ordinance has been the responsibility of the El Paso Water Utilities since June of 1992 and allows for fines from $50 to $500 for each violation.

- Changes in the Plumbing Code: Another area identified for significant water savings was the elimination of the high volume plumbing fixtures. Toilets using 1.6 gallons per flush and ultra-conserving showerheads and faucets using 2.5 gallons per minute (gpm) are now required under the City's Plumbing Code, to be installed in new constructions and remodeling jobs. Because in El Paso, thirty percent of the water consumed during the summer is used for evaporative cooling, the Plumbing Code does not allow any continuous bleed-off lines to be installed at evaporative cooling systems, only automated evacuation pumps are permitted to drain the unit reservoir after so many hours of operation. Existing bleed-off lines should be directed to drain into the landscape if possible. The code also requires swimming pools to be equipped with filtration or recycling systems and to be covered when not in use to reduce water loss through evaporation
- Voluntary Programs (Conservation Initiatives)
    - **Education:** El Paso Water Utilities is involved in many activities to increase public awareness. These include monthly conservation

messages on the back of bills, periodic bill stuffers, billboards, TV, radio, newspaper and displays at citywide shows, fairs, and festivals as well as presentations to civic groups and other organizations. The Conservation Department also makes presentations to school groups and youth organizations that often include a visit by our "Willie" mascot. Development of the "Willie" character has allowed greater visibility in promoting water conservation. The Utility is involved with "Drinking Water Week", a project of AWWA held every full week of May of every year. Different activities are planned for that time, with emphasis on tours of the different plants and a student poster contest.

- **Initiatives:** The Utility funds several programs that enhance the goals of the conservation program while providing information on wise water use.
- "Cash for Your Commode"- When the plumbing code changes became effective, (September 12, 1991) the Utility kicked off its "Cash for Your Commode" rebate program. A customer can receive a 75% rebate (up to $100 per toilet) for replacing an existing larger water-using toilet with an ultralow- flow toilet. Since the beginning of the program, over 30,000 toilets have been replaced, saving an estimated 340 million gallons of water and wastewater a year.
- "Free Showerhead Distribution"- During 2000, more than 160,000 low-flow showerheads were delivered to customers. An evaluation of this program showed a decrease of 1 Billion gallons of wastewater.
- "Refrigeration Units Rebate"- In coordination with the El Paso Electric, a rebate of $300.00 is given to residential customers or homebuilders for the installation of central refrigeration units.
- "Horizontal Washing Machines Rebates"- A rebate of $200 for the purchase and installation of horizontal washing machines is available to our residential and a $300 rebate for our commercial customers.
- "Evaporative Bleed-off Line Clamps"- The Utility distributes free evaporative bleed-off line clamps for customers that have evaporative cooling systems. Water used for cooling purposes in El Paso accounts for 15% of residential use, restricting the bleed-off flow will save millions of gallons that usually are dumped into the sewer.
- "Desert Blooms CDROM"- Since 1990, the Utility has been working with the Texas A&M Extension Service to promote water efficiency in urban landscapes. Workshops and seminars are provided to increase awareness of water issues in the region. The CDROM was developed to fill the need for regional plant selection information. "Desert Blooms", has information in both English and

Spanish of more than 400 trees, shrubs, groundcovers, grasses and flowers that are adapted or native to the Chihuahuan Desert.

- "Turf Rebate Program"- Living in the Chihuahuan Desert calls for beautiful, colorful and most importantly, water conserving landscapes. Because our desert receives an average of only 8 inches of rainfall a year, it makes sense to use native and watertight plants, which require little or no additional irrigation. Water is a precious commodity and living in harmony with our desert proves your commitment and respect for our region and its limited water resources. This rebate program offers an incentive to convert established turf areas to water efficient landscape designs that incorporate low water use plants and common sense horticulture practices. This program is for established residential customers (no-new homes are eligible) and established commercial and industrial customers. The Utility pays $1.00 per square foot of established grass that is replaced with an approved landscape.
- "Hot Water on Demand"- This new program has been added to our conservation portfolio as a result of Public Working Committee recommendations. The average home wastes nearly 10,000 gallons of water every year as people wait for hot water. The How Water on Demand systems recirculates hot water through the house so that hot water reaches the tap in a shorter time. This rebate offers direct retail customers of El Paso Water Utilities a $100 rebate check for each pump installed at the residential site, with a $300 rebate maximum per site.
- "Waterless Urinals"- The Utility continues to promote the installation of waterless urinals as another efficient way to save water. A total of 100 units have been distributed to area school districts and city offices. Staff is conducting installation verification visits to gather information about maintenance and acceptance comments

2.6 Region F

- The Region F Water Planning Group considered three major categories of water conservation: municipal, irrigation and steam-electric power generation. Overall, in Region F more than 106,000 acre-feet of water could be conserved by 2060. The recommended water conservation activities for municipal water users in Region F are:
    - Education and public awareness programs,
    - Reduction of unaccounted for water through water audits and maintenance of water systems, and
    - Water rate structures that discourage water waste
- Irrigation is the largest water user in Region F and the category with the largest needs. The irrigation conservation activities evaluated in as part of this plan focus on efficient irrigation practices.
- Much of the water conservation proposed for Region F is associated with steam-electric power generation. Region F identified alternative cooling technology that uses very little water as a means of reaching power generation goals. Alternative cooling technology is a water conservation strategy because it replaces a high water use technology, conventional steam-electric power generation, with a very low water use technology. Therefore this strategy is included in the total water conservation savings for the region.
  ***Region F has since amended their plan and removed this strategy due to its infeasible cost, leaving the steam-electric need unmet.
- Many cities in Region F have compiled water conservation plans to ensure that they will be able to meet the future water demands of their constituents. Water conservation education is stressed in most cities. These cities plan to provide educational brochures to new and existing customers. Other measures to conserve water include retrofit programs, leak detection and repair, recycling of wastewater, water conservation landscaping, and adoption of the plumbing code.
- Use of Reclaimed Water
    - The TWDB notes three important advantages of the use of reclaimed water:
        - Effluent from municipal wastewater plants is a drought-proof supply.
        - Treated effluent is the *only* source of water that automatically increases as economic and population growth occurs in the community.
        - The source of treated effluent is usually located near the intended use, not at some yet-to be developed, distant reservoir or well field.
    - A number of communities in Region F have direct wastewater reuse programs in place, utilizing municipal wastewater effluent for landscape irrigation or for industrial or agricultural purposes. Smaller programs (less than 0.1 MGD) are reported in Howard, Irion, Martin, and Reagan counties. The City of Midland's reuse program ranks Midland County among the top five counties in Texas for municipal reuse. San Angelo is considering options for expanding its use of reclaimed water. Industrial reuse is described by TWDB as being under-reported, but Ector County is

listed as having 2.09 MGD of industrial reuse, ranking the county among the top five in Texas for that category.

- Municipal Strategies Related to Conservation
  - City of Andrews- no conservation; desalination
  - City of Ballinger- reuse, water conservation
    - Reuse- Reuse has been identified as a feasible strategy for the City of Ballinger. The city currently holds a wastewater discharge permit for 0.48 MGD. This evaluation is based on a generalized direct reuse strategy developed for the Region F plan. This strategy assumes that a portion of the wastewater stream will be sent through membrane filtration and reverse osmosis (RO). The treated water will then be blended with raw water prior to treatment at the city's existing water treatment plant. It is assumed that the waste stream from the reuse facility will be permitted for discharge into a local stream. If this strategy is pursued, additional site-specific studies will be required to determine actual quantities of water available, costs and potential impacts. (4-37, 38)
    - Water Conservation Savings by the City of Ballinger- Recent drought has severely impacted the City of Ballinger. As a result, the city has actively promoted water conservation and drought management
  - City of Winters- reuse, conservation
    - Reuse- Reuse has been identified as a feasible strategy for the City of Winters. The city currently holds a wastewater discharge permit for 0.49 MGD. Treated effluent is also authorized for irrigation. This evaluation is based on a generalized direct reuse strategy developed for the Region F plan. This strategy assumes that a portion of the wastewater stream will be sent through membrane filtration and reverse osmosis (RO). The treated water will then be blended with raw water prior to treatment at the city's existing water treatment plant. It is assumed that the waste stream from the reuse facility will be combined with the remaining treated effluent and discharge into a local stream or disposed of using land application. If this strategy is pursued, additional site-specific studies will be required to determine actual quantities of water available, costs and potential impacts.
    - Water Conservation- Using the Region F suite of water conservation practices, it is estimated that the City of Winters can reduce water demand by as much as 20 percent.
  - City of Bronte- water conservation, reuse considered-not
    - Water Conservation- The City of Bronte has actively promoted water conservation and drought management during the recent drought. Peak demands have been reduced from as much as 760,000 gallons per day to about 600,000 gallons per day. The city uses mail outs, newspaper articles, public education and word-of-mouth to distribute information on water conservation. Several

sample xeriscape projects have been implemented in the city with assistance from Texas A&M University. School education programs targeting 5-6 grades are used as well.

- City of Robert Lee- water conservation
  - Quantity, Reliability and Cost of Water Conservation- Using the Region F criteria, conservation can reduce the demand for the City of Robert Lee by 66 acre-feet per year, about 19 percent of the expected demand for the city without conservation. The reliability of this supply is considered to be medium because of the uncertainty involved in the analysis used to calculate the savings. Site specific data would give a better estimate of the reliable supply from this strategy. Costs range from $0.91 per thousand gallons in 2010 to $0.51 per thousand gallons in 2060.
- City of Menard- water conservation
- Water Conservation- Using the Region F suite of water conservation practices, it is estimated that the City of Menard can reduce water demand by as much as 17 percent
  - Quantity, Reliability and Cost of Water Conservation- By 2060 up to 61 acre-feet of water per year could be saved, a reduction of almost 17 percent. The estimated reductions compare favorably with actual reductions in demand experienced by the city during the recent drought. The estimated per capita water demand in 2030 using the Region F criteria is 161 gpcd. In 2002, the most recent year for which per capita water use data are available, the city had a per capita demand of 161 gpcd. The reliability of water conservation is considered to be medium due to the uncertainty of the long-term savings from implementation of water conservation strategies.
- City of Midland- water conservation
  - Water Conservation- The City of Midland is evaluating and plans to implement an aggressive water conservation program. The city has recently completed a demonstration project at a city park that includes water conserving landscaping and irrigation practices. The city is also considering a rebate program. In addition, the city's wastewater may be used in a proposed reuse project sponsored by CRMWD.
- Brown County Other- no conservation, explanation below
  - Water conservation and drought management were not evaluated for Brown County Other because the demand is small and there is no identified sponsor to implement water conservation or drought management. Based on similar areas, water conservation savings could be expected to be about 14 percent of the demand, or 23 acre-feet per year. Once these users are connected to a surface water source, BCWID and either Brookesmith SUD or Zephyr WSC would be responsible for water conservation and drought management planning in the area.

    - City of Coleman- water conservation
        - Water Conservation- Using the Region F suite of water conservation practices, it is estimated that the City of Coleman can reduce water demand by as much as 14 percent. Additional information on Region F recommended water conservation practices may be found in Appendix 4I Region F recognizes that it has no authority to implement, enforce or regulate water conservation practices. The water conservation practices in this plan are guidelines. Region F considers water conservation strategies determined and implemented by the City of Coleman to supersede the recommendations in this plan and to meet regulatory requirements for consistency with this plan.
    - City of Brady- water conservation
        - Water Conservation- Using the Region F suite of water conservation practices, it is estimated that the City of Brady can reduce water demand by as much as 17 percent
    - Strategies for Hickory Aquifer Users- no water conservation
- Steam Electric Power Generation
    - Because it significantly reduces water usage, ACC cooling technology on future generation projects may be considered a water conservation strategy.
- Irrigation
    - Sixteen of the thirty-two counties in Region F have identified irrigation needs. However, the adoption of advanced conservation technologies throughout the region will help preserve existing water resources for continued agricultural use and provide for other demands.
    - Region F recommends improvements in the efficiency of irrigation equipment as the most effective water conservation strategy for irrigation within the region.
    - In addition to these practices, the region encourages research into development of drought-tolerant crops, implementation of a region-wide evapo-transpiration and soil moisture monitoring network, and, where applicable, water-saving improvements to water transmission systems.
    - . Implementation of irrigation conservation activities could save over 81,000 acre-feet of water by 2060
- Wholesale Water Providers
    - Colorado River Municipal Water District
        - Reuse – CRMWD Reclamation Project
        - Water conservation
    - Brown County Water Improvement District Number 1- no conservation
    - City of San Angelo
        - Rehabilitation of the Spence pipeline by 2010
        - Water Conservation
- Manufacturing- no conservation recommended, explanation below
    - Manufacturing water use is a minor demand in Region F, accounting for less than 2 percent of the water use in the region. From a regional

perspective, savings due to implementation of manufacturing water conservation practices will not be significant. Most manufacturing needs are associated with water supply needs for municipalities. For regional planning purposes, water conservation strategies will be developed for municipalities with needs, not for the manufacturers who purchase water from those municipalities. The region recommends that manufacturing water users be encouraged to develop and implement site specific water conservation practices through their contracts with the municipalities, as required by TCEQ.

- Mining- no conservation recommended, explanation below
    - Most of the mining water use in Region F is used in oil and gas production. In accordance with §27.0511 of the Texas Water Code, Region F encourages the use of alternatives to fresh water for oil and gas production whenever it is economically and technically feasible to do so. Furthermore, Region F recognizes the regulatory authority of the Railroad Commission and the TCEQ to determine alternatives to fresh water use in the permitting process. Because oil and gas production is already a regulated industry, Region F does not feel that additional conservation measures are needed.
- Livestock- no conservation recommended, explanation below
    - Most of the livestock demand in Region F is for free-range livestock. In addition, Region F has added water to account for wildlife that relies on the same water sources as commercial livestock. Region F encourages individual ranchers to adopt practices that prevent the waste of water for livestock. However, the savings from these practices will be small and difficult to quantify. Therefore, livestock water conservation will not be considered in the planning process
- The focus of the conservation activities for municipal water users in Region F are:
    - Education and public awareness programs
    - Reduction of unaccounted for water through water audits and maintenance of water systems
    - Water rate structures that discourage water waste
- These practices were used to evaluate the potential for water conservation for municipal water users with needs. Savings for passive implementation of water-efficient clothes washers was included as well. Implementing these practices could save over 10,000 acre-feet of water by 2060
- Water Conservation- Strategies for water conservation have been recommended that will reduce the demand for water, thereby reducing the impact on the region's groundwater and surface water sources. Water conservation practices are expected to save approximately 6,800 acre-feet of water annually by 2010, reducing impacts on both groundwater and surface water resources. The proposed plan also assumes an additional 115,600 acre-feet per year in savings by 2060

2.7 Region G

- The 2006 Brazos G Regional Water Plan includes recommendations for 21,393 acft/yr of municipal conservation savings and another 43,377 acft/yr for wastewater reuse. The conservation savings are on top of those already included in the TWDB demand projections, and the recommended reuse strategies are in excess of existing reuse supplies in the basin.
- Water Conservation, municipal conservation assumes a reduction in per capita water use of 21 gpcd beginning in year 2020 for municipal WUGs with needs and per capita water use exceeding a target of 140 gpcd. Municipalities are encouraged to utilize any BMPs to achieve the conservation goals, not just those used to develop costs.
- Non-municipal WUGs with needs are recommended by the Brazos G RWPG to reduce total water demand 3 percent by 2010, 5 percent by 2020, and 7 percent from 2030 to 2060 by using Best Management Practices (BMPs).
- Municipal Water Conservation
    - Conservation is recommended for every municipal WUG with a projected need (shortage) and a per capita water use rate greater than 140 gallons per capita per day (gpcd) in 2060. The Brazos G Regional Water Planning Group (BGRWPG) recommends conservation for municipal WUGs with per capita rates greater than 140 gpcd based on the Water Conservation Task Force's statewide gpcd target. This conservation can be achieved in a variety of ways, including using these BMPs identified by the Water Conservation Implementation Task Force.
    - The BGRWPG does not recommend specific conservation BMPs for each municipal entity, as each entity should choose those conservation strategies that best fit their individual situation.
- Irrigation Water Conservation
    - The focus is upon investments in irrigation application equipment, instruments, and conveyance facility improvements (canal lining and pipelines) to reduce seepage losses, deep percolation, and evaporation of water, and management of the irrigation process to improve efficiencies of irrigation water use and reduce the quantities of water needed to accomplish irrigation.
    - In February 2005, the Brazos G RWPG recommended that counties with projected irrigation needs (shortages) reduce their irrigation water demands by 3 percent by 2010, 5 percent by 2020, and 7 percent from 2030-2060 by using BMPs identified by the task force. A reduction in irrigation water demand subsequently reduces shortages for each decade, if water supplies remain constant.
    - The Brazos G RWPG recommended irrigation water conservation (7percent reduction in demands) as a water management strategy for irrigation needs, resulting in a maximum water savings of 8,675 acre feet per year
    - Three water strategies- furrow dikes, LESA, and LEPA- have the potential to increase water savings beyond the minimum recommended by the

Brazos G RWPG; however, none of the strategies can accomplish water savings sufficient to meet all of the projected needs.

- Industrial Water Conservation
  - For the ten mining users with projected needs, the total water savings after 7 percent water demand reduction in 2060 is 1074 acft/yr (a 11% reduction in total regional mining shortages). With the recommended demand reduction, the projected shortages are eliminated for Taylor County.
  - The Brazos G RWPG recommends implementing water conservation for industrial users (manufacturing, steam-electric, and mining) with projected needs amounting to a 3 percent water demand reduction by 2010, 5 percent by 2020, and 7 percent from 2030 to 2060. The eighteen counties in the Brazos G Area with projected manufacturing shortages can save up to 1,430 acft/yr in 2060. The nine counties in the Brazos G Area with projected steam-electric shortages can save up to 13,281 acft in 2060.

2.8 Region H

- Municipal Conservation-- The conservation strategy is applied at the WUG level, reducing demands from 5.5% to 7.0%, depending on the size of the WUG. Projected water savings total 71,109 ac-ft/yr in year 2030 and 101,200 ac-ft/yr in year 2060.
- Industrial Conservation—Industries with projected shortages will seek out ways to reduce their water demand as a means of managing their operating costs. The wide range of industries within Region H, and their varying progress in this area, prevented the estimation of projected savings for this strategy.
- Irrigation Conservation—Reduction of on-farm demands through land leveling, canal lining and other system improvements. Projected water savings are 18,792 acft/yr in Brazoria County, 24,018 a-ft/yr in Chamber County, 5,198 ac-ft/yr in Fort Bend County, 2,392 ac-ft/yr in Galveston County, 20,877 ac-ft/yr in San Jacinto County and 6,606 ac-ft/yr in Waller County.
- Wastewater Reclamation for Industry—This strategy proposes that 67,200 ac-ft/yr of Houston's municipal wastewater be treated and directly reused by industries along the Houston Ship Channel
- Houston Indirect Wastewater Reuse—The City of Houston has applied for a water right permit to indirectly reuse up to 580,900 ac-ft/yr of wastewater discharges. A portion of that is recommended for direct reuse to industry. An additional 98,000 acft/yr is recommended for use beginning in 2050
- NHCRWA Indirect Wastewater Reuse—The North Harris County Regional Water Authority has the potential to indirectly reuse up to 157,000 ac-ft/yr of wastewater discharges. 31,400 ac-ft/yr is recommended for use beginning in 2060
- Recommended Water Management Strategies Related to Water Conservation

Water Management Strategy	Yield (ac-ft/yr)	Capital Cost	Starting Decade
Municipal Conservation	101,200	0	2000
Irrigation Conservation	77,900	$573,000	2010
Industrial Conservation	TBD	TBD	2000
Wastewater Reuse for Industry	67,200	$234,158,000	2020
Houston Indirect Wastewater Reuse	98,000	TBD	2050
NHCRWA Indirect Wastewater Reuse	31,400	TBD	2060

- Water conservation is recommended for all water user groups, although it is calculated and applied for WUGs with shortages
- Recommended Water Management Strategies Related to Conservation by County:
    - Brazoria County- municipal conservation, irrigation conservation
    - Chambers County- municipal conservation, irrigation conservation
    - Fort Bend County- municipal conservation
    - Galveston County- municipal conservation, irrigation conservation
    - Harris County- municipal conservation, wastewater reuse for industry, wastewater reuse- Houston, wastewater reuse- NHCRWA
    - Liberty County- irrigation conservation
    - Montgomery County- municipal conservation
    - Waller County- municipal conservation

- The RHWPG assumed that every municipal WUG with a projected shortage would utilize conservation before seeking out or increasing a WWP contract.
- Rankings of strategies:
    - As would be expected, water conservation and full use of existing supplies rated the highest of the potential strategies. Direct wastewater reuse for industry also rated highly. Although direct reuse is more costly that using existing supply, it is less expensive than developing a new freshwater source, and with fewer environmental impacts. Seawater desalination ranked below direct reuse due to the higher cost of the supply, but it too carried few environmental impacts
- The RHWPG advocates water conservation for all water users in the Region, noting that "the least expensive water you can get is the water you already have." Some conservation will be realized through low-flow water fixture laws (embedded in the demand estimates), and from new energy-efficient clothes washers, but more savings can be achieved. Every water user group and provider is encouraged to establish an aggressive water conservation goal.

2.9 Region I

- Water management strategies considered to meet the shortages included water conservation, wastewater reuse, expansion of existing supplies and new reservoirs. Water conservation includes those actions that could be implemented to provide additional savings in water above that already considered in calculation of the water demands. Water conservation will provide approximately 1% of the supply needed to meet the shortages. Only one wastewater reuse strategy, for the City of Athens, was identified.
- The water demand projections developed assume that approved conservation plans are in place and effective for all entities. The savings in water, associated with reduction in per capita usage attributed to the conservation measures, is estimated to be 20,600 acre-feet per year in 2060. The assumed reductions tended to increase for future projections. Conservation activities that were assumed to be in place for the projections included:
    - Water-efficient plumbing fixtures consistent with the State Water Efficient Plumbing Act of 1991;
    - More thorough use of leak detection processes;
    - More widespread use of water efficient appliances
- Water conservation strategies for other users; Irrigation, Steam-Electric, Livestock and Mining; were not developed. The above four users comprise between 25% to 33% of the total water demand in the Region during the planning period. Water conservation has recently begun to be utilized in irrigation of rice in one area of the East Texas Region. The water conservation efforts were driven by economic reasons (i.e. billing of water used from metered flow as opposed to acreage farmed). The financial incentive has led to four conservation measures being implemented; irrigation scheduling, field maintenance, land leveling and tail water recovery. Metering began in 2004 but it was not until 2005 that billing on the amount metered was implemented. Comparison of the two years indicated average water consumption to be reduced from 3.79 acre-feet per acre farmed to 2.84 acre-feet per acre farmed. The demand for Steam- Electric use is projected to grow from 4% to 12% of the demand during the 50 year period. The projections for Steam-Electric use was provided by the TWDB. Most of the demand will be consumed by new projects which include conservation in the projected water use. Livestock and mining comprise a total of 4% to 5% of the demand. The cost of water in these industries comprises a small percentage of the overall business cost and it is not expected these industries will see an economic benefit to water conservation.
- Municipal Water Conservation Strategies
    - Summary: Water conservation strategies were evaluated for those municipal users showing a need during the planning period and have a per capita water use greater than 140 gpcd. Entities with this type of use customarily have larger commercial and industrial users in relation to the general population. Water conservation practices evaluated included public and school education, water conservation pricing, and passive implementation of new water conserving clothes washers. Public and school education would involve providing formal and indirect means of

information on how to conserve water. Water conservation pricing requires an increasing rate structure with increasing use. The effectiveness of this measure is in part affected by whether water conservation pricing is currently implemented. The passive implementation of new water conserving clothes washers is the natural replacement of clothes washers with time.

- Education:
  - Education costs were applied to all of the entities meeting the above criteria. Assumptions made in evaluating the efficiency of this measure included restrictions that the annual budget spent on education would be limited to approximately $1.00 per capita or per 1000 gallons water conserved, whichever was most restrictive. The total budget available will be an indication as to the effectiveness of the program.
- Water Conservation Pricing:
  - Water conservation pricing will be most effective in areas where groundwater resources are becoming less available and requires high expenditures in capital projects to supply water. Only those entities meeting the above criteria and located in counties that are reaching the limits of groundwater were considered for this strategy. Where the recommended strategies were less than $1.00 per 1000 gallons the efficiency achieved is assumed to be 1.0%. A 2% efficiency is assumed where the recommended strategy exceeds $1.00 per 1000 gallon.
- Passive Clothes Washer:
  - Implementation of the passive clothes washer strategy was limited to areas where the recommended strategy exceeds $1.00 per 1000 gallon. The assumptions made in this strategy include a replacement rate of 7.7% per year with a total saving of 5.6 gpcd where installed.

- Manufacturing
  - The criteria for evaluating water conservation measures in manufacturing uses was limited to counties showing a need in this sector during the planning period with use greater than 1000 acre-feet per year or with an identifiable industry with water use greater than 500 acre-feet per year. The counties meeting this criteria include Angelina, Nacogdoches, Newton, Orange and Polk.
  - There are readily available supplies of water to meet manufacturing needs in Newton, Orange and Polk counties. Development of water management strategies for Angelina and Nacogdoches will require more intense planning. The timber and paper industries in Angelina County for the most part provide their own ground or surface water. Any conservation measures taken on their part will more than likely be based on economic justification to expand plant capacity and will not affect water availability to the Region as a whole. The remaining industries, food and manufacturing facilities in Angelina and Nacogdoches counties should be

considered for water conservation. The majority of the water in these sectors are supplied by municipal suppliers that face the needs for major water management strategies.

  - TWDB Report 362 lists fourteen best management practices for industrial users. Application of each of the practices to the food and manufacturing industries in Angelina and Nacogdoches counties is not practical at this time. However, the industrial water audit practice is a feasible alternative to consider for implementation. The TWDB Report 362 reports that an audit should result in savings of 10 to 35 percent if an audit has not been performed.

- Reuse
  - One wastewater reuse strategy was defined for the East Texas Region. Athens MWA has received a reuse permit that allows the City of Athens to discharge its wastewater effluent to Lake Athens. This discharge will be redirected for water supply. The reuse permit is for 2,677 acre-feet per year. This strategy is targeted to meet livestock needs in Henderson County.

2.10 Region J

- Reuse
    - Water recycling, or reuse, is reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation or industrial processes. The City of Kerrville and the Town of Camp Wood have active water reuse programs.
    - In Kerrville, wastewater is treated to strict government standards. In fact, Kerrville treats its wastewater to the strictest set of standards in the State of Texas. Because of the high level of treatment, Kerrville's wastewater nearly meets drinking water standards. Treated wastewater is pumped through a dedicated pipeline for reuse as irrigation water for the Scott Schreiner Municipal Golf Course, the Hill Country Youth Soccer Fields, and the golf course at Comanche Trace Ranch & Golf Club. Additional treated water is sold by the truckload for construction projects. The remaining wastewater is released into Third Creek, which flows into Flatrock Lake on the Guadalupe River. That water is then available for use downstream of Kerrville. Future expansion of Kerrville's reuse project is anticipated to yield approximately 1 million gallons per day. The current thinking within city leadership is that potable reuse is a better use for that water than irrigation.
    - The Community of Camp Wood also has a water reuse program. Treated wastewater is used to irrigate hay fields in the near vicinity of town
- Water conservation management strategies recommended for Kerrville and Camp Wood include water audits and loss audits to reduce distribution losses, and public education to bring awareness of wasteful practices. Brush management, rainfall harvesting, and conservative landscape irrigation are recognized as constructive conservation practices on a regional scale.
- Agricultural resources are protected in this plan by providing irrigation strategy recommendations that address irrigation conservation best management practices. These strategies include appropriate application scheduling, use monitoring, and use of low-pressure delivery systems. If implemented, these practices will result in reduced water application per acre irrigated. Also, non-agricultural strategies include an analysis of potential impact to agricultural interests.
- City of Kerrville
    - Kerrville passed a comprehensive water management plan in 2004. This plan focuses on water conservation and efficient management of local water resources. The plan outlines water conservation activities and provides guidance for the various stages of emergency water conservation measures and enforcement. 2003 water use surveys indicate that Kerrville is using approximately 189 gallons per capita per day (GPCD). If a 1 percent annual reduction in demand is adopted, Kerrville would reach the Texas Water Conservation Taskforce recommended target of 140 GPCD around 2030.
    - The availability of water will become a factor limiting the growth of both Kerrville and Kerr County. Water management strategies that the City can consider as possible future sources of supply include:

        - Contracting with UGRA for additional water supply to be delivered to Kerr County.
        - Increased water treatment capacity.
        - Increasing water treatment capacity in conjunction with growth of ASR.
        - Development of a remote well fields to provide additional groundwater sources beyond the Lower Trinity in the Kerrville area.
        - Municipal conservation savings
- Municipal Water Management Strategies Related to Water Conservation
    - Strategy J-5, Water User Name: City of Kerrville
        - Strategy: System water audit and water loss
        - Time intended to implement: Short Term (prior to the year 2030): To be implemented during this period. Long Term (from the year 2030 to the year 2060): To be continued indefinitely.
        - Quantity of Water: In conjunction with Strategy J-6 (public information) a total of 1 percent reduction in demand is anticipated. This would result in a water savings of 44 acre-feet in 2010 and increasing to 53 acre-feet by 2060.
    - Strategy J-6, Water User Name: City of Kerrville
        - Strategy Name: Public Information
        - Strategy Description: Public information programs, even though they may not be directly related to any equipment or operational change, can result in both short- and long-term water savings. Behavioral changes by customers will only occur if a reasonable yet compelling cause can be presented with sufficient frequency to be recognized and absorbed by the customers. There are many resources that can be consulted to provide insight into implementing effective information programs. Like any marketing or public information program, to be effective, water conservation public information should be planned out and implemented in a consistent and continual manner.
        - The goal is education of customers about the overall picture of water resources in the community and how conservation is important for meeting the goals of managing and sustaining existing water supplies and avoiding or delaying building new facilities. An equally important part of the program is to provide data and information on specific actions and measures the customers should take to implement these community goals. Showing customers that the results of those actions have made a difference encourages greater participation in conservation efforts.
        - Time intended to implement: Short Term (prior to the year 2030): To be implemented during this period. Long Term (from the year 2030 to the year 2060): To be continued indefinitely.
        - Quantity of Water: In conjunction with Strategy J-5 (system water audit and water loss) a total of 1 percent reduction in demand is

anticipated, which would result in a water savings of 44 acre feet in 2010 and increasing to 53 acre-feet by 2060.

- Strategy J-9, Water User Name: Town of Camp Wood
  - Strategy Name: System water audit and water loss
  - Time intended to implement: Short Term (prior to the year 2030): To be implemented during this period. Long Term (from the year 2030 to the year 2060): To be continued indefinitely
  - Quantity of water: In conjunction with Strategy J-10 (public information) a total of 1 percent reduction in demand is anticipated. This would result in a water savings of approximately 2 acre-feet per year.
- Strategy J-10, Water User Name: Town of Camp Wood
  - Strategy Name: Public information
  - Time intended to implement: Short Term (prior to the year 2030): To be implemented during this period. Long Term (from the year 2030 to the year 2060): To be continued indefinitely.
  - Quantity of Water: In conjunction with Strategy J-9 (system water audit and water loss) a total of 1 percent reduction in demand is anticipated. This would result in a water savings of 2 acre feet annually.

- Irrigation Water Management Strategies
  - The Plateau Water Planning Group suggests that river authorities, river masters, agricultural agencies, and groundwater conservation districts encourage irrigators to implement BMPs. The following BMPs have been selected for their suitability to the irrigation practices occurring in the Plateau Region.
  - Agricultural Irrigation Water Use Management
    - Irrigation Scheduling
    - Volumetric Measurement of Irrigation Water Use
    - Crop Residue Management and Conservation Tillage
    - On-Farm Irrigation Audit
  - On-Farm Water Delivery Systems
    - Low Pressure Center Pivot Sprinkler Irrigation Systems
- Brush Management
  - Selective Brush Management, as a tool to improve watershed yields and water quality, is a strategy of great interest in the Plateau Region, as well as in surrounding planning regions. Funding and direction is needed to expedite multi-disciplinary research to develop methodologies of defining watersheds of greatest potential for increasing water yields. Teams of geologists, hydrologists, ecologists, wildlife biologists, economists and rangeland scientists working with GIS and various types of aerial photography would have the highest probability of developing tools to identify and quantify the best yielding watersheds for treatment. These studies would estimate the cost-benefit ratios of this Best Management Practice (BMP) including cost of initial brush management; ecological benefits; grazing benefits; reseeding costs, if necessary; and other range

management BMPs as needed to restore brush-infested rangelands while preserving or enhancing wildlife and esthetic values. The end product would quantify both the short-term and long-term costs and benefits per acre-foot of water to such a regional program. Downstream and aquifer users in urban areas would possibly be major beneficiaries and as such should be part of the final equation and possibly part of the funding mechanism. Studies should be of a realistic, large-scale size in order to more accurately correlate with full-scale watershed treatments.

  - Currently, Texas Parks & Wildlife Department (TPWD) has a program specifically directed at utilizing BMPs for landowners involving brush management in areas possibly containing endangered species. As has been proven on the Kerr Wildlife Management Area (TPWD) with long-term studies, selective brush management coupled with good rangeland management can benefit endangered species and ranchers as well. It is highly likely that watershed values will fit into the same package to provide a win-win situation for all. The voluntary partnership of landowners and TPWD is important to this program, just as it was under the NRCS' Great Plains Program. However, as major parts of targeted watersheds must be treated in order to provide the desired hydrological benefits, it is likely that a high percentage of watershed landowners must opt-in to the program before it could be accepted by the State for treatment and management contracts.
  - The PWPG joins with the Rio Grande Region (M) and the Far West Texas Region (E) in encouraging funding for projects aimed at the eradication and long-term suppression of salt cedar and other nuisance phreatophytes in the Rio Grande watershed.

- Conservation Management of State Owned Lands
  - All state-owned land should be managed in ways that enhance water conservation. State agencies need to take the lead in water conservation and it should start on state-owned properties. Unless State agencies set good conservation examples for the public, any public program encouraging such conservation will likely be perceived as "do as I say, not as I do", something that never plays well. Considering that approximately 95 percent of Texas land is privately owned, the State needs to be convincing when making recommendations to the public if it hopes to be successful.
- Development of Educational Programs by the State for Regional Water Planning Groups
  - There is a need for the development of educational programs by State agencies to assist Regional Water Planning Groups in educating both the public and private sectors. Examples of the educational programs include the following:
    - Encourage development and construction of recharge structures
    - Encourage rainfall harvesting to supplement or replace aquifer pumping

- Educate and encourage municipalities to manage water systems to maximize their preparedness for drought conditions
- Encourage the public to conserve water through low-flow appliances and fixtures, low-water landscaping and elimination of waste

2.11 Region K

- Conservation was recommended as the first strategy for all municipal WUGs within the CRWPA that were expected to have a shortage and had a per capita demand in excess of 140 gallons per capita per day (gpcd). The LCRWPG recommends a 1 percent reduction in per capita use annually for all municipal WUGs with shortages and per capita usage above 140 gpcd.
- Rice Irrigation Water Management Strategies with Conservation- continued use of Austin Return Flows, on farm conservation, irrigation district conveyance improvements
- Steam Electric Water Management Strategies with Conservation- Indirect and Direct Reuse
- Water conservation is recommended for all water user groups, although it is calculated and applied for WUGs with shortages
- The LCRWPG recognizes the complexities and the seemingly insurmountable political obstacles that prevent the adoption of growth management plans. Therefore, it is the LCRWPG's recommendation that the issue of sustainable growth be addressed primarily through educational efforts. The LCRWPG strongly supports the proposed state-wide Water IQ public education campaign and encourages that this campaign be saturated with information regarding the finite nature of water resources and the inescapable trade-offs that inevitably must occur when water use in a given geographic area or economic sector increases. Care must be taken in such a program to highlight the need for a balance to be sought among competing water uses that would ensure the maintenance of:
    - Healthy riparian, riverine, estuarine, and hardwood bottomland ecosystems
    - Historic cultural resources
    - Regional economic opportunities
    - Agricultural development
    - Preservation of rural communities
- City of Austin
    - The COA plans to meet its future needs with a combination of conservation, municipal effluent reuse, and additional contract water from LCRA. The COA conservation program has been successful at making significant impact upon peak and average water demands, and this strategy aims to further reduce demands placed on the city's supplies by continuing these efforts. Reclaimed water will be used, either directly or indirectly, to provide for municipal, manufacturing, and steam electric demands, and this resource will be used in a continuously greater capacity through the decades of the planning period.
    - Water Conservation
        - The COA began an aggressive water conservation campaign in the mid 1980s in response to rapid growth and a series of particularly dry years. COA has achieved significant reductions in both per capita consumption and peak day to average day demand ratio. For the per capita use calculations, the COA used year 1998 as their

base year instead of year 2000, since the COA had mandatory water conservation measures in place during year 2000.

- The adopted LCRWPG projections for municipal, manufacturing, and wholesale water commitments for the COA and its wholesale customers are projected to increase from approximately 188,776 ac-ft/yr in the year 2000 to approximately 378,686 ac-ft/yr in 2060. Projections for water demands in succeeding decades assume the continuation and expansion of the City's conservation programs. These programs represent a roughly 9 percent savings in 2060 over the demands with no per capita reduction. With conservation and reuse an overall per capita reduction of roughly 11 percent is projected.
- In 1990, the City's conservation program evolved from primarily reacting to high summertime demands to a comprehensive program with the goals of reducing both per capita consumption and peak day demand. To achieve these broader goals, the City has implemented and anticipates continuing water conservation programs in a number of areas including:
    - Public education and outreach including school programs
    - Rebate and incentive programs
    - Local ordinances that increase water efficiency by customers
    - Support of legislation that increases water efficiency in plumbing products and appliances at both the State and Federal level
    - Increased water efficiency in utility operations
    - Conservation-oriented rate structures

- Reclaimed Water Initiative
    - The COA reclaimed water alternative includes the development of water distribution systems to provide reclaimed water to meet non-potable water demands within the City's service area. The City is currently constructing its Central Reclaimed Water System from the Walnut Creek WWTP. This system is expected to have a planning horizon capacity of 18,000 ac-ft/yr. In addition, the City is constructing a similarly sized South Reclaimed Water System from the South Austin Regional WWTP. Austin has also evaluated the feasibility of developing reclaimed water facilities in other areas of the City. The City projects that it will need to develop the use of reclaimed water to the maximum extent possible, up to, if necessary, 100 percent reuse of its effluent to meet future needs. As the level of authorized reclaimed water use in the COA increases, the amount of flow it returns to the Colorado River may decrease accordingly. Development of reclaimed water facilities necessary to provide for the projected 2060 direct municipal reuse (non-potable) demands of 33,537 ac-ft/yr is anticipated to require a

capital expenditure of $178 million. The unit cost of reclaimed water is expected to be $445 per ac-ft

- In addition to the water conservation measures the COA has implemented to reduce water demands, the COA is pursuing the development of reclaimed water as an additional supply of water to meet non-potable demands in the area. The COA has indicated that it will develop and use reclaimed water as the primary strategy to meet the projected needs in 2060, and likely beyond. To meet the total projected water demands, the Water Reclamation Initiative would need to supply up to 33,537 ac-ft/yr for direct municipal non-potable purposes by the year 2060 plus approximately 13,690 ac-ft/yr of COA direct non-potable use for steam electric needs in Travis County. The total amount of this direct reuse supply in Travis County is 47,227 ac-ft/yr. Additionally, Austin has proposed an indirect reuse project for its steam electric demands in Fayette County, at the Fayette Power Project. The projected amount of effluent needed to meet Austin's projected indirect reuse needs at the Fayette Power Project is 27,411 ac-ft/yr. Therefore, the total amount of projected reuse is 74,638 ac-ft/yr.
- The City is currently using reclaimed water from its existing reclaimed system to irrigate several golf courses and meet other non-potable needs. The City estimates this use to be 2,000 ac-ft/yr. In order to expand the availability and use of reclaimed water, the COA has completed a series of planning activities, including the publication of the 1998 Water Reclamation Initiative (WRI) Planning Document, and completion of the north and south system master plans. In addition, COA is in the process of developing an implementation plan in conjunction with the Federal Bureau of Reclamation (FBR).

- Agricultural Conservation
  - The LCRWPG supports further efforts to promote agricultural conservation practices. The large magnitude of agricultural demands indicates a strong potential for making a major reduction in overall demand through conservation. In particular, the LCRWPG supports increased funding of programs such as the Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP) and future cooperation between municipalities and farmers as in the LSWP
- Reuse
  - Approximately 60 percent of all municipal diversions by the City of Austin (COA) and others are currently returned to the Colorado River as effluent discharges. Unless otherwise authorized by permit, once discharged to the river, this water is subject to diversion under existing water rights' permits. Further, state law currently allows a water right holder to directly reuse all of its effluent unless its permit restricts such use. As recognized elsewhere in this Plan, control and ownership of these

return flows is the subject of litigation. The November 2004 version of the WAM for the Colorado River that was used for this round of planning (with the "No Call" modifications) excludes all sources of return flows in the model.

- The LCRWPG supports reuse as a water management strategy but acknowledges that the practice has many complex issues that may have long-term impacts. The LCRWPG looks to continue monitoring of legislative activity involving reuse and supports further review of planned reuse projects.

- Education
  - Because public involvement is an important part of the planning process, public education is vital for assuring that constituents are aware of planning issues and their role in the planning process. The LCRWPG has set forth seven goals to increase public awareness of the regional water planning process in the LCRWPA. In addition, the LCRWPG moved to support the recommendations of the Water Conservation Implementation Task Force to the Legislature to increase awareness of the importance of water conservation and the protection of the state's water resources.
- Irrigation
  - On-Farm Water Conservation
    - The water needed for irrigation in Colorado, Wharton, and Matagorda Counties is the largest deficit identified within the LCRWPA. On-farm water conservation for irrigation is one of the water management strategies developed under LSWP to address the issue.
    - It is anticipated that significant water savings can be achieved through the use of precision land leveling, multiple field inlets, and reduced levee intervals. The estimated amount of water savings from on-farm water conservation from the LSWP 2005 Project Viability Assessment (PVA) for the 2006 LCRWPG Water Plan (CH2M HILL 2005) is 36,519 ac-ft/yr of water savings in an average scenario which is slightly less than the 37,348 ac-ft/yr that the 2001 Region K Water Plan estimated. The conservation estimate was based on updated estimates of total rice acreage in each irrigation district, and the estimates are slightly different from those used in the 2001 Region K Water Plan. These estimates will continue to be refined throughout the LSWP study period.
    - There are many potential on-farm irrigation improvements, but in general water savings can best be achieved by minimizing flooding depth and improving management of the flushing and flooding operations. The techniques that have the most significant impact in accomplishing these goals include precision or laser land leveling, use of a field lateral with multiple field inlets, reducing the vertical interval or elevation difference between levees, improved management of water control activities, and improved

recordkeeping. Individual water conservation measures are discussed in the following sections
        - Several combinations of conservation practices could be evaluated, but the LCRWPG Rice Irrigation Working Group decided that the most common combined approach that would result in the greatest water savings would be the combination of land leveling with the use of multiple inlets. In many cases the farmers that use these two conservation practices may also implement a reduced levee interval, but the cost associated with the additional combination of conservation practices becomes less discernible as does the water savings.
    - Irrigation District Conveyance Improvements
        - The water needed for irrigation in Colorado, Wharton, and Matagorda Counties is the largest deficit identified within the LCRWPA. Irrigation district conveyance improvement is one of the water management strategies developed under LSWP to address the issue.
        - The 2004 LSWP PVA estimated 76,891 ac-ft/yr of water savings from improved efficiency of rice irrigation delivery system by the irrigation districts in an average scenario. The 2001 Region K Plan estimated an amount of 45,650 ac-ft/yr of water savings from this water management strategy. The improved efficiency of rice irrigation delivery system savings amount adopted for the 2006 Region K Water Plan is 46,184 ac-ft/yr. This amount is obtained as a difference between the total LSWP irrigation savings dedicated to Region K of 118,000 ac-ft/yr and the total of the other two estimated LCRA-SAWS irrigation savings strategies.
- Steam Electric Power Water Management Strategies
    - City of Austin Steam Electric Water Management Strategies
        - Direct and indirect reuse
    - STP Nuclear Operating Company Water Management Strategies
        - In order to ensure a long-term, cost-effective water supply beyond expiration of the current LCRA contract in 2030, this regional plan anticipates renegotiation and renewal of contractual supplies to supplement run-of-the river diversions. Additional and alternative strategies include but are not limited to the following:
            - Desalination of brackish water
            - Rainwater harvesting
            - Subordination of upstream senior water rights
            - Dedication of return flows from other users
            - Conservation also is an integral part of STPNOC's operational philosophy as documented in the Water Conservation Plan filed with the TCEQ
- Brush Control

- The LCRWPG adopted the following motion regarding the potential water supply benefits of brush management for the purpose of enhancing water supplies:
    - The LCRWPG recommends and endorses studies of brush control projects on a voluntary basis for the Lower Colorado Region, especially west of Interstate Highway 35, and recommends that state and/or federal funds be made available for landowner assistance on a pro-rata basis as needed or requested

2.12 Region L

- The South Central Texas Regional Water Plan includes recommended water management strategies that emphasize water conservation; maximize utilization of available resources, water rights, and reservoirs; engage the efficiency of conjunctive use of surface and groundwater, avoid development of large new reservoirs; and limit depletion of storage in aquifers. There are additional strategies that have significant support within the region, yet require further study regarding quantity of dependable water supply made available during severe drought, feasibility, and/or cost of implementation, that are also included in the Plan. Water management strategies recommended to meet projected needs in the South Central Texas Region could produce new supplies in excess of 738,000 acft/yr in 2060.
- Water management strategies emphasizing conservation comprise about 16 percent of recommended new supplies and include:
    - Municipal Water Conservation (72,570 acft/yr @ $432/acft/yr);
    - Steam-Electric Water Conservation (28,459 acft/yr);
    - Irrigation Water Conservation (14,089 acft/yr @ $113/acft/yr); and
    - Mining Water Conservation (1,425 acft/yr).
- Water management strategies maximizing use of available resources, water rights, and reservoirs comprise about 29 percent of recommended new supplies and include:
    - Edwards Transfers (71,335 acft/yr @ $135/acft/yr);
    - SAWS Recycled Water Program Expansion and other Recycled Water (46,634 acft/yr @ $434/acft/yr);
    - Canyon Reservoir (27,150 acft/yr @ $294/acft/yr+);
    - Wimberley & Woodcreek Water Supply from Canyon Reservoir (4,636 acft/yr @ $989/acft/yr);
    - Purchase from Wholesale Water Provider (LNRA) (489 acft/yr @ $897/acft/yr);
    - Surface Water Rights (2,867+ acft/yr); and
    - Lower Guadalupe Water Supply Project for GBRA Needs (63,072 acft/yr @ $1,344/acft/yr)
- Water management strategies that simultaneously develop groundwater supplies and limit depletion of storage in regional aquifers comprise about 19 percent of recommended new supplies and include:
    - Local Carrizo, Gulf Coast, Trinity, and Barton Springs Edwards (46,917 acft/yr @ $135/acft/yr - $904/acft/yr);
    - Regional Carrizo for Bexar County Supply (56,188 acft/yr @ $862/acft/yr);
    - Regional Carrizo for SSLGC Project Expansion (12,800 acft/yr @ $411/acft/yr);
    - Hays/Caldwell Carrizo Project (15,000 acft/yr @ $694/acft/yr);
    - Wells Ranch Project (3,400 acft/yr @ $690/acft/yr); and
    - Brackish Groundwater Desalination – Wilcox Aquifer (5,662 acft/yr @ $1,502/acft/yr)

- Recommended water management strategies that engage the efficiency of conjunctive use of surface and groundwater as well as maximize the use of available resources and water rights comprise approximately 25 percent of recommended new supplies and include:
    - Edwards Recharge – Type 2 Projects (L-18a) (21,577 acft/yr @ $1,355/acft/yr);
    - CRWA Dunlap Project (5,600 acft/yr @ $956/acft/yr)
    - CRWA Siesta Project (5,042 acft/yr @ $853/acft/yr); and
    - LCRA-SAWS Water Project (150,000 acft/yr @ $1,326/acft/yr
- Reuse
    - Current water supplies in the South Central Texas Region involving reuse of treated wastewater are associated with the Recycled Water Program of the San Antonio Water System (SAWS) and contractual commitments by the Guadalupe-Blanco River Authority (GBRA) and the City of San Marcos. SAWS has installed a distribution system capable of transmitting up to about 35,000 acft/yr of recycled water from its Leon, Salado, and Dos Rios Water Recycling Centers to a number of customers in the San Antonio area. For regional planning purposes, current reuse supplies of 18,994 acft/yr for landscape irrigation (municipal) use and 7,723 acft/yr for industrial use from the SAWS Recycled Water Program have been included for water users of Bexar County. Pursuant to a commitment by GBRA from their Dunlap Wastewater Treatment Plant, a reuse supply of 1,120 acft/yr has been included as supply for steam-electric use in Guadalupe County. Similarly, a contractual commitment of 3,936 acft/yr by the City of San Marcos has been included as a reuse supply for steam-electric use in Hays County.
- Municipal Water Conservation
    - The Municipal Water Conservation water management strategy includes conservation practices and programs to reduce per capita water use in cities by amounts in addition to reductions already incorporated into the TWDB water demand projections. The SCTRWPG established municipal water conservation goals as follows:
        - For municipal WUGs with water use of 140 gpcd and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 gpcd is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year for the remainder of the planning period
        - For municipal WUGs having year 2000 water use of less than 140 gpcd, the goal is to reduce per capita water use by one-fourth percent per year (0.25% per year).
    - Best Management Practices (BMPs) for water conservation, as identified by the Water Conservation Implementation Task Force, are recommended as means of achieving these municipal water conservation goals. The objective of municipal water conservation programs is to reduce the per capita water use parameter without adversely affecting the quality of life

        - Use of low flow plumbing fixtures (e.g., toilets, shower heads, and faucets that are designed for low quantities of flow per unit of use);
        - The selection and use of more efficient water-using appliances (e.g., clothes washers and dishwashers);
        - Modifying and/or installing lawn and landscaping systems to use grass and plants that require less water;
        - Repair of plumbing and water-using appliances to reduce leaks; and
        - Modification of personal behavior that controls the use of plumbing fixtures, appliances, and lawn watering methods.
    - The SCTRWPG recognizes that meeting the water conservation goals through implementation of these, or other, BMPs represents the highest practicable level of water conservation pursuant to 31 TAC 357.7(a)(7)(A)(iii). Planned additional municipal water conservation focused on these BMPs could effectively increase supply through demand reduction in the South Central Texas Region by about 72,570 acft/yr in the year 2060 at unit costs ranging from $432 per acft/yr to $494 per acft/yr.
    - The Municipal Water Conservation water management strategy includes retrofit of plumbing fixtures, adoption and use of efficient clothes washers, and significant reduction of lawn and landscape watering. The combined plumbing fixtures, clothes washers, and lawn watering water conservation practices would reduce municipal water demand by 13,231 acft/yr in 2010, 31,616 acft/yr in 2030, and 72,570 acft/yr in 2060 (Section 4C.1). Of these totals, in 2010, 91 percent would be from plumbing fixtures and clothes washers, and 9 percent would be from lawn watering. In 2030, of the 31,616 acft/yr of municipal water conservation, 48 percent would be from plumbing fixture and clothes washer retrofit, and 52 percent would be from lawn irrigation, while in 2060, the 72,570 acft/yr of municipal water conservation would be 26 percent would be from plumbing fixtures and clothes washers, and 74 percent would be from lawn irrigation.
- Industrial Water Conservation
    - The Industrial Water Conservation strategy can achieve water conservation through the use of BMPs such as water audits, waste reduction submetering, cooling towers, reuse of process water, landscape water conservation, and specific water conservation plans designed for individual manufacturing plants. The SCTRWPG recommends that water conservation be considered by individual industries, as a means to meet a part of the projected water needs.
- Steam-Electric Water Conservation
    - The Steam-Electric Water Conservation strategy achieves water conservation through the use of BMPs such as air-cooling or other cooling systems that can significantly reduce existing and projected water demands for steam-electric power generation. It is recommended that implementation of this strategy would reduce projected demands assigned

to Guadalupe and Hays Counties by 28,459 acft/yr in 2060. Costs for this strategy have not been estimated due to lack of available data. The SCTRWPG recognizes that it may not be economically feasible to satisfy all projected water needs for steam-electric power generation in Guadalupe and Hays Counties.

- Irrigation Water Conservation
  - The Irrigation Water Conservation strategy achieves water conservation through the installation of Low Energy Precision Application (LEPA) irrigation systems and furrow dikes. Recommended implementation of these conservation measures in Atascosa, Bexar, Medina, and Zavala Counties could effectively increase supply for irrigation through demand reduction by up to 23,074 acft/yr at a unit cost of $113 per acft/yr.
- Mining Water Conservation
  - The Mining Water Conservation strategy achieves water conservation through the use of recommended BMPs such as onsite collection and use of precipitation runoff and onsite reuse of process water. Volume II, Section 4C.1 includes a listing of other potential BMPs. It is recommended that implementation of this strategy could reduce projected demands assigned to Bexar Comal Counties by 1,425 acft/yr in 2060. Costs for this strategy have not been estimated due to lack of available data.
- Recycled Water Programs
  - The Recycled Water Use water management strategy involves expansion of programs that reclaim municipal wastewater for non-potable uses such as irrigation of golf courses, parks, and open spaces of cities, landscape watering of large office and business complexes, cooling of large office and business complexes, steam-electric power plant cooling, process or wash water for mining operations, irrigation of farms that produce livestock feed and forage, irrigation of farms that produce sod, ornamentals, and landscape plants, and for instream uses such as river walks and waterways. This strategy is being used within the region by entities including SAWS, SARA, New Braunfels Utilities, the City of Seguin and the City of San Marcos and can be expanded as the quantities of municipal wastewater increase with population growth. An advantage of this strategy is that the water has already been developed and brought to the locations of many of the uses listed above.
  - One specific example of this water management strategy involves the phased expansion of SAWS Recycled Water Program to provide dependable water supplies for non-potable uses and meet about 20 about percent of SAWS projected municipal and industrial water demands. The existing SAWS recycled water system is capable of delivering about 35,000 acft/yr and consumptive reuse of about 25,000 acft/yr is included in the 2006 Regional Water Plan as current supply. Planned phased implementation of this water management strategy will provide additional dependable annual supplies of about 18,700 acft in 2010 and about 36,250 acft in 2060 at an estimated unit cost of $434 per acft/yr. Facilities for

future expansion are expected to include a southern interconnection between the Leon Creek and Dos Rios Water Recycling Centers and a northern interconnection linking the Leon Creek and Salado Creek transmission lines.

- Agricultural Water
  - Feasibility of Meeting Irrigation Water Needs: The SCTRWPG finds that, under current conditions, it is not economically feasible for agricultural producers to pay for additional water supplies to meet all of the projected irrigation water shortages. See Section 4C.1.2 for an analysis of economic feasibility underlying this finding of the Regional Water Planning Group. The SCTRWPG recommends that the TWDB undertake economic studies of water management strategies that may meet irrigation needs in Texas.
  - Agricultural Water Conservation Programs: The SCTRWPG recommends restoring funding to the Agricultural Water Conservation programs provided by the TWDB.
  - Water Use Information: The SCTRWPG recommends that TWDB improve the water use information for irrigation and livestock watering categories
- Irrigation Technology Center
  - The State should provide additional funding for the Irrigation Technology Center, as instituted by the Texas A&M University System, in order to provide hands-on access to state-of-the-art water conservation technologies tailored to the specific urban and agricultural conservation needs of this region

2.13 Region M

- The Rio Grande RWPG has adopted five basic goals or "pillars" that underlie their regional water plan. These are:
    - Optimize the supply of water available from the Rio Grande;
    - Reduce projected municipal water supply needs through expanded water conservation programs;
    - Diversify water supply sources for DMI uses through the appropriate development of alternative water sources (e.g., brackish water desalination, seawater desalination, reuse of reclaimed water, groundwater); and
    - Minimize irrigation shortages through the implementation of agricultural water conservation measures and other measures; and
    - Recognize that the acquisition of additional Rio Grande water supplies will be the preferred strategy of many DMI users for meeting future water supply needs
- Irrigation
    - Because the Rio Grande is the main source for both DMI use and irrigation use, optimizing the supply of water available from the river is an important aspect of protecting the state's water, agricultural, and natural resources. A key strategy here is implementing on-farm practices and rehabilitating irrigation systems to conserve water.
    - For irrigation users, the water management strategies considered for this plan are:
        - Agricultural water conservation (conveyance system)
        - On-farm water use efficiency
    - Analyses conducted for the Rio Grande RWPG found that improvements to irrigation district conveyance systems and on-farm conservation measures can produce significant water savings at economical costs.
    - Conveyance system improvements could produce water savings of more than 243,000 AF/yr – about 40 percent of the total water shortage projected for the 8-county area in 2060 – at an annual cost of less than $121/AF. On-farm conservation measures could produce annual savings of more than 274,000 AF/yr at an annual cost of about $253/AF.
    - Recommendations for improvements to conveyance systems include:
        - installing no-leak gates;
        - installing additional water measurement devices;
        - converting smaller concrete canals in poor condition to pipeline;
        - lining smaller earthen canals previously constructed of more porous soils; and
        - implementing a verification program to monitor and measure the effectiveness of the efficiency improvements
    - Technologies and methods available for on-farm conservation include plastic pipe (poly pipe), low energy precision application systems, irrigation scheduling using an evapotranspiration network, drip irrigation, metering, unit pricing of water, and switching to water efficient crops.

    - There is tremendous potential for water savings in both areas: 274,000 AF through on-farm improvements and 243,000 AF through conveyance system improvements. In the long run, total water savings associated with both strategies would allow irrigators to offset water supply deficits. However, the implementation timeframe will not offer immediate relief.
    - However, there are few programs that provide financial assistance to irrigation districts for infrastructure improvements. Because agricultural water conservation is a central element of this regional water plan – and is essential to maintaining the viability of this sector of the regional economy – the Rio Grande RWPG recommends that new public funding sources be developed to assist irrigation districts with implementing conservation programs
- The Rio Grande RWPG identified three primary strategies for meeting increasing domestic, municipal and industrial (DMI) needs:
    - Optimize the supply of water available from the Rio Grande;
    - Expand water conservation programs; and
    - Diversify water supplies for DMI use by developing alternative sources, including reused or reclaimed water, groundwater, and desalination
- Municipal
    - The Rio Grande RWPG identified 10 municipal strategies for meeting water demand. The most economical is implementing advanced water conservation measures, such as retrofitting plumbing fixtures and installing water-wise landscaping. Total cost of all water management strategies identified approaches $235 million.
    - Few opportunities exist to increase the water supply yield of the Rio Grande. However, a number of strategies for augmenting municipal water supplies have been examined as part of this planning effort. These include advanced municipal water conservation, Brownsville weir and reservoir, reuse of reclaimed water strategies for optimizing surface water supply from the Rio Grande, groundwater development, brackish and sea water desalination, and acquisition of additional Rio Grande supplies for domestic-municipal-industrial (DMI) uses.
- The Rio Grande Regional Water Planning Group has incorporated into the 2006 Regional Water Plan strategies presented by the statewide Water Conservation Implementation Task Force in the *Water Conservation Best Management Practices Guide* (TWDB Report 362, Nov. 2004). Recommended strategies include:
    - golf course conservation
    - metering all new connections & retrofit on existing connections
    - showerhead, aerator, and toilet flapper retrofit
    - school education
    - landscape irrigation conservation
    - water wise landscape design
    - athletic field conservation
    - public information
    - rainwater harvesting

    - park conservation
    - residential clothes washer incentive program
- Recommended Strategies for Meeting Projected Manufacturing Needs
    - Manufacturing deficits exist in Cameron, Hidalgo, and Willacy Counties. These deficits are expected to be supplied with a combination of additional groundwater, non-potable reuse, and water right purchase. Manufacturing needs are projected to in double by 2060. There will be a steady increase in this demand according to the data provide by the TWDB.
- Recommended Strategies for Meeting Projected Steam Electric Needs
    - Combined, the county-level steam electric power generation WUGs in the region are expected to have a deficit of 649 acre-feet in 2020 increasing to 16,383 acre feet in 2060. Water management strategies considered potentially applicable to this need include acquisition of additional Rio Grande supplies and non-potable reuse. It is recommended that all of the projected steam electric demands be met through a combination of these strategies.
- Recommended Strategies for Meeting Projected Mining Needs
    - There are not projected to be any mining water supply shortages throughout the extent of this planning study.
- Recommended Strategies for Meeting Projected Livestock Needs
    - There are not projected to be any livestock water supply shortages throughout the extent of this planning study.
- Reuse
    - Non-Potable Reuse
        - The Rio Grande RWPG recommends that direct non-potable water reuse be considered a water management strategy for the following WUGs: Brownsville, Alamo, Edinburg, McAllen, Mission, Pharr, and Laredo. It is further recommended that the non-potable use of reclaimed water be adopted as a strategy for meeting a portion of projected municipal water needs, as well as a portion of the projected steam electric power generation needs. It is also recommended that funding be provided by TWDB and from other sources for the purpose of conducting a more thorough assessment of non-potable reuse opportunities within the municipal, manufacturing, and steam electric water use categories. This assessment should be completed on a schedule that will allow the results to be incorporated into a future update of this regional water plan
    - Potable Reuse
        - The Rio Grande RWPG recommends indirect potable water reuse as a water management strategy for the City of Weslaco. It is also recommended that funding be provided by TWDB and from other sources for the purpose of conducting a more thorough assessment of potable reuse opportunities within the municipal water use category. This assessment should be completed on a schedule that

will allow the results to be incorporated into a future update of this regional water plan.

- Examples of Water Conservation Plans Implemented in Region M
- City of McAllen
    - Water conservation goals for the City of McAllen are based on the City's utility profile and water practices. The City's goals are:
        - to reduce daily municipal per-capita water use to 125 gpcd (gallons per capita per day) by the year 2005, and to reduce unaccounted-for water loss to 12 percent by 2005;
        - to implement long-term cost-effective recovery measures for major causes of unaccounted-for water losses related to metering;
        - to increase both public and employee awareness regarding water conservation and water-related issues;
        - to investigate the potential for wastewater effluent reuse;
        - to promote xeriscaping (low-water-using shrubs and plants, patios, rocks, decks, and walkways) in order to reduce the number of high-water-consuming landscape areas on business and residential properties; and,
        - to promote more efficient irrigation techniques for agriculture, industry, and private use through rebates, retrofit, and education.
    - Water conservation strategies have helped the City of McAllen reach goals. To carry out its education strategy, McAllen uses public service announcements and periodic mailings about indoor and outdoor water conservation, while utility employees are trained in conservation and water-wise uses. The City of McAllen even proclaimed Water Utilities Awareness Week in May. Under this strategy, new customers are required to read and agree to Water Conversation Plan provisions.
    - A second strategy of recycling and reuse is accomplished by adopting an efficient water reuse plan that includes elements ranging from golf course irrigation to non-potable industrial water usage.
    - McAllen's third strategy involves updating metering devices and employing universal metering. All new meters must meet the AWWA New Meter Standard for Cold-Water Meters.
    - The fourth strategy is a water distribution audit and leak survey, whose results sparked a continuous leak detection and repair program carried out by the utilities department.
    - McAllen's fifth strategy, following the 1994 Standard Plumbing Code, is an update-and retrofit plumbing fixtures program issued by the Southern Building Code of Congress International.
    - The sixth strategy is conservation education through landscaping techniques which advocate drip irrigation at commercial establishments. McAllen's municipal pools were evaluated for efficient water use. Landscape architects and local nurseries were asked to utilize efficient irrigation systems and native low-water plantings and grasses. Irrigation contractors were asked to evaluate and improve their own water use efficiencies.

    - The City's seventh strategy updates the rate structure more conservatively. In effect, the rates are higher for heavier water use.
- City of Weslaco
    - The City of Weslaco's water conservation plan aims to reduce quantities required within a service area when efficient water use procedures have been implemented. Objectives are long-term, with needs clearly identified and goals established. A system water audit is required to determine unaccounted-for water volumes and probable causes of losses.
    - Peak, maximum-day, average, and per capita usage will be monitored. Accomplishment phases include:
        - By 2007, reduce per capita water usage of 150 gpcd (gallons per capita per day) to 110 gpcd.
        - Implement long-term cost-effective recovery measures for major causes of unaccounted-for water losses related to metering.
        - Increase public and employee awareness of water conservation and water-related issues, especially during summer months when water consumption increases significantly.
        - Investigate the feasibility of wastewater effluent reuse;
        - Promote xeriscape landscapes wherever feasible to reduce total square footage planted with shrubs and grasses requiring high water consumption.
        - Implement rebates for retrofitting, and implement education programs to promote more efficient agricultural, industrial, and private irrigation techniques.
    - Weslaco's plan will implement water conservation in several ways. Logically, a crucial element for success is educating and informing the public about both short- and long-term conservation objectives. The plan charges more to high-volume customers and offers tips on water-smart household, landscaping, and irrigation procedures. Customers with older-model fixtures will be encouraged to retrofit their plumbing as Weslaco adopts updated water codes.
    - Furthermore, pressure reduction in the water system will save water by reducing excessive mechanical stress on fixtures, appliances, and distribution systems. Water wells for personal use will be disallowed in all circumstances. During drought conditions the City of Weslaco will follow a phase-driven Emergency Water Demand Management Plan

2.14 Region N

- The Coastal Bend Regional Water Plan includes recommended water management strategies that emphasize water conservation; maximize utilization of available resources, water rights, and reservoirs; engage the efficiency of conjunctive use of surface and groundwater; and limit depletion of storage in aquifers. There are additional strategies that have significant support within the region, yet require further study regarding quantity of dependable water supply made available during severe drought, feasibility, and/or cost of implementation, that are also included in the plan.
- Water management strategies recommended in the Coastal Bend Region could produce new supplies in excess of the projected regional need of 53,431 acft in Year 2060. Supplies exceed shortages in case water growth patterns and demands exceed TWDB projections or supplies are reduced under current interbasin water supply contracts.
- Potential Water management Strategies to Meet Long-Term Needs for Wholesale Water Providers
    - Municipal Water Conservation
    - Mining Water Conservation
    - Reclaimed Wastewater Supplies
- Potential Water management Strategies to Meet Long-Term Needs for Local Service Areas
    - Municipal Water Conservation
    - Irrigation Water Conservation
    - Mining Water Conservation
    - Reclaimed Wastewater Supplies
- Recommended Management Strategies to Meet Need (Shortage) for Counties
    - Aransas County- municipal conservation and reuse, reclaimed wastewater supplies, manufacturing water conservation
    - Brooks County- additional municipal water conservation recommended for all municipal entities reported use greater than 165 gpcd in 2060
    - Duval County- additional municipal water conservation recommended for all municipal entities reported use greater than 165 gpcd in 2060; mining water conservation, potential reuse
    - Jim Wells County- additional municipal water conservation recommended for all municipal entities reported use greater than 165 gpcd in 2060
    - Live Oak County- additional municipal water conservation recommended for all municipal entities reported use greater than 165 gpcd in 2060, mining water conservation including potential reuse, irrigation water conservation
    - McMullen County- additional municipal water conservation recommended for all municipal entities reported use greater than 165 gpcd in 2060
    - Nueces County- additional municipal water conservation recommended for all municipal entities reported use greater than 165 gpcd in 2060, mining water conservation including potential reuse
    - San Patricio County- municipal water conservation and reuse, reclaimed wastewater supplies, and manufacturing water conservation

- The City of Corpus Christi, the largest municipal water user in the Coastal Bend Region, has demonstrated significant water savings attributable to water conservation efforts over the last decade. The City's municipal water use was nearly 220 gpcd in 19902 and was reduced to 179 gpcd by 2000, a decrease of 41 gpcd (or 19 percent). According to TWDB water use projections, the City of Corpus Christi water use is anticipated to decline to 165 gpcd by 2060
- Based on the success of the City's water conservation program, the Coastal Bend Regional Water Planning Group recommends that water user groups, with and without shortages, exceeding 165 gpcd should reduce consumption by 15 percent by 2060. For entities with projected water use equal or less than 165 gpcd in 2060, TWDB projections are recommended.
- Water Conservation
    - Indoor Water Conservation: An average demand reduction of 13 gpcd for Coastal Bend municipal entities is included in the TWDB per capita water use projections associated with replacing plumbing fixtures. The TWDB water use projections have a maximum built-in per capita reduction of 16 gpcd from 2000 to 2060, which assumes 100 percent participation in low flow plumbing fixture programs. The amount of additional indoor water conservation is calculated based upon the potential typical water conservation of 11 gpcd, which assumes 50 percent participation in toilet retrofit/showerhead programs and 45 percent participation in clothes washer rebate. The potential amount of "additional" indoor conservation beyond the savings included in the TWDB projections was determined for the projected population at the respective projection dates, by subtracting the plumbing fixtures effects already in the water demand projections. For municipal entities that already have a built-in reduction exceeding 11 gpcd in TWDB per capita water use projections, no additional savings would be expected from indoor water conservation.
    - Landscape Irrigation Water Conservation: In addition to the indoor water conservation measures described above, the water conservation water management strategy for municipal entities for the Coastal Bend Region includes landscape irrigation. The estimated potentials are based upon the following conditions and assumptions:
        - For those municipal entities having year 2060 water use of 165 to 200 gpcd, landscape irrigation potential can be 15 percent of water use above 75 gpcd.
        - For those WUGs having year 2060 water use greater than 200 gpcd, landscape irrigation potential can be as much as 30 percent of water use greater than 75 gpcd.
    - General Water Conservation: A municipality can determine unaccounted for water losses by performing a water audit. To maximize the benefits of this conservation strategy, the utility uses this audit information to revise meter testing and repairs, reduce unmetered use, improve accuracy of the utility's metering system, and implement effective water loss management strategies. Factors that affect the amount of unaccounted for water include

density of the system, age of the system, construction quality of the system, and accuracy of the water metering.

- Reclaimed Wastewater
  - Existing Wastewater Sources
    - There are about 61 active, permitted domestic and industrial WWTP discharges that discharge to the Nueces Estuary System in the 11-county Coastal Bend Regional Water Planning Area (CBRWPA). These domestic and industrial discharges total about 95,937 acft/yr, based on the 2003 annual discharge from each WWTP. The Nueces River Authority and TCEQ compiled this list. Of the 95,937 acft, major municipal/domestic discharges generate about 44,971 acft/yr (47 percent), while industrial discharges generate about 50,966 acft/yr (53 percent).
  - City of Corpus Christi Wastewater Reuse
    - The City of Corpus Christi's present water conservation and reuse plans emphasize education and changes to the water rate structure to promote conservation and reuse. Water customers have been requested to reduce water usage wherever possible through the installation of more efficient plumbing fixtures and through landscape watering schedules. The City adopted plans to reduce water use by diverting a portion of its WWTP effluent to some public facilities for irrigation purpose; i.e., for golf course and park irrigation. This practice has some limitations, as the need for wastewater for irrigation is not continuous and is often highly variable. Thus, the wastewater is not reused in the same amount every month. For example, it is not used after heavy rains and it is not used during winter months when the grass is not growing and will not consume the wastewater. For example, in 2001, wastewater reuse from the City's WWTPs for golf course and baseball park irrigation was about 394 million gallons (or 1,210 acft/yr). In 2002, the wastewater reuse was reduced to 333 million gallons (or 1,020 acft).
- Industry Water Conservation
  - During the 1984 drought, the City requested that its industrial water customers minimize water use from the CCR/LCC System without seriously jeopardizing production. Industry representatives responded by carefully studying ways to reduce water demands through increased efficiency in the use of existing supplies, reuse of available supplies, and development and use of alternative water supplies. In response to water shortages during the drought of 1984, concerns about rising costs of water, increased regulation and rising costs of wastewater treatment and disposal, and public interest in water conservation, Corpus Christi area industries implemented water conservation and water reuse measures that have significantly reduced quantities of water needed per unit of production. For example, Corpus Christi area petroleum refineries use between 35 and

46 gallons of water per barrel of crude oil refined, while refineries in Houston use 91 gallons, and refineries in Beaumont use 96 gallons.

- As a result of these events, the major Corpus Christi area industrial customers have implemented various water conservation measures since the 1984 drought period and especially in the last 3 to 5 years, particularly during periods of plant expansion. Since 1984 there has been increasing quantities of water conserved by local industry. In comparison to other Texas industry, the industries in Corpus Christi have one of the best records of water use efficiency based on results of the TWDB's "Pequod Survey."
- Water Conservation Measures Corpus Christi Area Industry
  - Current Measures
    - Recycling Cooling Tower and Boiler Blowdown
    - Improved Control Systems
    - Dry Cooling, Air Cooled Heat Exchangers
    - More Efficient Drift Eliminators
    - Changed Washdown Procedures
    - Automatic Cooling Tower Blowdown
    - Leak Detection/Repair
    - Steam Condensate Recovery
    - Reuse Wastewater Treatment Effluent for Firewater, Cooling Tower Make-up
    - Cycling-Up Cooling Towers
    - Stormwater Reuse
    - Salt Water for Area Washdown
    - Salt Water Lubrication of Circulating Water Feed Pumps
    - Reverse Osmosis with Demineralization
    - Voluntary Water Conservation Planning
    - Regulatory Requirement to Consider Reuse
    - Saltwater for Cooling
  - Future Measures
    - Uniform blending of Lake Texana/Nueces River waters to provide consistently better water quality with less variation in dissolved minerals.
    - Increased Evaluation of Alternative Water Sources to Replace Treated City Water
    - Additional Application of Reverse Osmosis Treatment
    - Increased Wastewater Treatment Plant Effluent Reuse
    - Possible Side-Stream Softening
    - New Process Changes
    - Additional Steam Leak Repair
    - New Chemical Treatment Technology
    - Increased Water Audit by Industry
    - Possible Water Conservation Incentives

- Possible Regulatory or Local Government Water Conservation Planning Goals
- Increasing Water Conservation Research and Education
- Additional Industry Pursuing Water Conservation Measures

2.15 Region O

- The LERWPG identified the following water management strategies as potential strategies to meet the projected needs of the region:
    - Municipal and Irrigation Water Conservation;
    - Water Supply from Nearby Groundwater Sources for Cities Projected to Need Additional Municipal Water Supply;
    - Water Supply from Lake Alan Henry, Groundwater Sources, and Reclaimed Water;
    - Precipitation Enhancement;
    - Brush Control;
    - Desalt Brackish Groundwater;
    - Post Reservoir – Raw Water at the Reservoir;
    - Research and Development of Drought Tolerant Crops and New Technology;
    - Reuse of Municipal Effluent;
    - Storm water Capture and Use; and
    - Public Education
- Irrigation
    - Irrigation farmers of Region O have implemented many of the irrigation water conservation application methods and farming practices considered to be the most efficient today. For example, irrigation farmers of the Region have adopted and are using the following irrigation water conservation Best Management Practices (BMPs):
        - Contour Farming;
        - Tailwater Recovery and Use;
        - Replacement of On-farm Irrigation Ditches with Pipelines;
        - Gated and Flexible Pipe for Field Water Distribution;
        - Low Pressure Center Pivot Sprinkler Irrigation Systems (LEPA and LESA);
        - Surge Flow Irrigation for Field Water Distribution Systems;
        - Furrow Dikes, Chiseling, and Deep Ripping;
        - Crop Residue Management and Conservation Tillage;
        - Linear Move Sprinkler Irrigation Systems;
        - Drip/Micro-Irrigation Systems; and Volumetric Measuring
    - The Llano Estacado Regional Water Plan includes the recommendation that Llano Estacado Region irrigation farmers continue to use irrigation water conservation BMPs, and further recommends that irrigation farmers of the Region consider installation of efficient irrigation application equipment, such as LEPA and/or LESA systems on approximately the 908.8 thousand irrigated acres that have not yet been equipped with such systems. When used in conjunction with furrow dikes, which hold both precipitation and sprinkler applied water within the furrows, this water management strategy has the potential to meet approximately 44 percent of the projected irrigation shortages in the region in 2010, 22 percent of projected shortages in 2030, and approximately 14 percent of projected shortages in 2060. The capital cost of this irrigation water management

strategy is estimated at approximately $353 million in Second Quarter 2002 prices, with an annual cost of approximately $27.6 million. Capital cost per acre-foot of water is estimated at $50 in 2010, $62 in 2030, and $84 in 2060. Capital cost per acre-foot of water saved increases over time, since well yields are projected to decline as the aquifer levels decline, thus the irrigation equipment has less total quantity of water with which to work. However, with more efficient irrigation application methods, less water would be pumped per acre irrigated, thereby reducing farm production costs by at least the value of the energy that would have been needed to pump the water saved, and although data are not available with which to estimate its value, it is recognized that this is one of the major sources of income with which to make the payments to meet the capital costs of the irrigation water conservation strategy.

    - In addition to the following recommended irrigation water conservation strategies, the planning group recommends the adoption of newly developed irrigation water conservation methods and site specific water management methods that are currently available or may become available in the future, such as remote sensing for irrigation scheduling, and variable rate irrigation application. Particular attention should be given to using any successful management strategies that result from the Texas Alliance for Water Conservation Demonstration Project located in Floyd and Hale Counties. The Texas Alliance for Water Conservation Demonstration Project is an eight-year study to identify and quantify the best agricultural production practices and technologies to reduce groundwater pumpage from the Ogallala aquifer, while maintaining agricultural production and economic opportunities.

- Reclaimed Water
    - Examples of the use of reclaimed water are the use of treated municipal effluent for irrigation of golf courses, parks, cemeteries, and other public lands, irrigation of agricultural land near to or adjacent to the town or city from which the effluent is obtained, and in some cases, for public supply. In the Llano Estacado Region, the primary use of reclaimed municipal and feedlot wastewater is to irrigate farmland. Approximately 95 percent of all the water obtained from the Ogallala Aquifer is used for irrigation purposes. By substituting water pumped from the Ogallala Aquifer with reclaimed water, the amount of groundwater withdrawal can be decreased.
- Municipal Water Conservation
    - Municipal water is freshwater that meets drinking water standards. Such water is supplied by both public and private utilities. In areas not served by water utilities private wells supply individual households. The objective of the municipal water conservation option is to reduce per capita water use without adversely affecting the quality of life of the people involved. The municipal water conservation water management strategy is estimated to meet 2,858 acft/yr of municipal water needs in Region O in 2010, 3,412 acft/yr in 2020, 3,616 acft/yr in 2030, and 4,020 acft/yr in 2060. In terms of projected municipal water demand, the

municipal water conservation water management strategy could meet about 3.9 percent of the projected municipal water demand of 93,549 acft/yr in 2060. The proposed municipal water conservation water management strategy has the potential to reduce per capita water use in the region from an average of 168 gallons per person per day in 2010 to 151 gallons per person per day in 2060. Municipal water conservation strategies are strongly recommended.

- The TWDB has estimated that the effect of the new plumbing fixtures in dwellings, offices, and public places will be a reduction in per capita water use of 18 gpcd, in comparison to what would have occurred with previous generations of plumbing fixtures.
- For purposes of developing the 2006 Llano Estacado Regional Water Plan, the LERWPG adopted a municipal water conservation goal of reducing per capita water use by 1 percent per year for those WUGs that have projected needs (shortages) and that had per capita water use in year 2000 that was greater than the Llano Estacado Region average per capita water use in 2000. The goal is to continue the municipal water conservation water management strategy of reducing per capita water use by 1 percent per year until per capita water use is reduced to the year 2000 Region average municipal water use of 172 gpcd. (The Llano Estacado Region total municipal water use in 2000 was 87,322 acft; total population in 2000 was 453,997, giving a calculated Regional average municipal water use in 2000 of 172 gpcd (87,322/453,997)).
- The municipal water conservation water management strategy is estimated to meet 2,858 acft/yr of municipal water needs in Region O in 2010, 3,412 acft/yr in 2020, 3,616 acft/yr in 2030, and 4,020 acft/yr in 2060. Estimated cost of the water conservation water management strategy for the Region is $1,504,270 in 2010, and increases to $1,666,924 in 2060. Cost per acft in year 2010 is approximately $526, and in 2060 is approximately $415.

- Agricultural Water Conservation Practices on Farms
  - Dryland and irrigation farmers in the Llano Estacado Region attempt to obtain maximum benefit from the use of the precipitation they receive on their farms. Irrigation application methods have been the subject of research and development since irrigation became possible in the Llano Estacado Region in the 1930s, and in recent decades there have been significant improvements in irrigation application and conservation methods. The following irrigation practices are currently being used in the planning region:
    - Subsurface Drip Irrigation—SDI,
    - Low Energy Precision Application—LEPA pivot,
    - Low Elevation Spray Applicator/Low Pressure in Canopy—LESA/LPIC
    - Surge Valves
    - Pipelines
    - Lay Flat Tubing
    - Furrow Diking and Chiseling

        - Soil Moisture Monitoring
- Reuse of Municipal Effluent
    - Of the total quantities of water used for municipal purposes, 45 percent to 65 percent is returned to the respective municipal wastewater treatment plants for treatment and disposal. In the Llano Estacado Region a large percentage of this treated effluent, or reclaimed water, is used for irrigation of open spaces, golf courses, and neighboring farmland. This water could become a significant source of municipal water in the future if treatment levels were increased to the extent that the use of this water does not pose a health risk. The LERWPG highly recommends that funding be made available to universities, water districts, and the cities to further study the quantity of water available from this option and to study treatment technologies to make this option feasible.
- Public Education
    - Underground water conservation districts, cities, universities, the Texas Agricultural Extension Service and other water agencies will continue existing education and information dissemination programs. In addition, Llano Estacado Region water suppliers and agencies will build a strong cooperative relationship with formal and informal educators including the region's Educational Service Centers and Independent School Districts.

2.16 Region P

- The management strategies considered for shortages in the 2001 RWP that have been carried through to the 2006 RWP are as follow:
    - Conjunctive use of groundwater in Jackson and Wharton Counties
    - Conversion of Ganado and Edna to surface water
    - Reuse of municipal effluent
    - Construction of the Palmetto Bend Phase II reservoir site on the Lavaca River
- The ultimate factor considered by LRWPG when selecting management strategies is the cost of the proposed strategy. As farmers are the only users in the region with an anticipated shortage, they would bear the costs of any water management strategy. Irrigators would not be able to financially support strategies above a certain cost as higher rates for water would become economically prohibitive. A maximum cost of $50 per ac-ft was set by LRWPG as a cost that would be reasonable for irrigators to pay for additional water. Management strategies with a unit cost greater than this were not considered, and costs previously developed for these measures in the 2001 RWP were not revised for this Plan.
- Municipal Water Conservation- Explanation why not recommended
    - As noted above, there are no municipal WUGs with shortages. In addition, while water conservation by municipalities is encouraged, the significance of even a 20 percent reduction in municipal use, when applied to the 3 percent of total usage that municipal usage composes, results in a 0.6 percent savings overall. Further, most of the municipalities have standby well capacities so that they can provide the maximum daily demand with the largest well out of service. Since the anticipated growth in total population is only 10,000 persons, it is not anticipated that conservation savings will result in significant savings over the 50-year planning horizon. In fact, many of the cities are projected to experience a decrease in population over time. As a result, they have no incentive to conserve to delay implementation of costly expansions. There is no real driver to induce conservation for these WUGs.
- Agricultural Water Conservation- Explanation why not recommended
    - On the agricultural side, conservation savings would not result in a reduction of capital expenditures but a forced expenditure of funding to garner any savings. As noted previously by several of the group members, there is a finite upper limit to the amount of money that can be spent to conserve agricultural water and still be supported by on-farm income. There are no municipalities within the planning area that are in need of additional supplies that cannot be supported by groundwater. Neighboring regions with needs tend to have much larger needs than could be supported by savings in groundwater for irrigation purposes. As an example, if 20 percent of the total irrigation water used in Jackson County could be conserved by the canal and on-farm conservation practices outlined in the management strategies, the net effect is that the usage would be reduced to the sustainable yield of the aquifer and there would still not be any surplus to be marketed under DOR conditions. With total

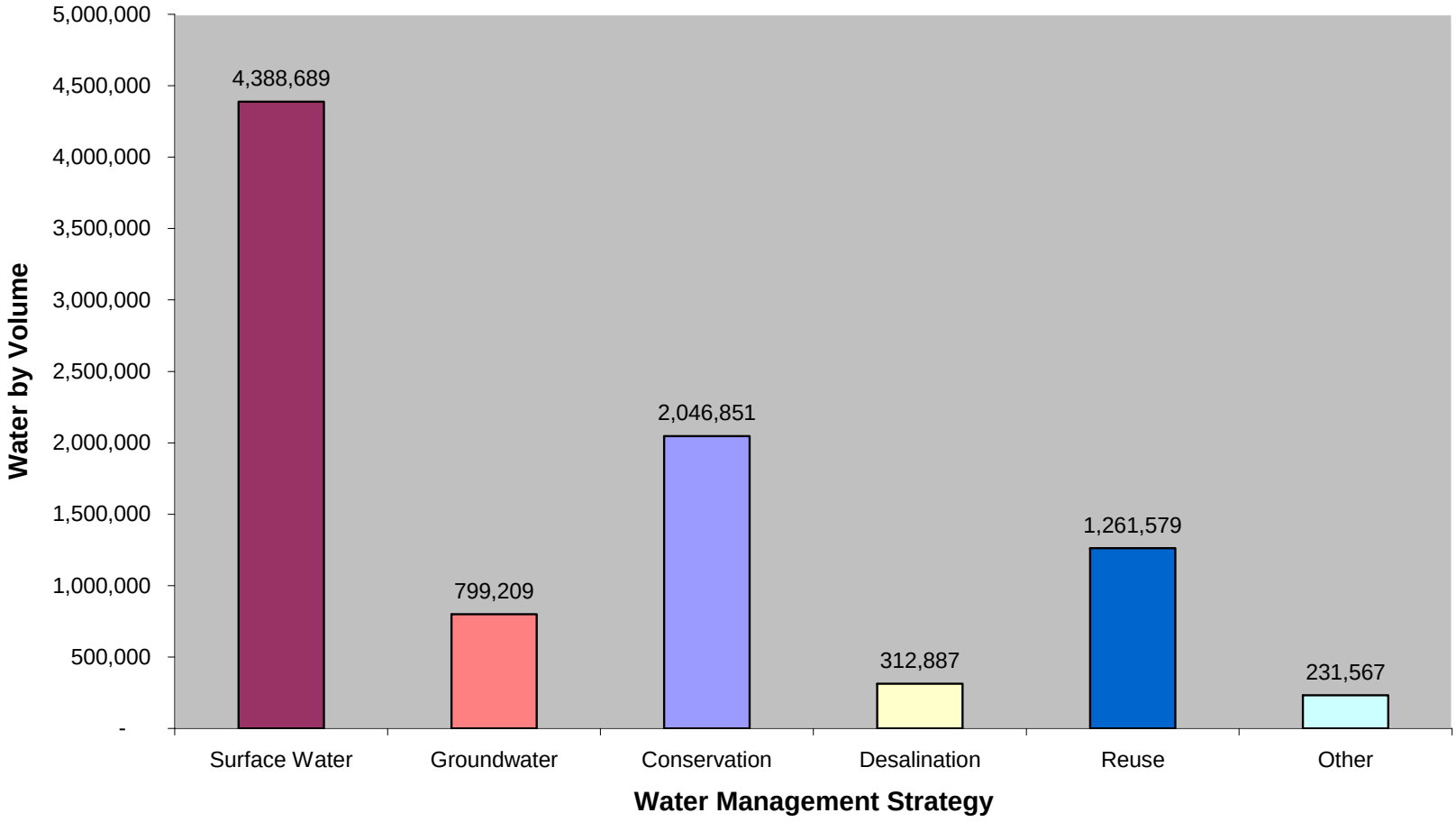
usage of approximately 100,000 ac-ft annually, the savings would only result in 20,000 ac-ft of available water annually even under the best of conditions. The needs of neighboring basins are such that much larger projects are needed to provide economical costs for new supplies.

- Water conservation plans were also included with the drought contingency plans for the Cities of Shiner and Yoakum. These documents include the following recommendations for reducing municipal water demands:
    - Public Education – distribution of conservation materials through mail distribution and published articles.
    - Plumbing Code – setting plumbing standards for new construction and replacement in existing structures.
    - Retrofit Program – encouraging the replacement of plumbing devices with water having devices by informing the public on where to obtain these devices and encouraging the sale of such fixtures.
    - Water Rate Structure – using a conservation water rate structure to discourage the excessive use of water.
    - Metering – scheduling regular meter testing programs.
    - Water Conservation Landscaping – encouraging the use of plants with low water demands through public education.
    - Leak Detection and Repair – through electronic and traditional monitoring of water use and water system infrastructure

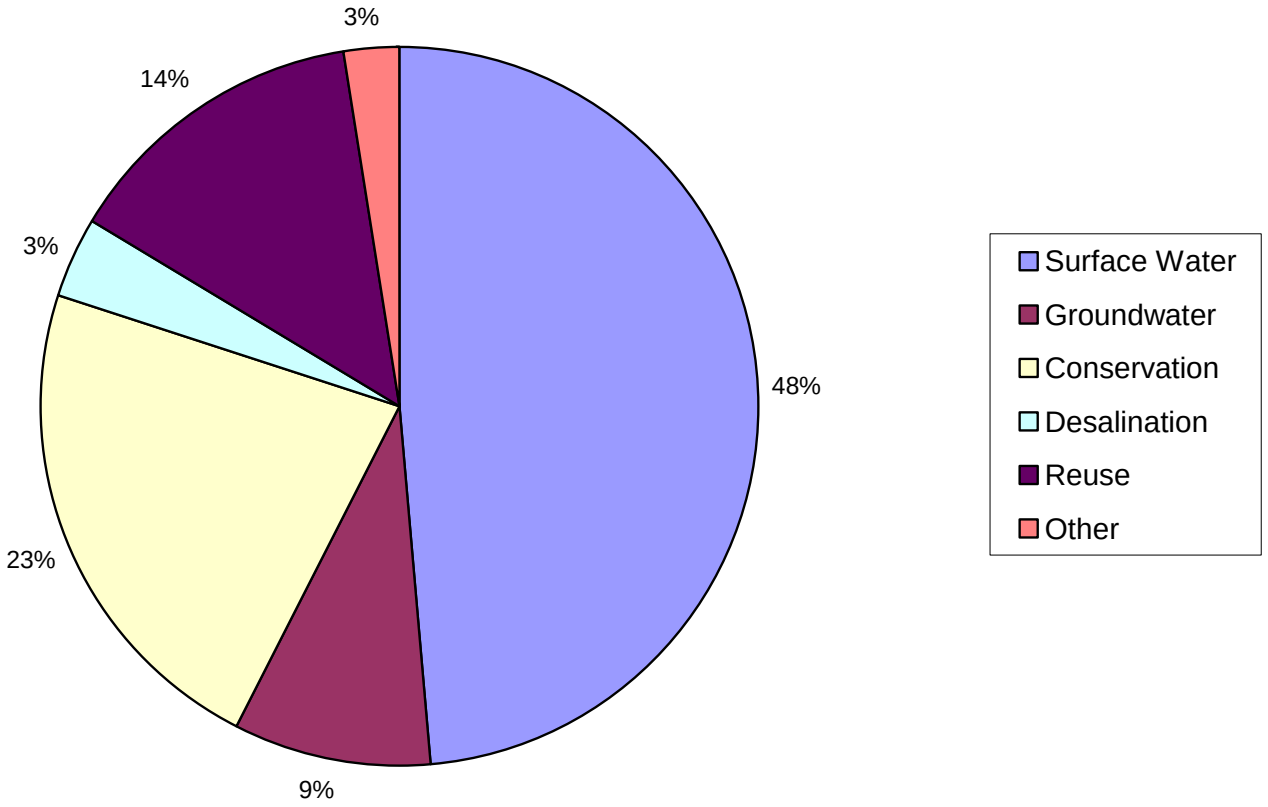
Section 3: Texas Water Management Strategies for 2060

(Compiled from the Water for Texas 2007)

Texas Water Management Strategies (by volume of water) for 2060 from the 2007 Texas Water Plan



Texas Water Management Strategies (by volume of water) for 2060 from the 2007 Texas Water Plan

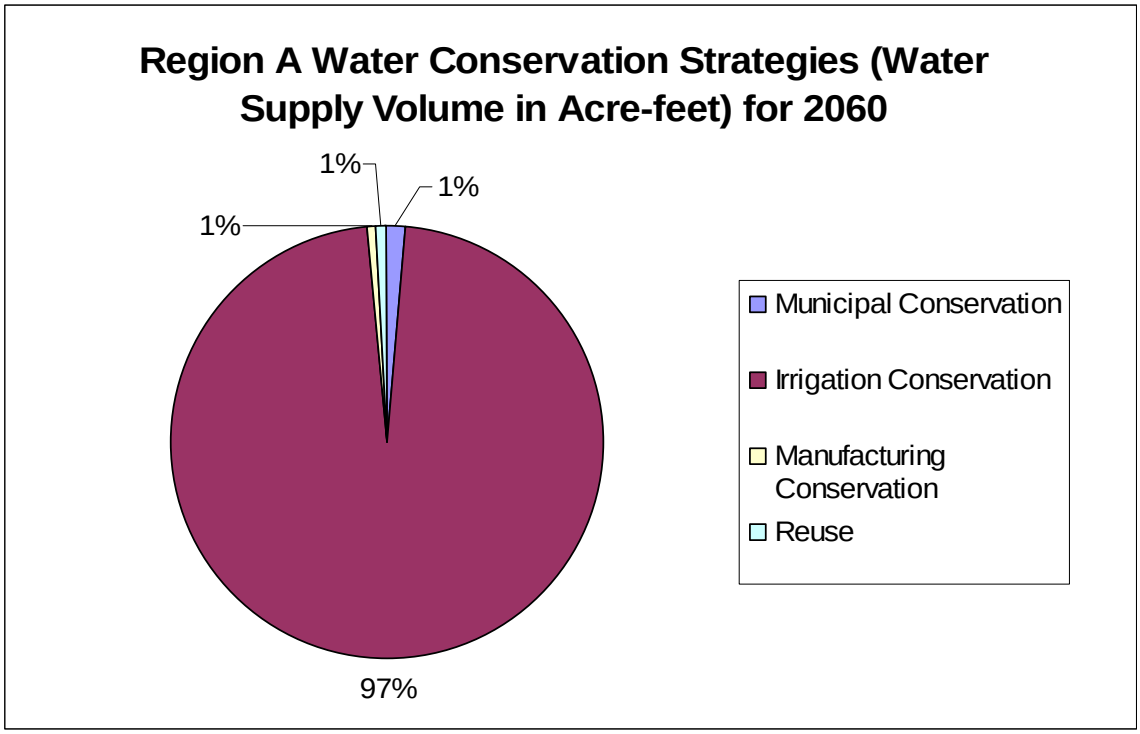


Section 4: Regional Conservation Strategies by Water Supply Volume for 2060

Data compiled from the Water for Texas 2007:
Table 10.1: Summary of recommended municipal water conservation management strategies in 2060
Table 10.2: Summary of recommended irrigation water conservation management strategies in 2060
Appendix 2.1: Recommended Water Management Strategies and Costs Estimates

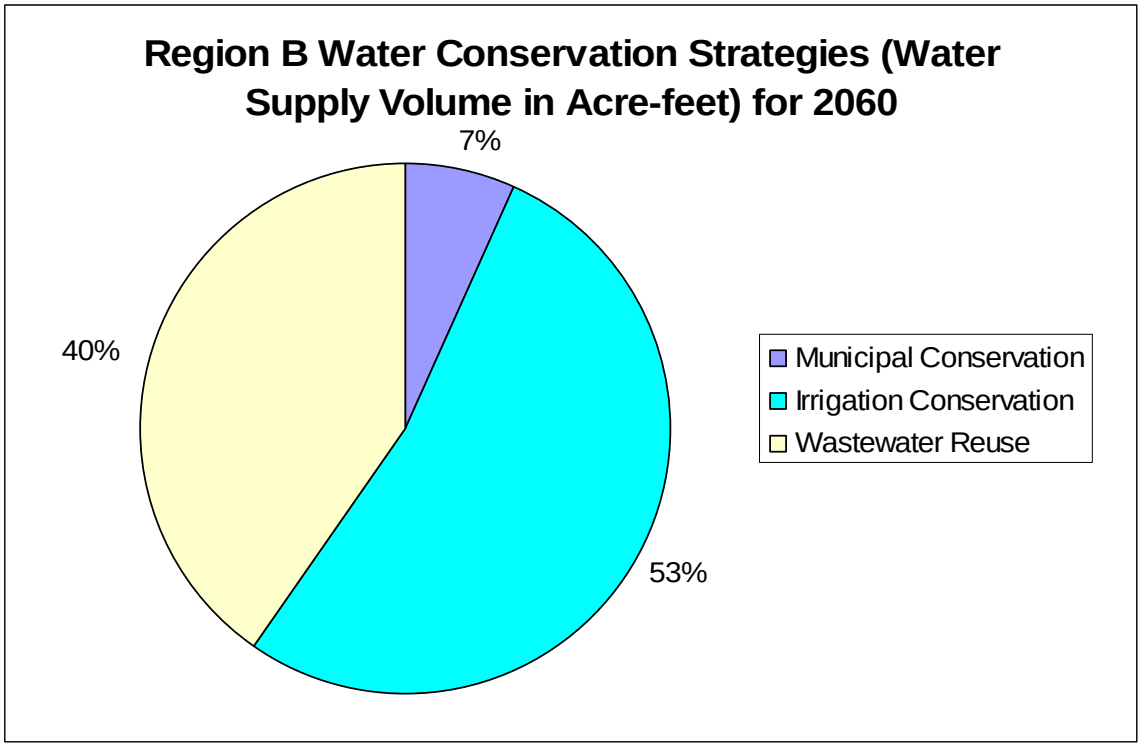
4.1 Region A

Strategy	2060 Water Supply Volume in acre-feet
Municipal Conservation	4,255
Irrigation Conservation	282,549
Manufacturing Conservation	1,672
Reuse	2,700
Total	**291,176**



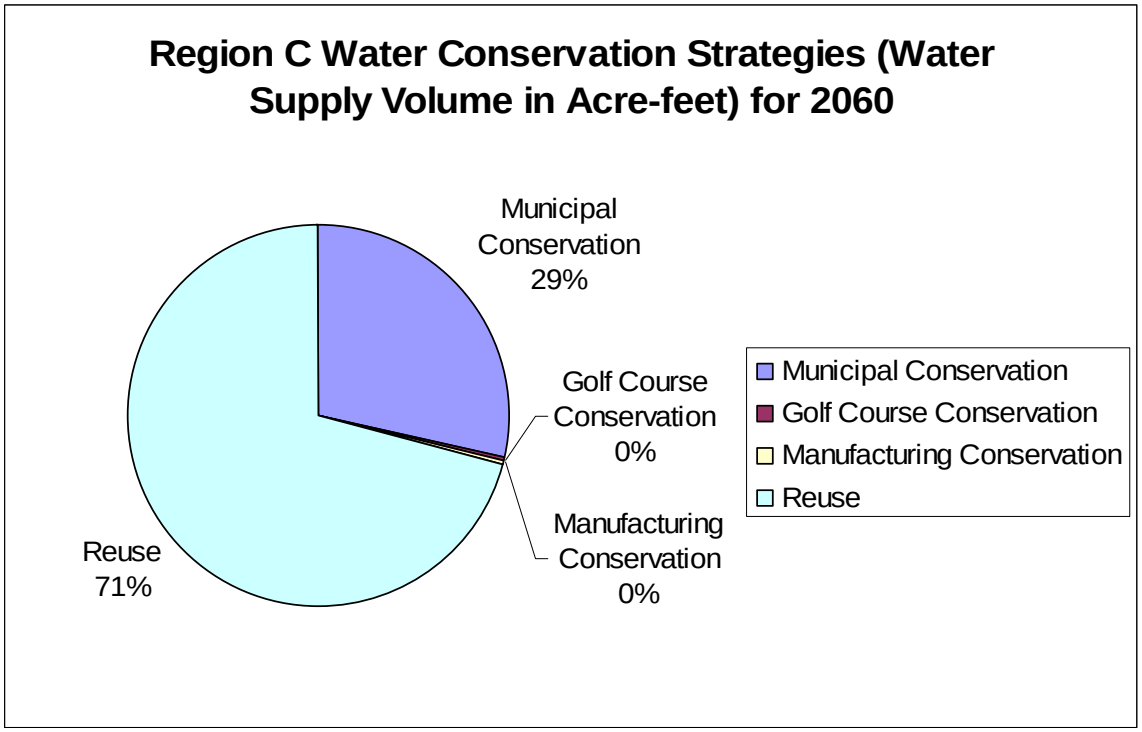
4.2 Region B

Strategy	2060 Water Supply Volume in acre-feet
Municipal Conservation	1,855
Irrigation Conservation	14,607
Wastewater Reuse	11,134
Total	**27,596**



4.3 Region C

Strategy	2060 Water Supply Volume in acre-feet
Municipal Conservation	291,909
Golf Course Conservation	3,121
Manufacturing Conservation	2,617
Reuse	720,846
Total	**1,018,493**

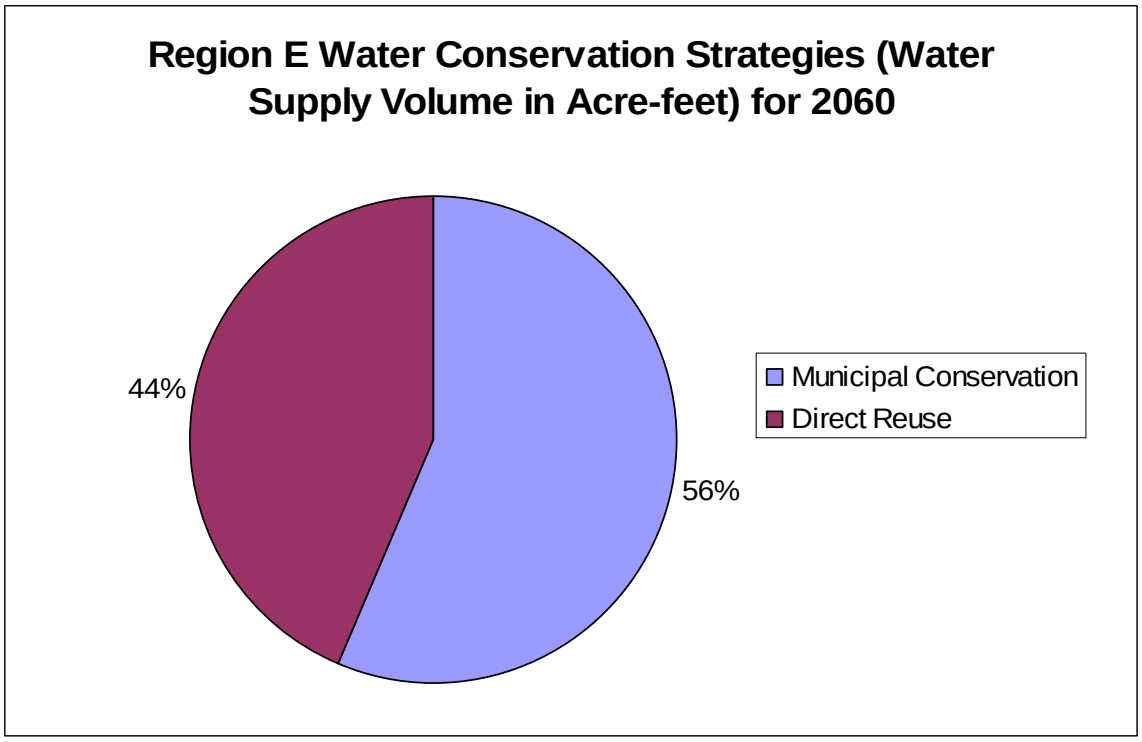


4.4 Region D

Strategy	2060 Water Supply Volume in acre-feet
Municipal Conservation	0
Irrigation Conservation	0
Total	**0**

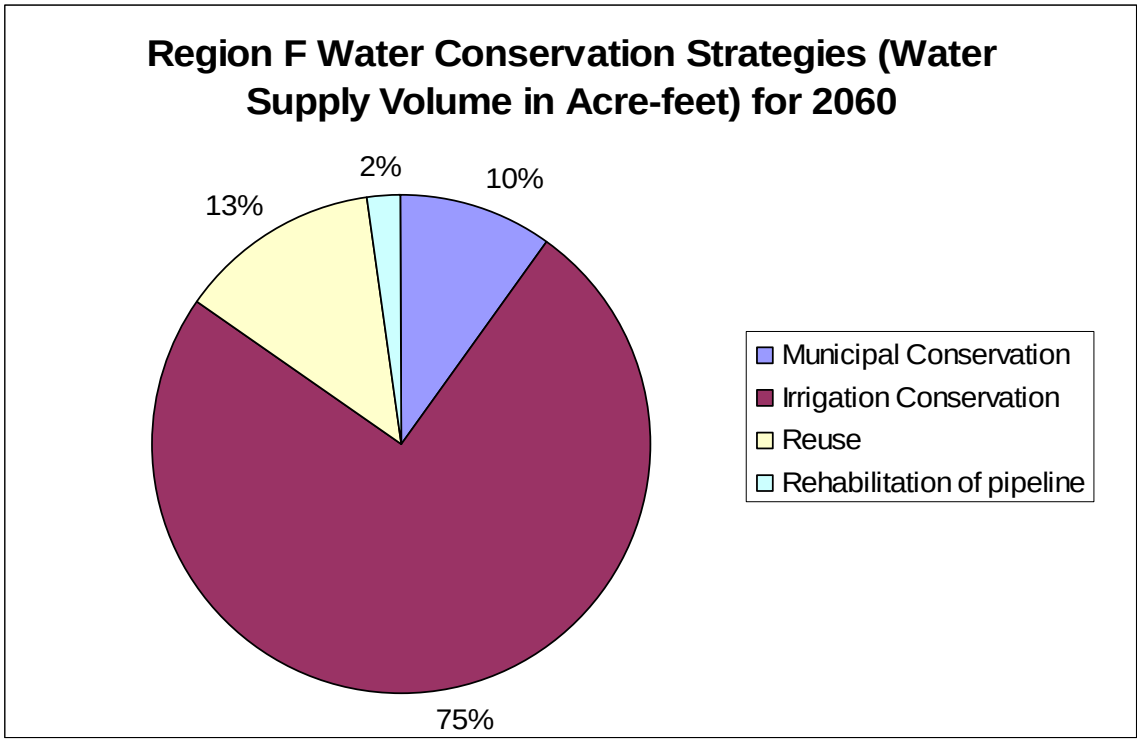
4.5 Region E

Strategy	2060 Water Supply Volume in acre-feet
Municipal Conservation	23,437
Direct Reuse	18,109
Total	**41,546**



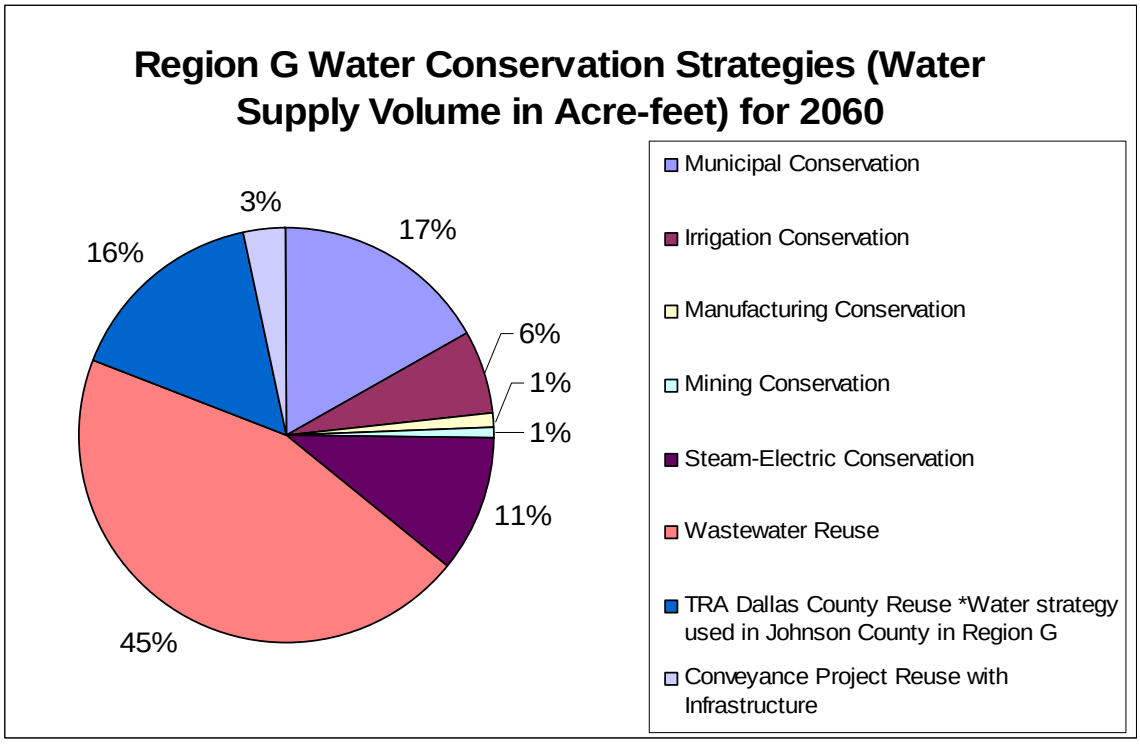
4.6 Region F

Strategy	**2060 Water Supply Volume in acre-feet**
Municipal Conservation	9,727
Irrigation Conservation	72,247
Reuse	12,710
Rehabilitation of pipeline	2,206
Total	**96,890**



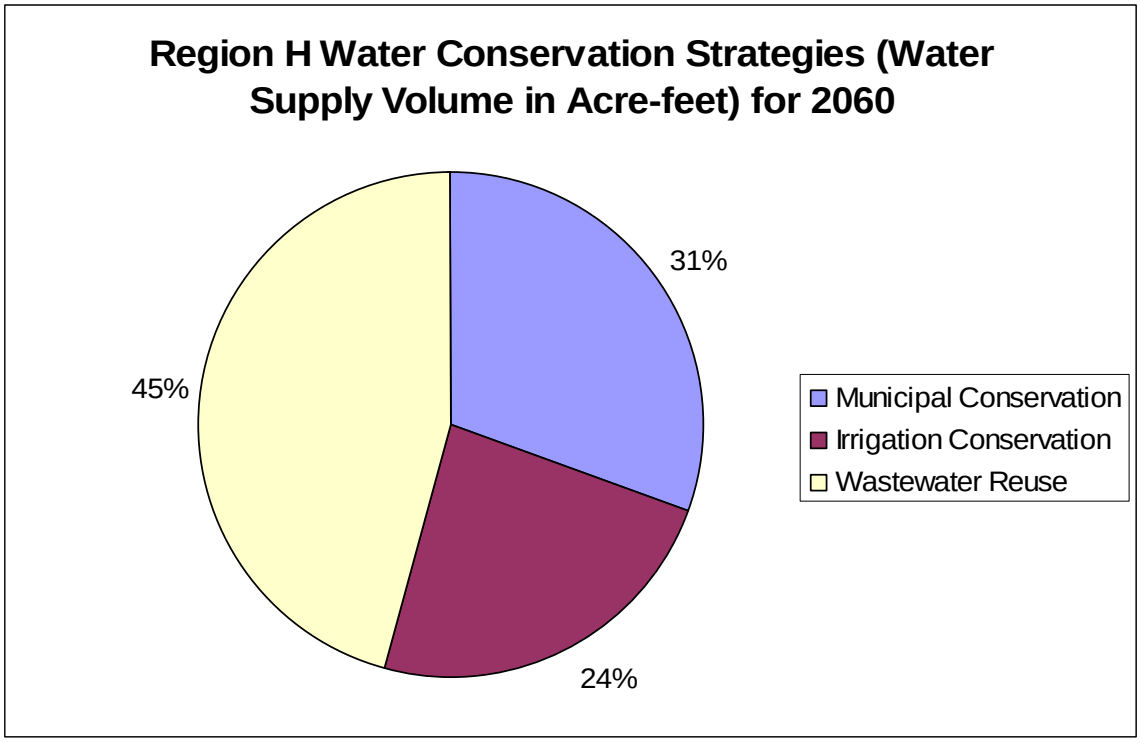
4.7 Region G

Strategy	2060 Water Supply Volume in acre-feet
Municipal Conservation	21,406
Irrigation Conservation	8,027
Manufacturing Conservation	1,430
Mining Conservation	1,074
Steam-Electric Conservation	13,281
Wastewater Reuse	56,852
TRA Dallas County Reuse *Water strategy used in Johnson County in Region G	20,000
Conveyance Project Reuse with Infrastructure	4,361
Total	**126,431**



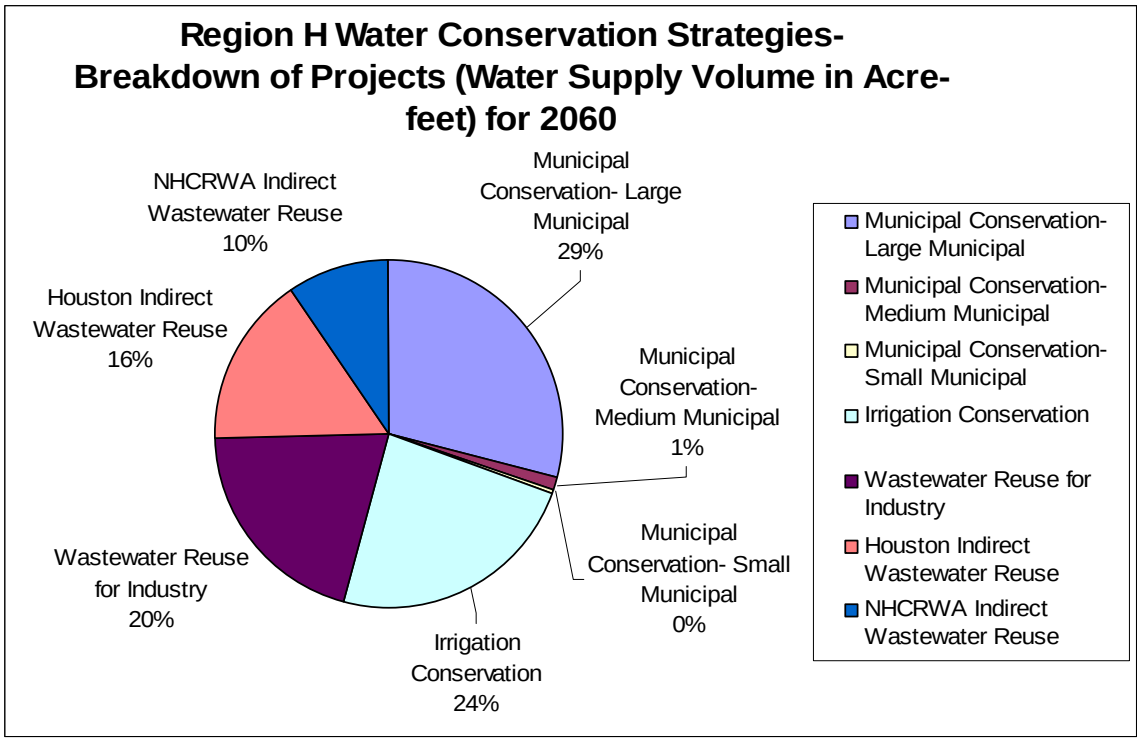
4.8-1 Region H

Strategy	2060 Water Supply Volume in acre-feet
Municipal Conservation	100,987
Irrigation Conservation	77,881
Wastewater Reuse	151,125
Total	**329,993**



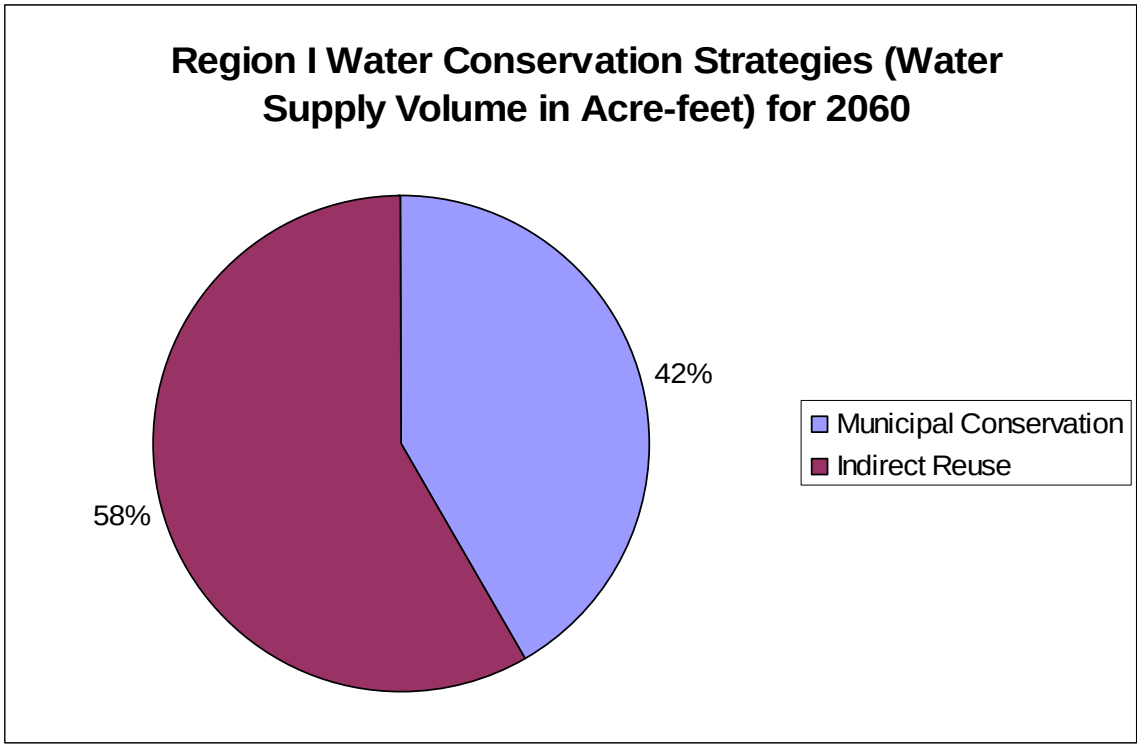
4.8-2 Region H Breakdown of Water Conservation Projects

Strategy- Breakdown of Projects	2060 Water Supply Volume in acre-feet
Municipal Conservation- Large Municipal	95,894
Municipal Conservation- Medium Municipal	4,395
Municipal Conservation- Small Municipal	698
Irrigation Conservation	77,881
Wastewater Reuse for Industry	67,200
Houston Indirect Wastewater Reuse	52,525
NHCRWA Indirect Wastewater Reuse	31,400
Total	**329,993**



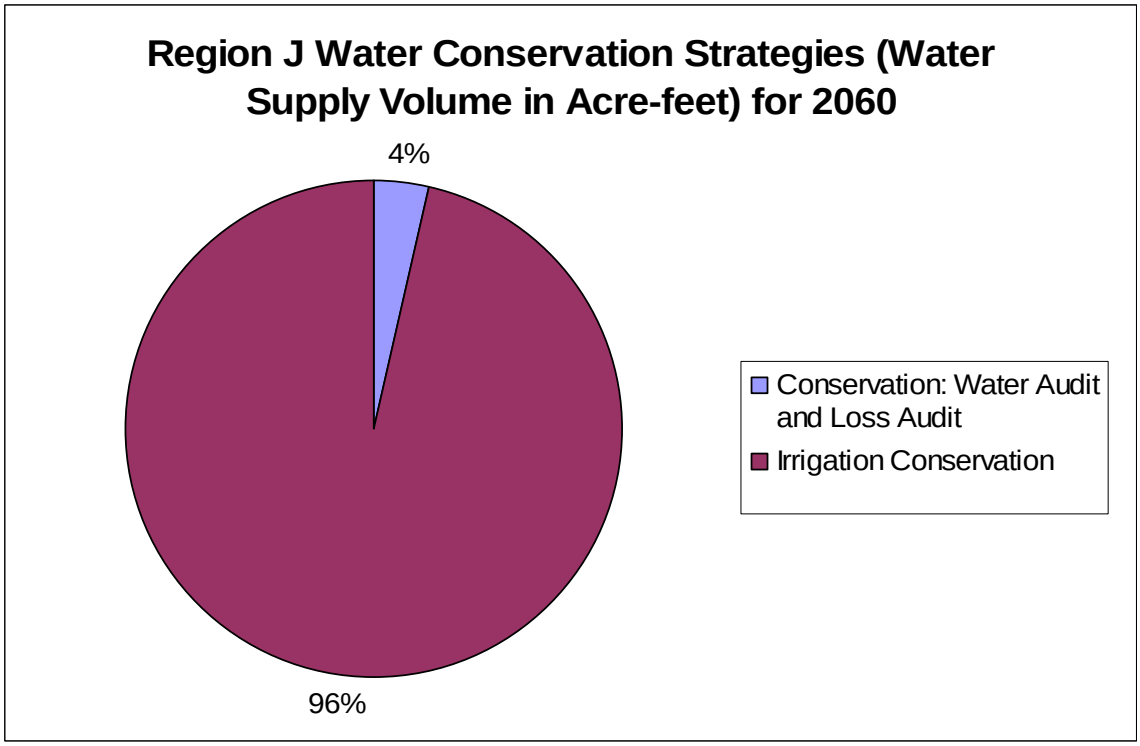
4.9 Region I

Strategy	**2060 Water Supply Volume in acre-feet**
Municipal Conservation	1,916
Indirect Reuse	2,676
Total	**4,592**



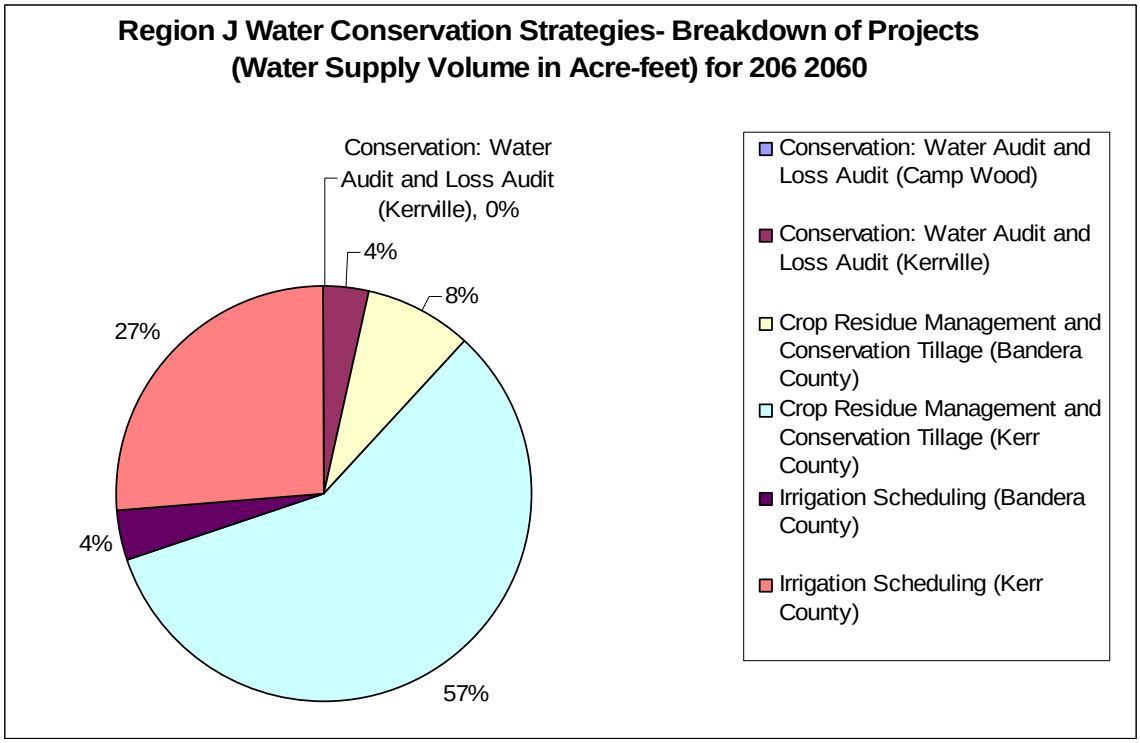
4.10-1 Region J

Strategy	2060 Water Supply Volume in acre-feet
Conservation: Water Audit and Loss Audit	55
Irrigation Conservation	1,446
Total	**1,501**



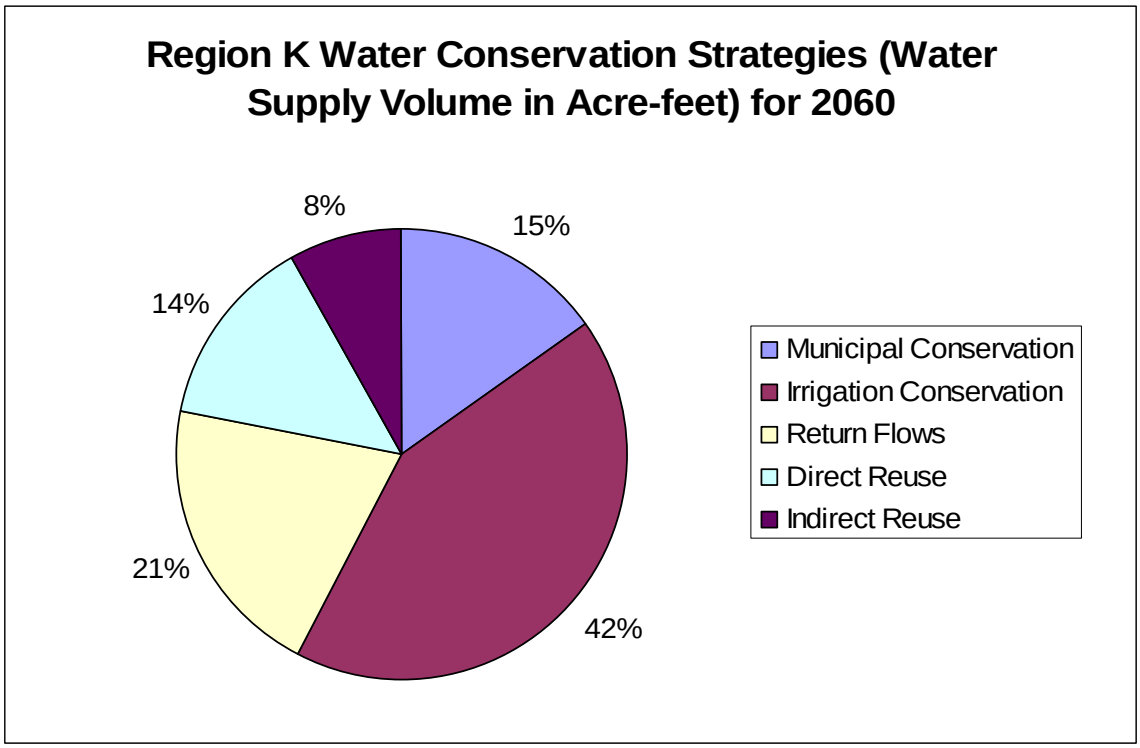
4.10-2 Region J Breakdown of Water Conservation Projects

Strategy- Breakdown of Projects	2060 Water Supply Volume in acre-feet
Conservation: Water Audit and Loss Audit (Camp Wood)	2
Conservation: Water Audit and Loss Audit (Kerrville)	53
Crop Residue Management and Conservation Tillage (Bandera County)	125
Crop Residue Management and Conservation Tillage (Kerr County)	865
Irrigation Scheduling (Bandera County)	58
Irrigation Scheduling (Kerr County)	398
Total	**1,501**



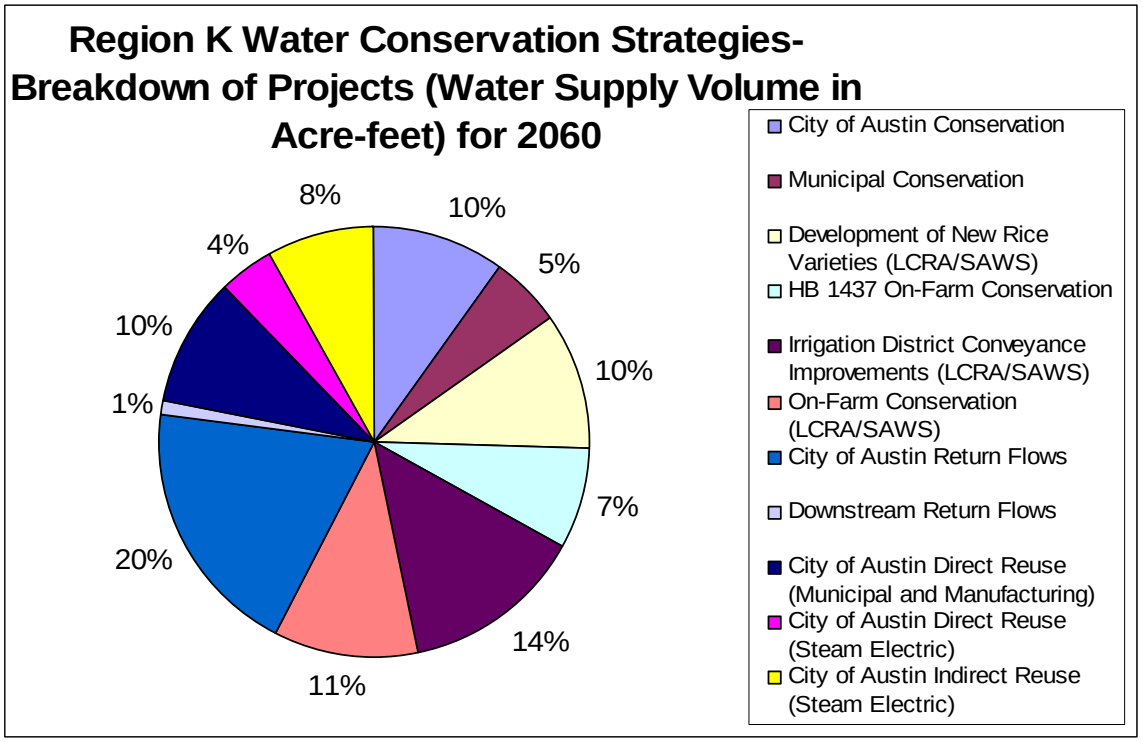
4.11-1 Region K

Strategy	2060 Water Supply Volume in acre-feet
Municipal Conservation	51,315
Irrigation Conservation	143,000
Return Flows	69,452
Direct Reuse	47,227
Indirect Reuse	27,411
Total	**338,405**



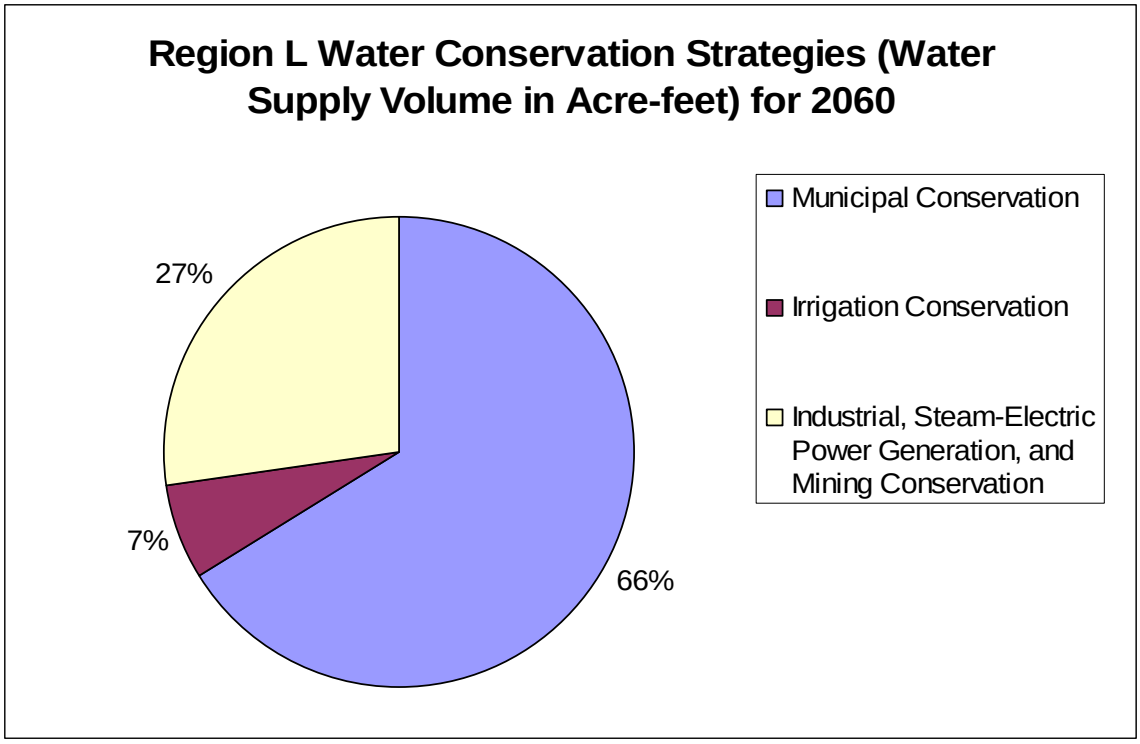
4.11-2 Region K Breakdown of Water Conservation Projects

Strategy- Breakdown of Projects	2060 Water Supply Volume in acre-feet
City of Austin Conservation	33,537
Municipal Conservation	17,778
Development of New Rice Varieties (LCRA/SAWS)	35,297
HB 1437 On-Farm Conservation	25,000
Irrigation District Conveyance Improvements (LCRA/SAWS)	46,184
On-Farm Conservation (LCRA/SAWS)	36,519
City of Austin Return Flows	65,962
Downstream Return Flows	3,490
City of Austin Direct Reuse (Municipal and Manufacturing)	33,537
City of Austin Direct Reuse (Steam Electric)	13,690
City of Austin Indirect Reuse (Seam Electric)	27,411
Total	**338,405**



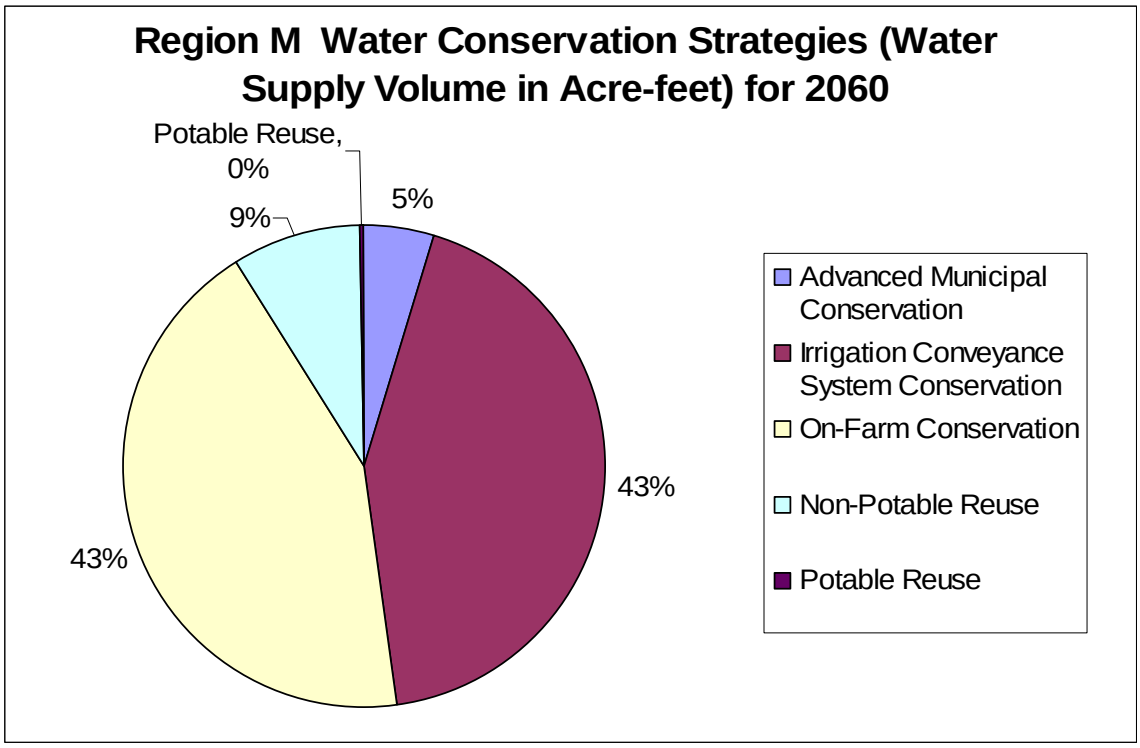
4.12 Region L

Strategy	2060 Water Supply Volume in acre-feet
Municipal Conservation	72,566
Irrigation Conservation	7,477
Industrial, Steam-Electric Power Generation, and Mining Conservation	29,884
Total	**109,927**



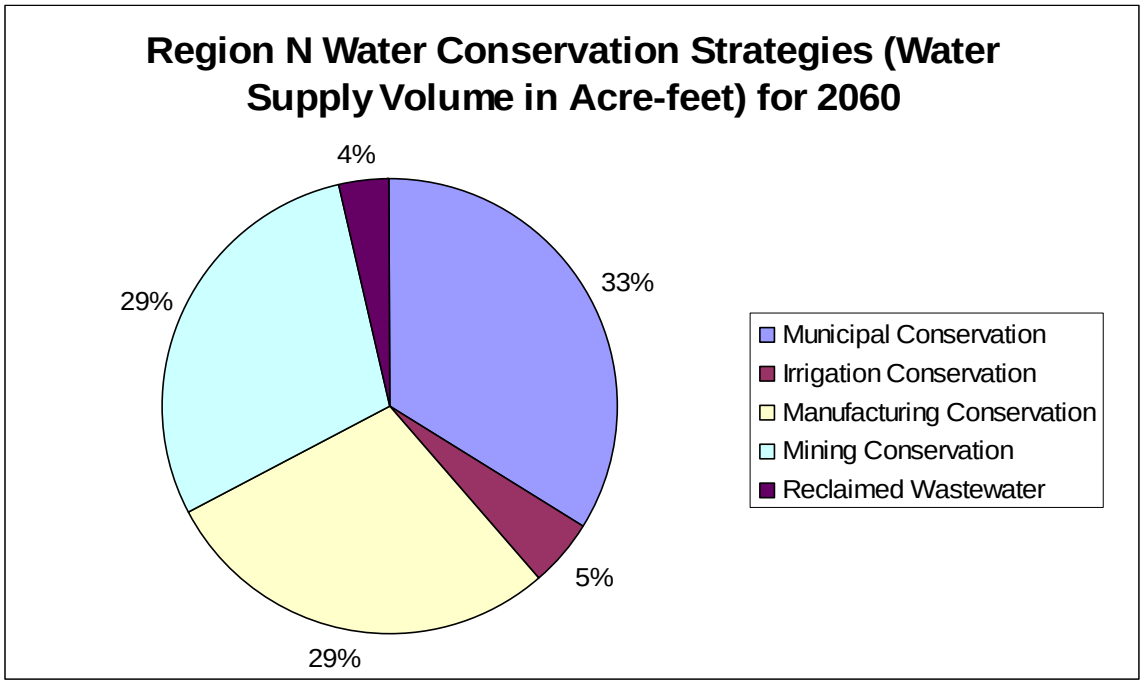
4.13 Region M

Strategy	2060 Water Supply Volume in acre-feet
Advanced Municipal Conservation	24,412
Irrigation Conveyance System Conservation	218,783
On-Farm Conservation	219,228
Non-Potable Reuse	44,661
Potable Reuse	1,120
Total	**508,204**



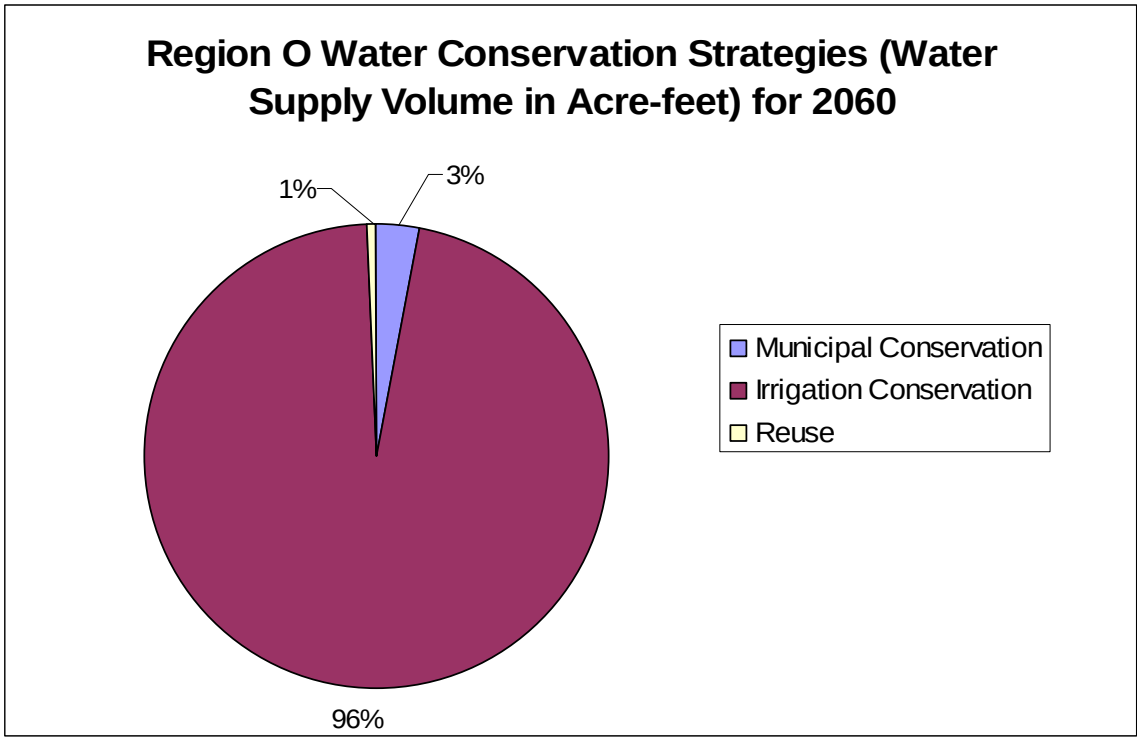
4.14 Region N

Strategy	2060 Water Supply Volume in acre-feet
Municipal Conservation	2,415
Irrigation Conservation	342
Manufacturing Conservation	2,050
Mining Conservation	2,084
Reclaimed Wastewater	250
Total	**7,141**



4.15 Region O

Strategy	2060 Water Supply Volume in acre-feet
Municipal Conservation	10,424
Irrigation Conservation	327,366
Reuse	2,240
Total	**340,030**

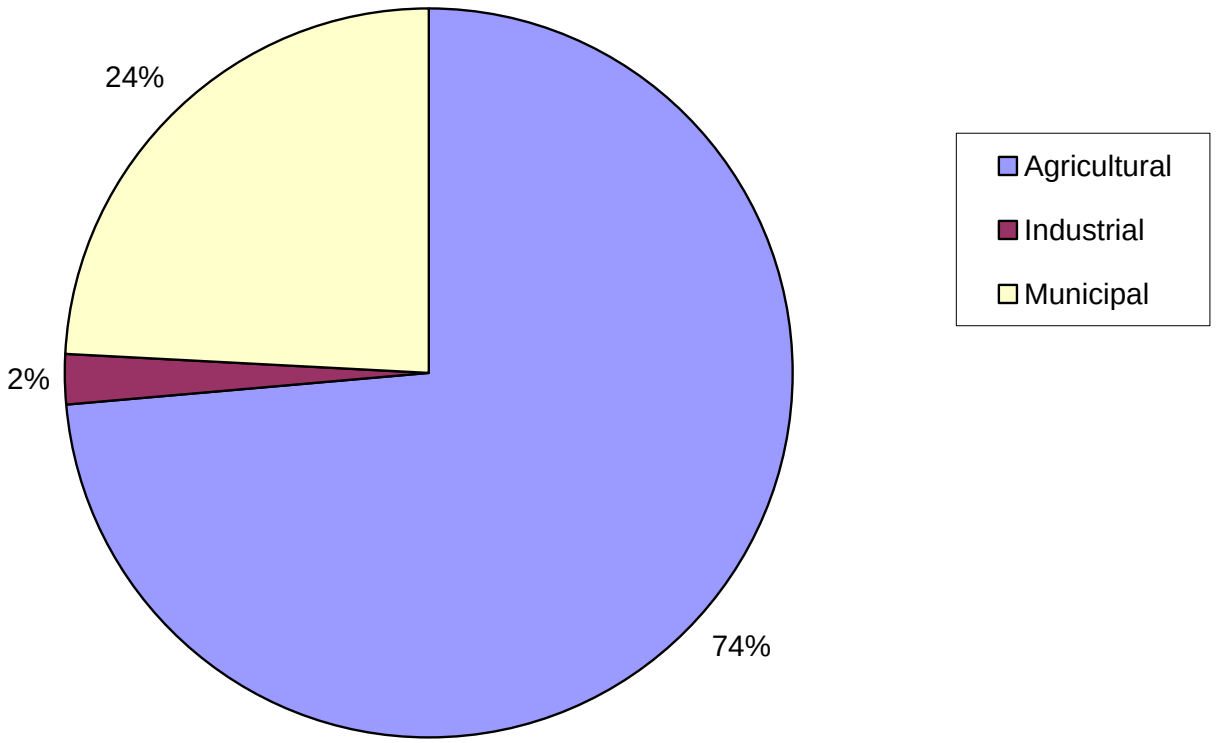


4.16 Region P

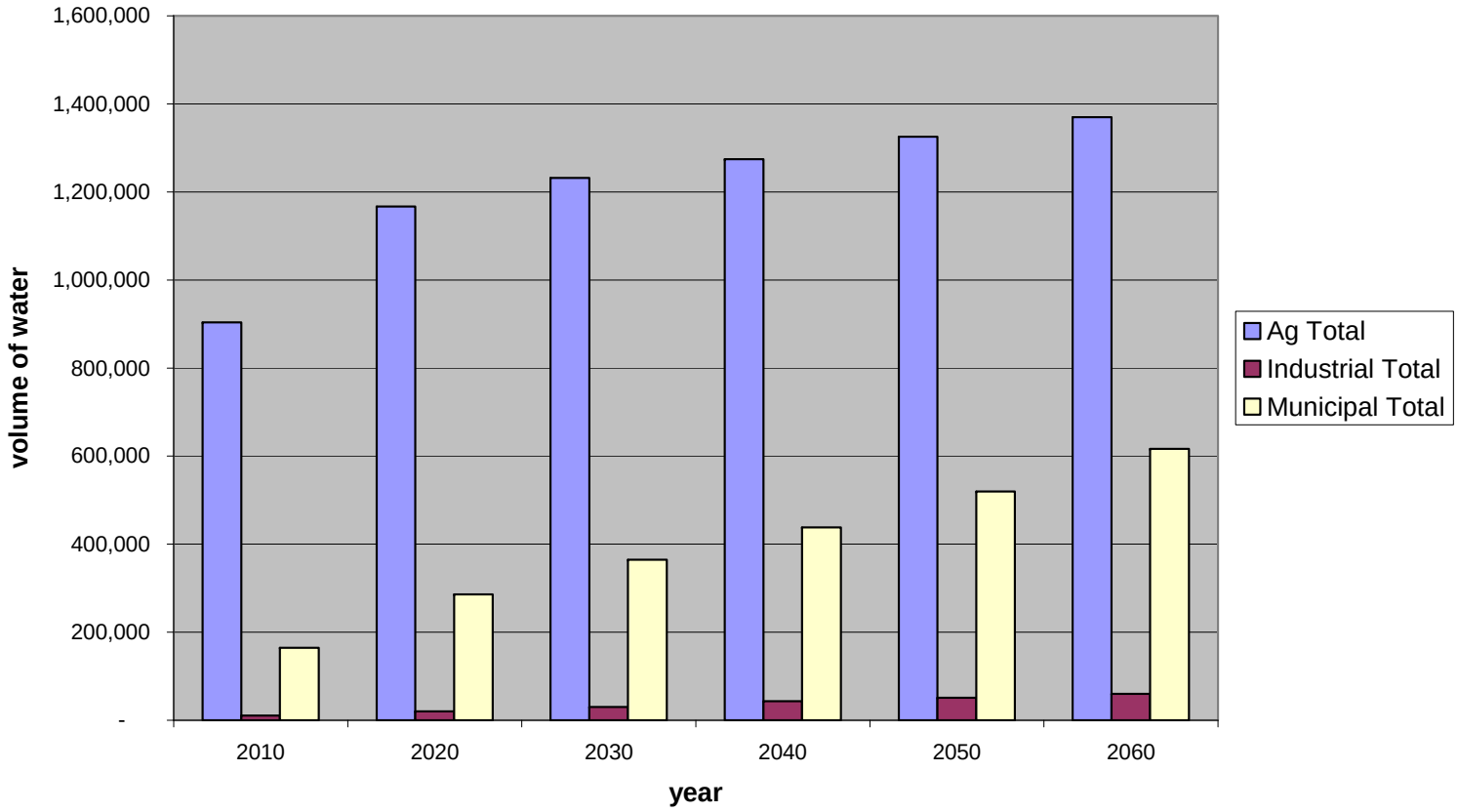
Strategy	2060 Water Supply Volume in acre-feet
Municipal Conservation	0
Irrigation Conservation	0
Total	**0**

Section 5: Statewide Water Conservation Strategies by WUG Type 2010-2060

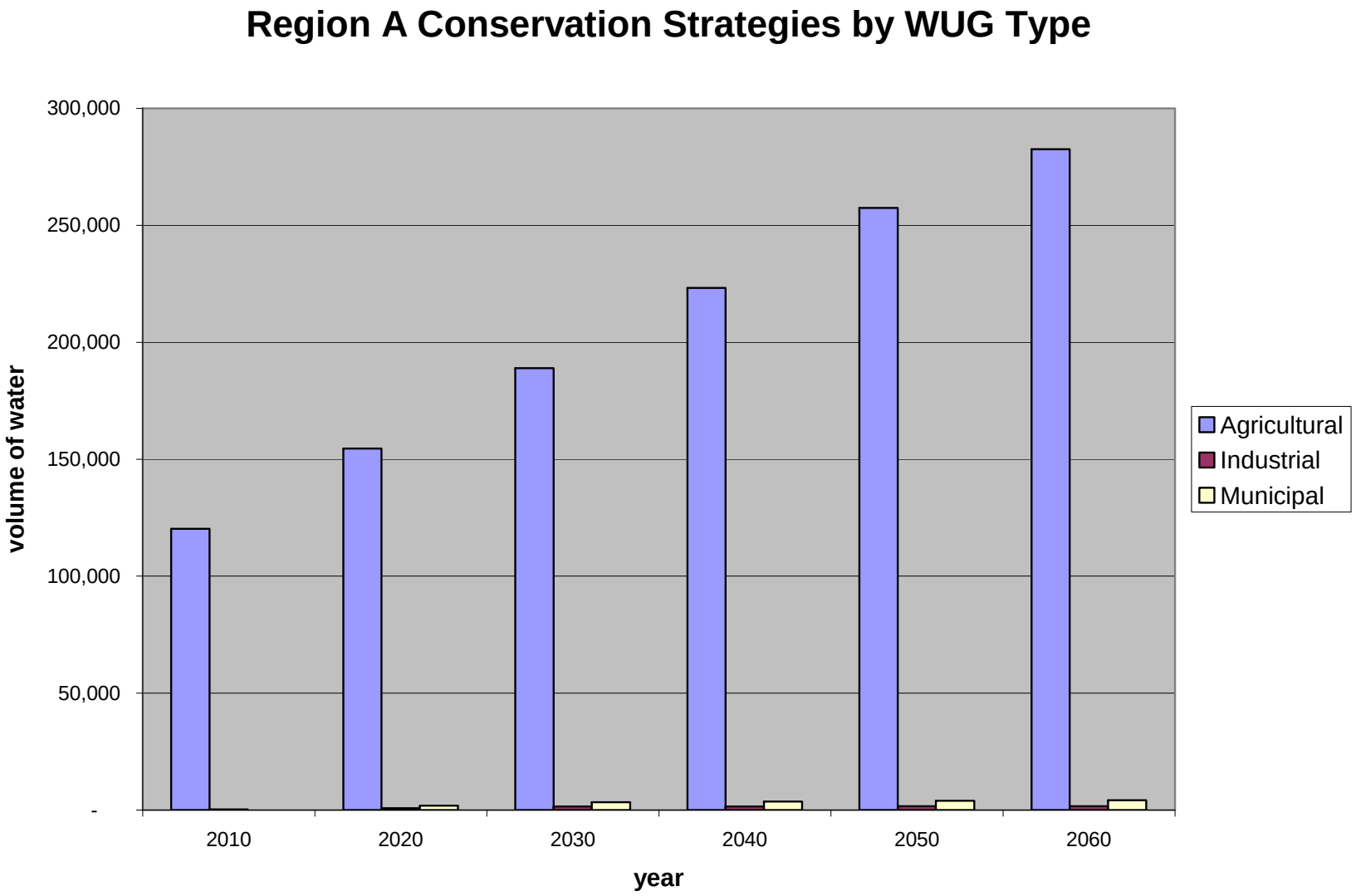
Water Conservation Strategies by WUG Type Totals for the State of Texas for 2010-2060



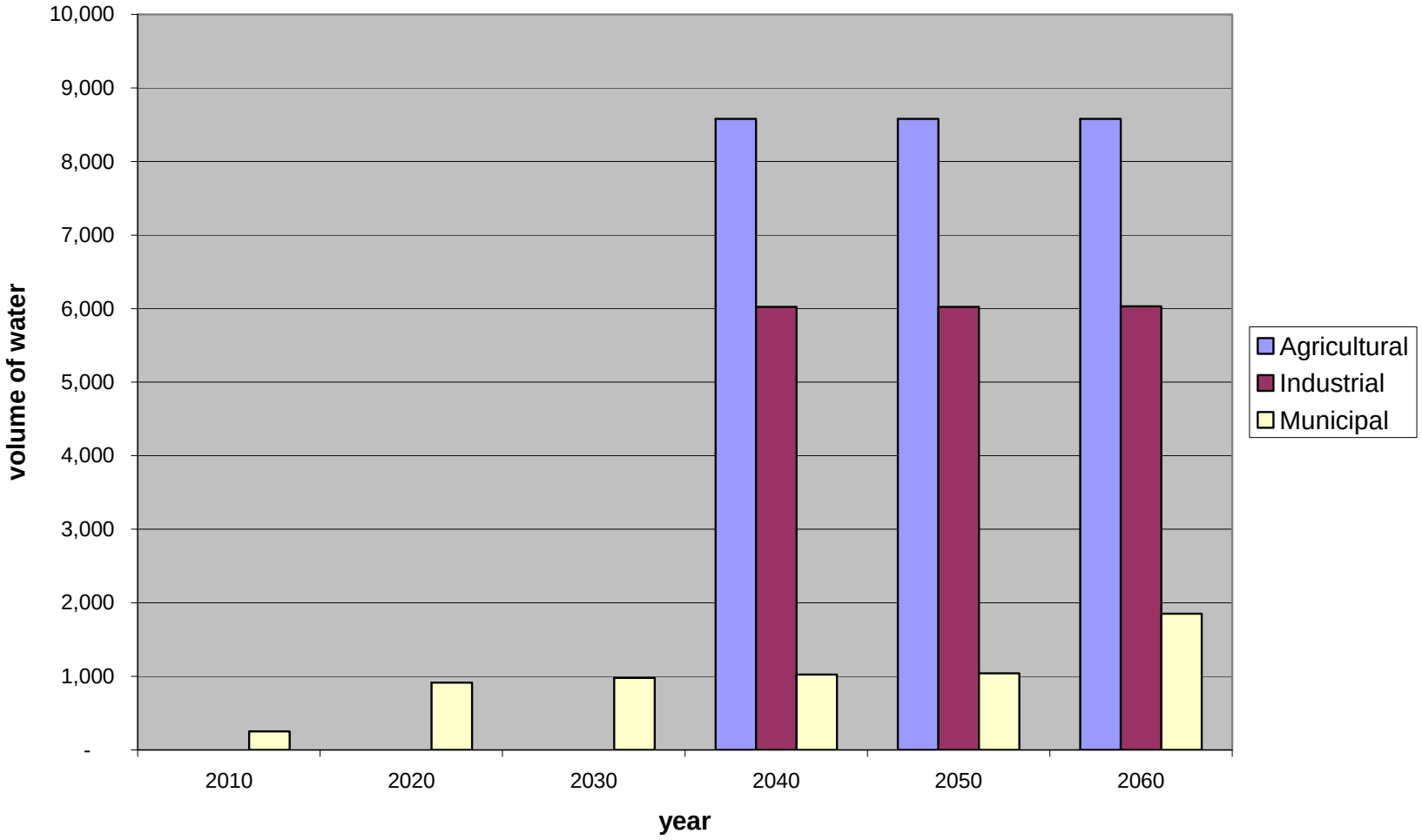
Water Conservation Strategies by WUG Type Totals for the State of Texas for 2010-2060

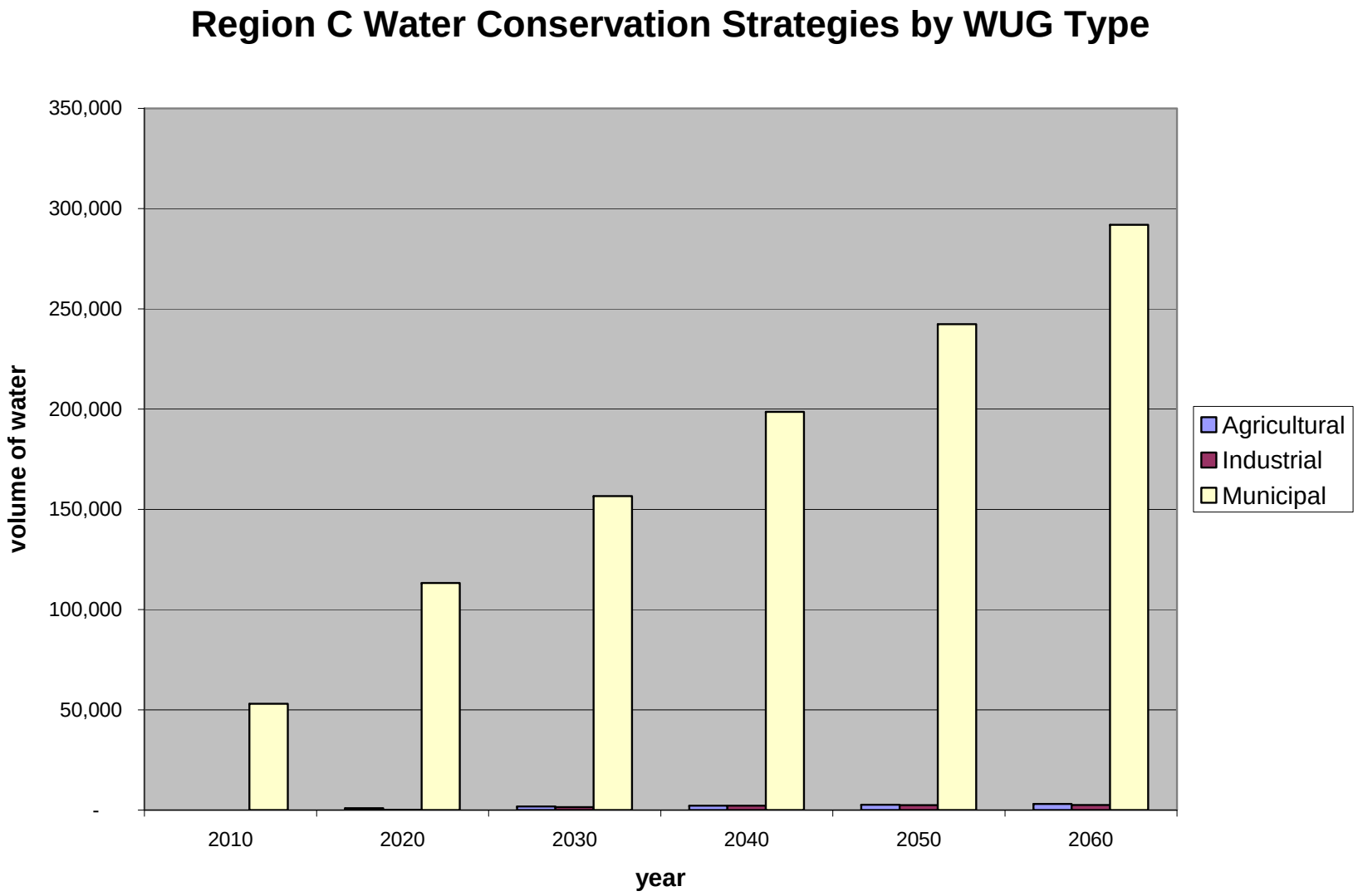


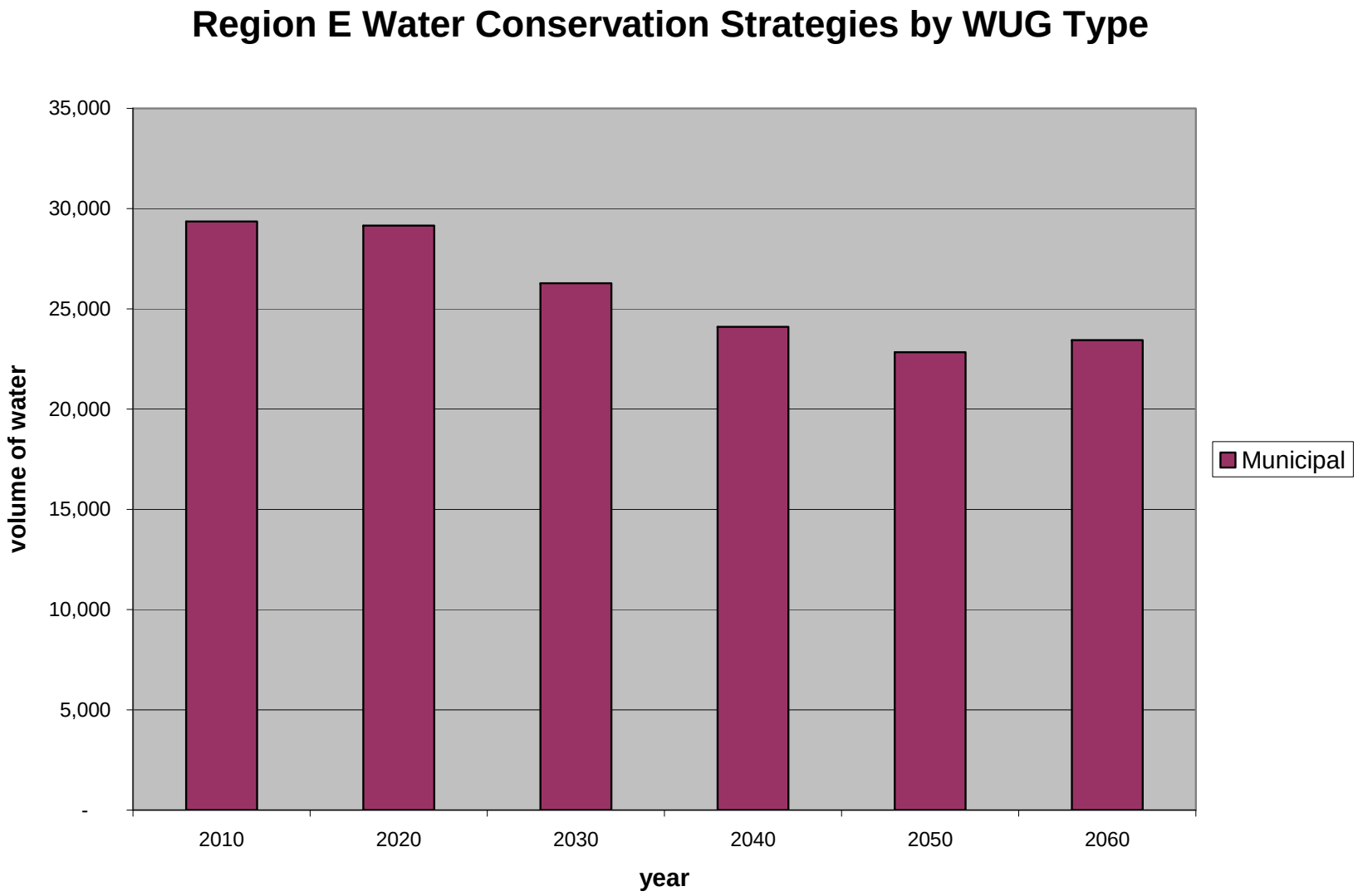
Section 6: Regional Water Conservation Strategies by WUG Type 2010-2060

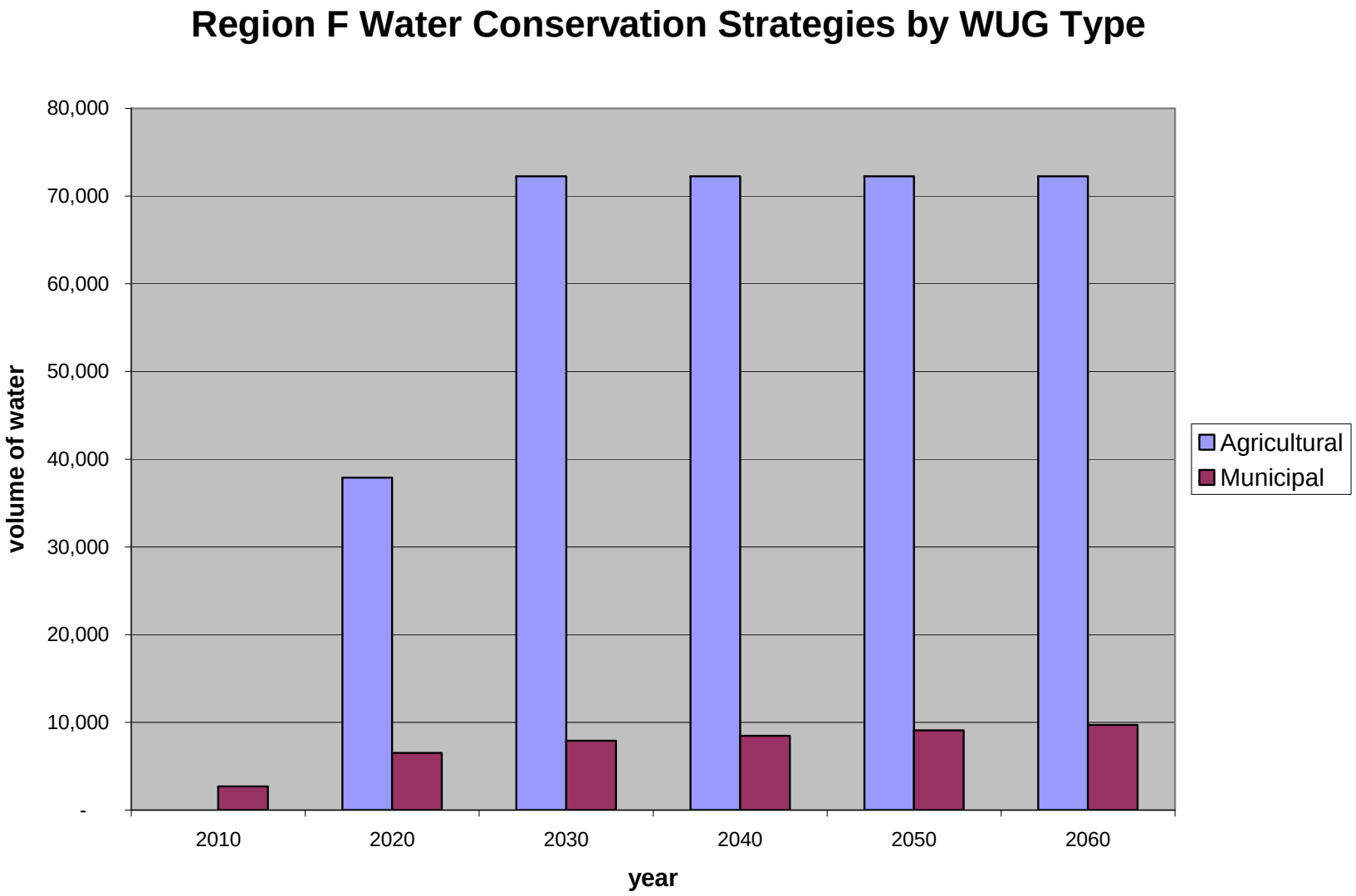

Region A Conservation Strategies by WUG Type
300,000
250,000
200,000
150,000
100,000
50,000
-
volume of water
2010
2020
2030
2040
2050
2060
year
Agricultural
Industrial
Municipal

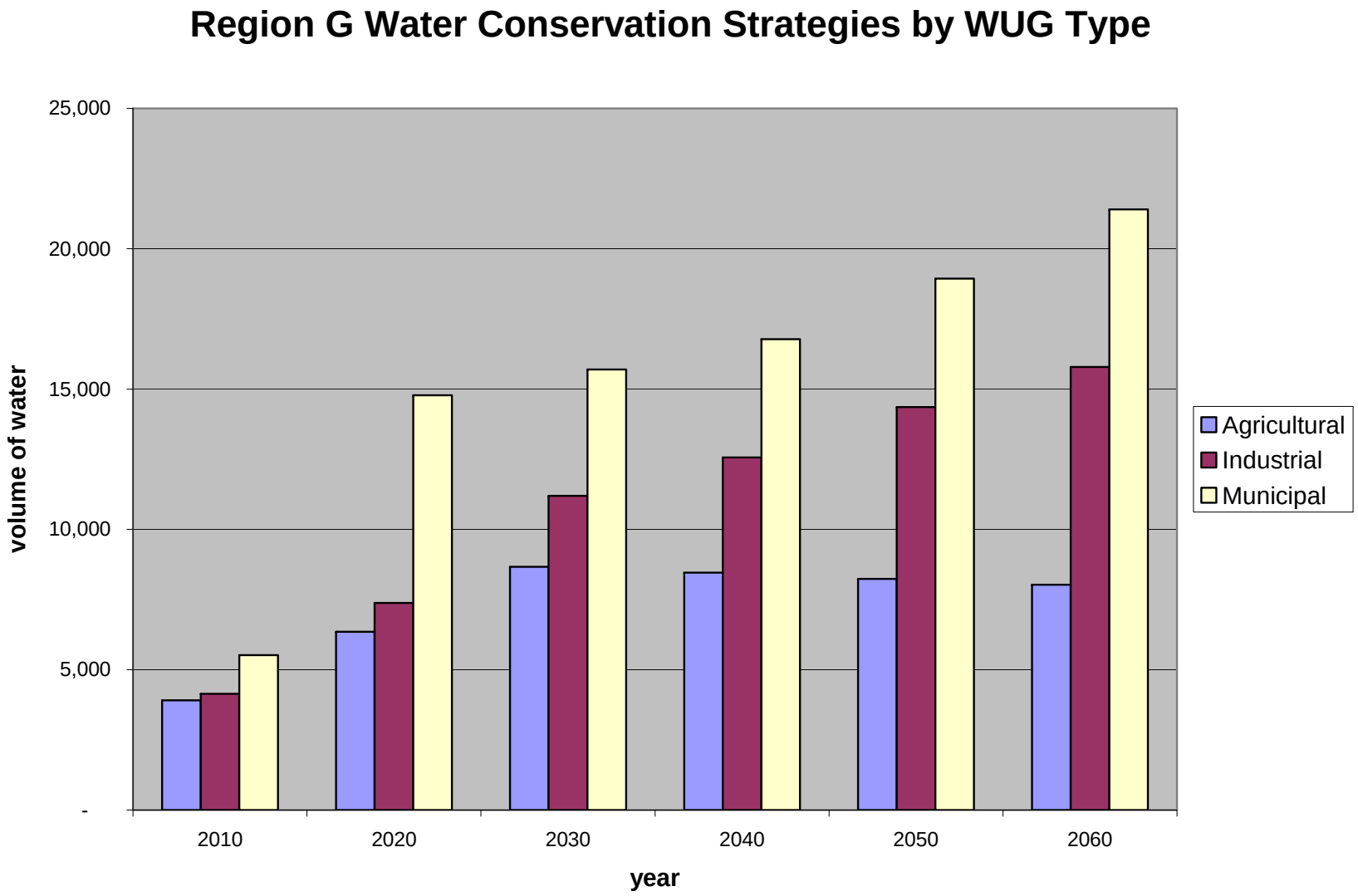
Region B Water Conservation Strategies by WUG Type

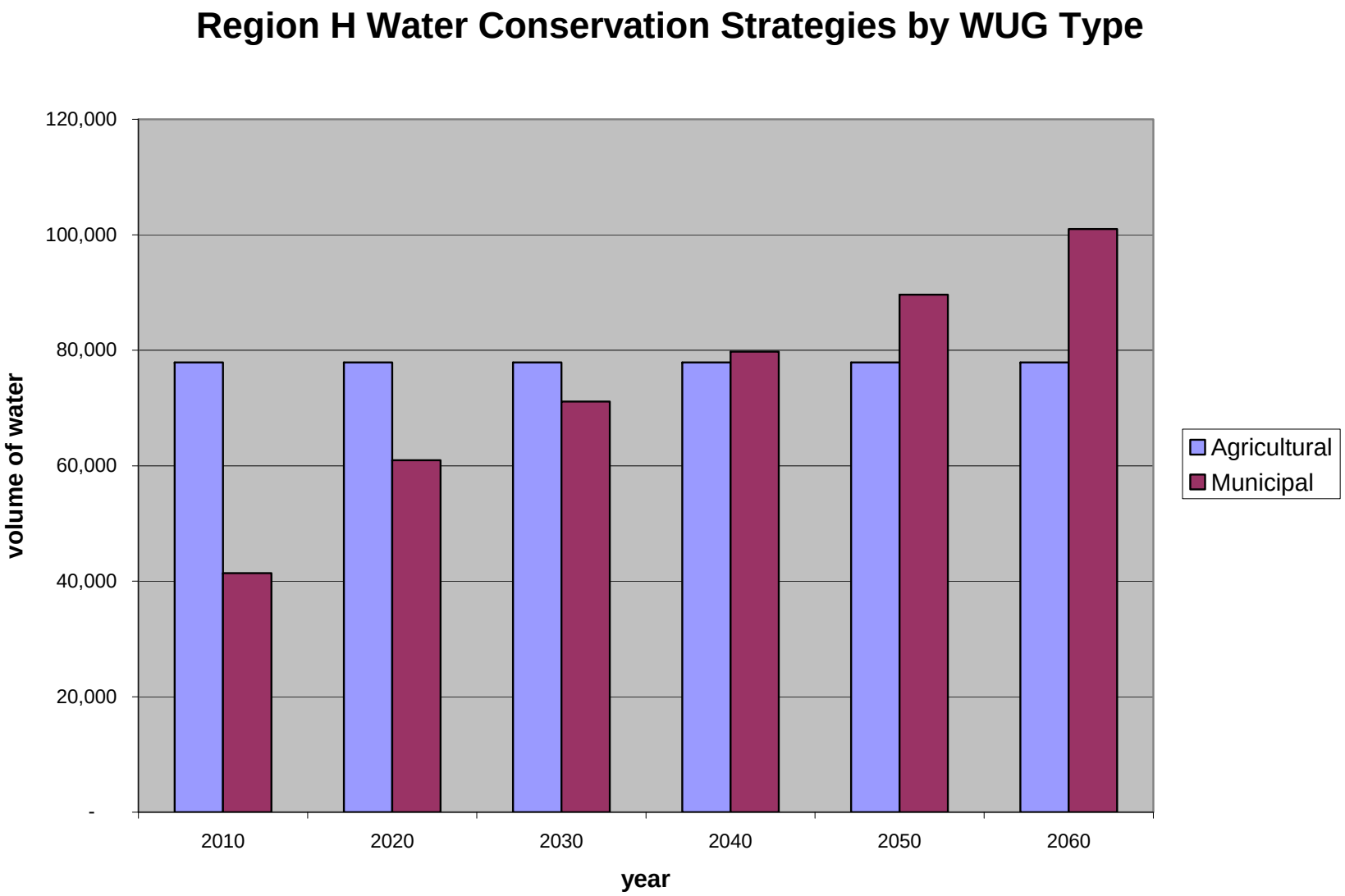


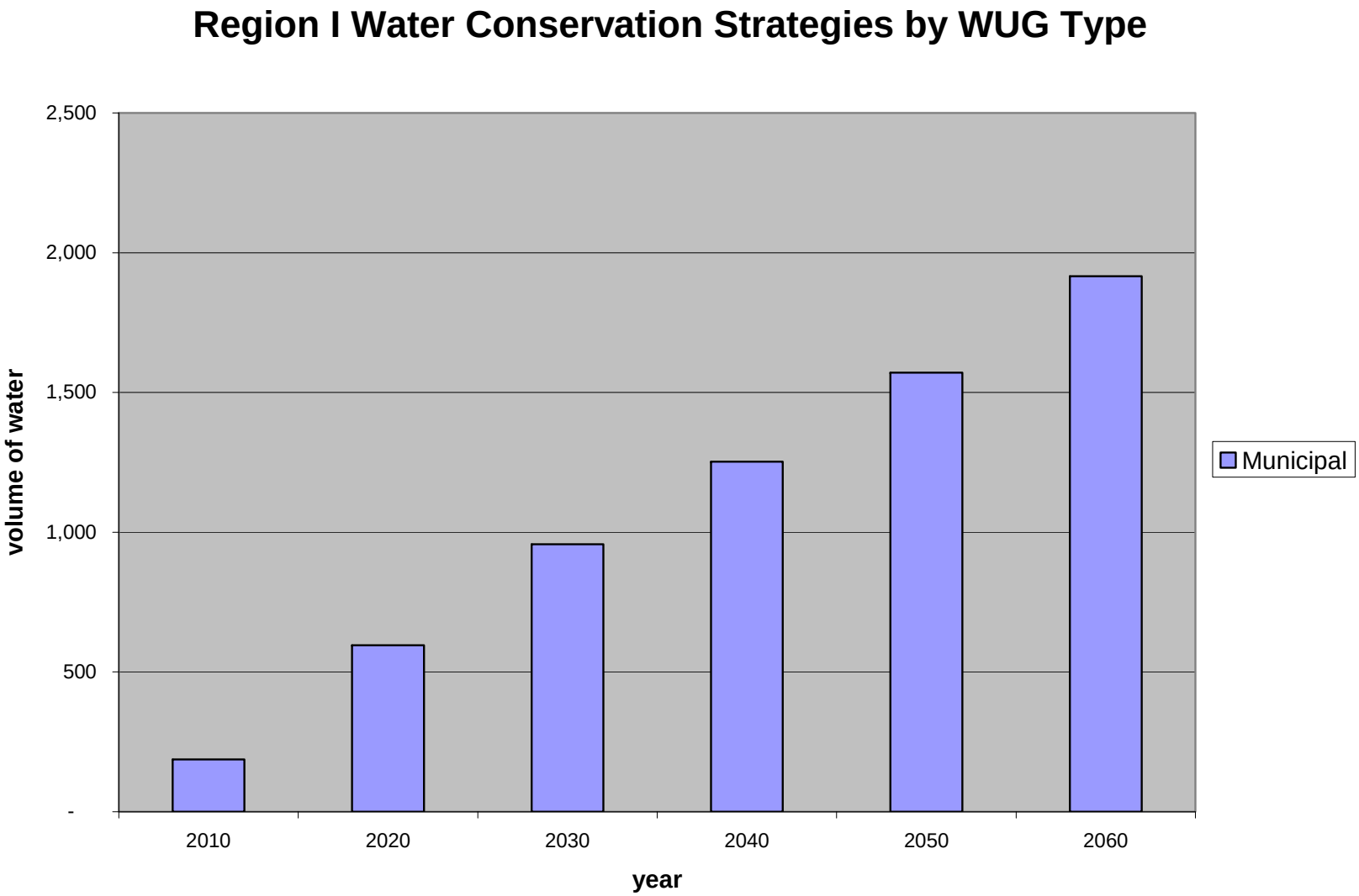

Region C Water Conservation Strategies by WUG Type
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
volume of water
2010
2020
2030
2040
2050
2060
year
Agricultural
Industrial
Municipal


Region E Water Conservation Strategies by WUG Type
35,000
30,000
25,000
20,000
15,000
10,000
5,000
-
volume of water
2010
2020
2030
2040
2050
2060
year
Municipal

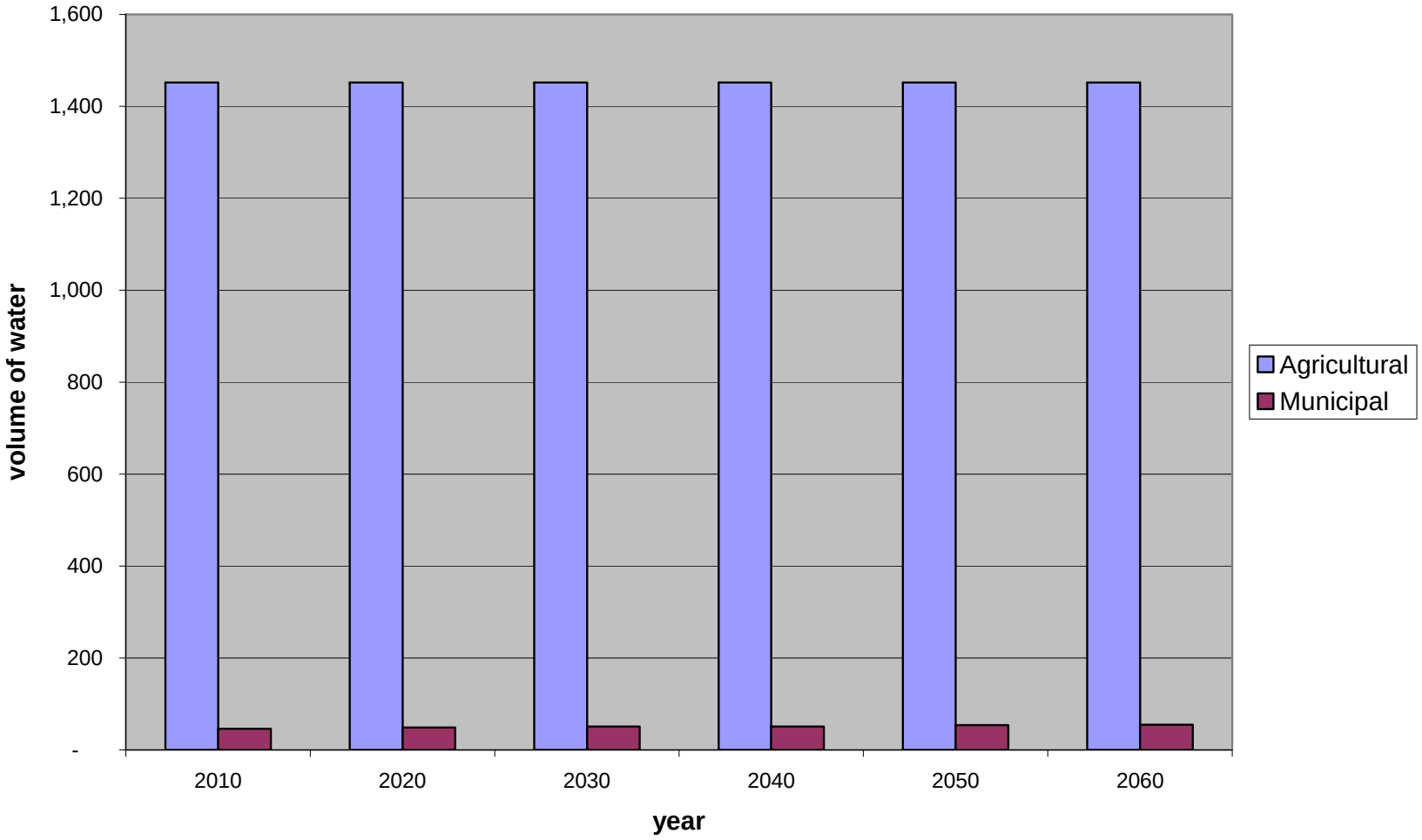

Region F Water Conservation Strategies by WUG Type
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
volume of water
2010
2020
2030
2040
2050
2060
year
Agricultural
Municipal

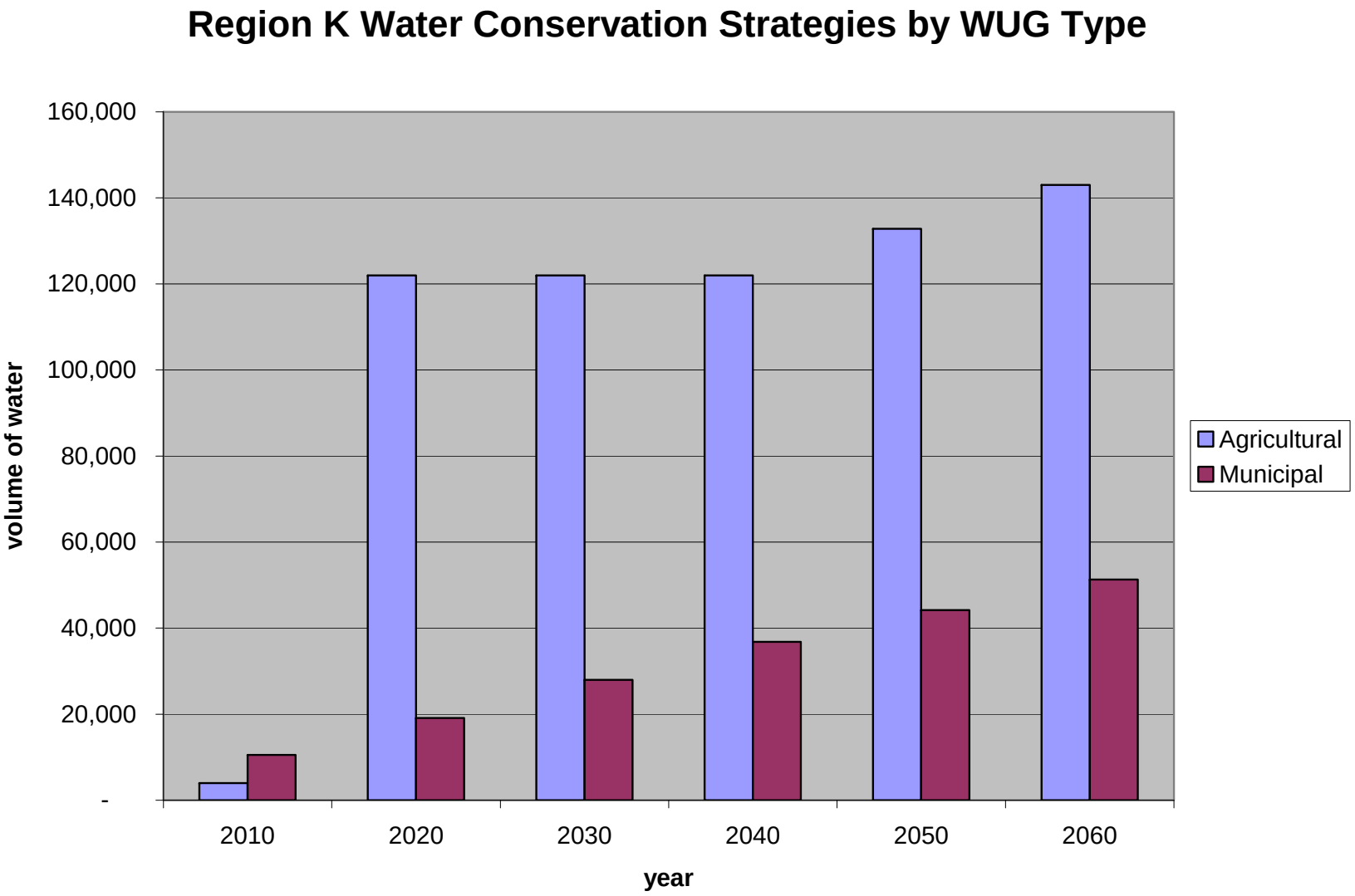

Region G Water Conservation Strategies by WUG Type
25,000
20,000
15,000
10,000
5,000
-
volume of water
2010
2020
2030
2040
2050
2060
year
Agricultural
Industrial
Municipal

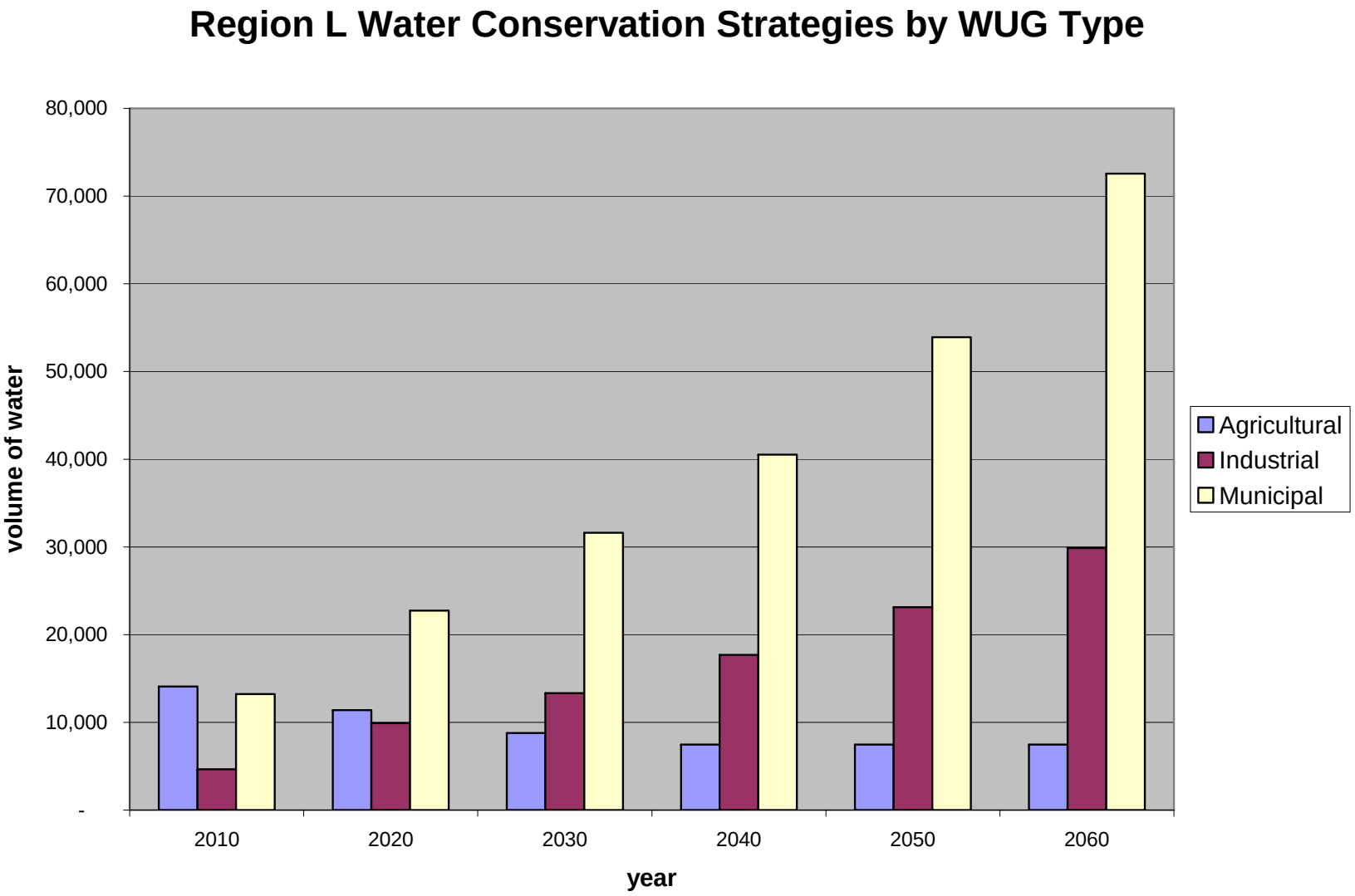

Region H Water Conservation Strategies by WUG Type
120,000
100,000
80,000
60,000
40,000
20,000
-
volume of water
2010
2020
2030
2040
2050
2060
year
Agricultural
Municipal

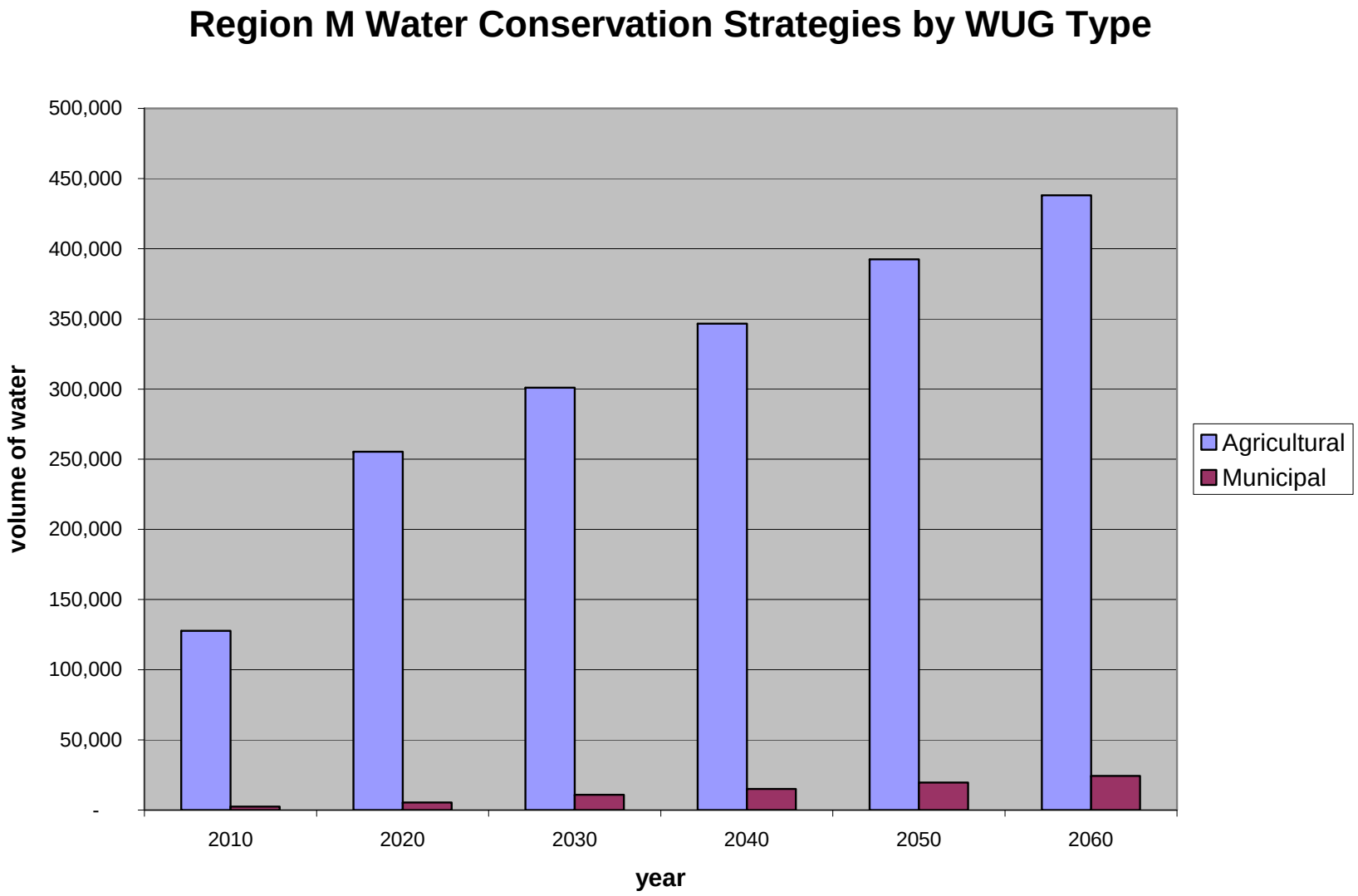

Region I Water Conservation Strategies by WUG Type
2,500
2,000
1,500
1,000
500
-
volume of water
2010
2020
2030
2040
2050
2060
year
Municipal

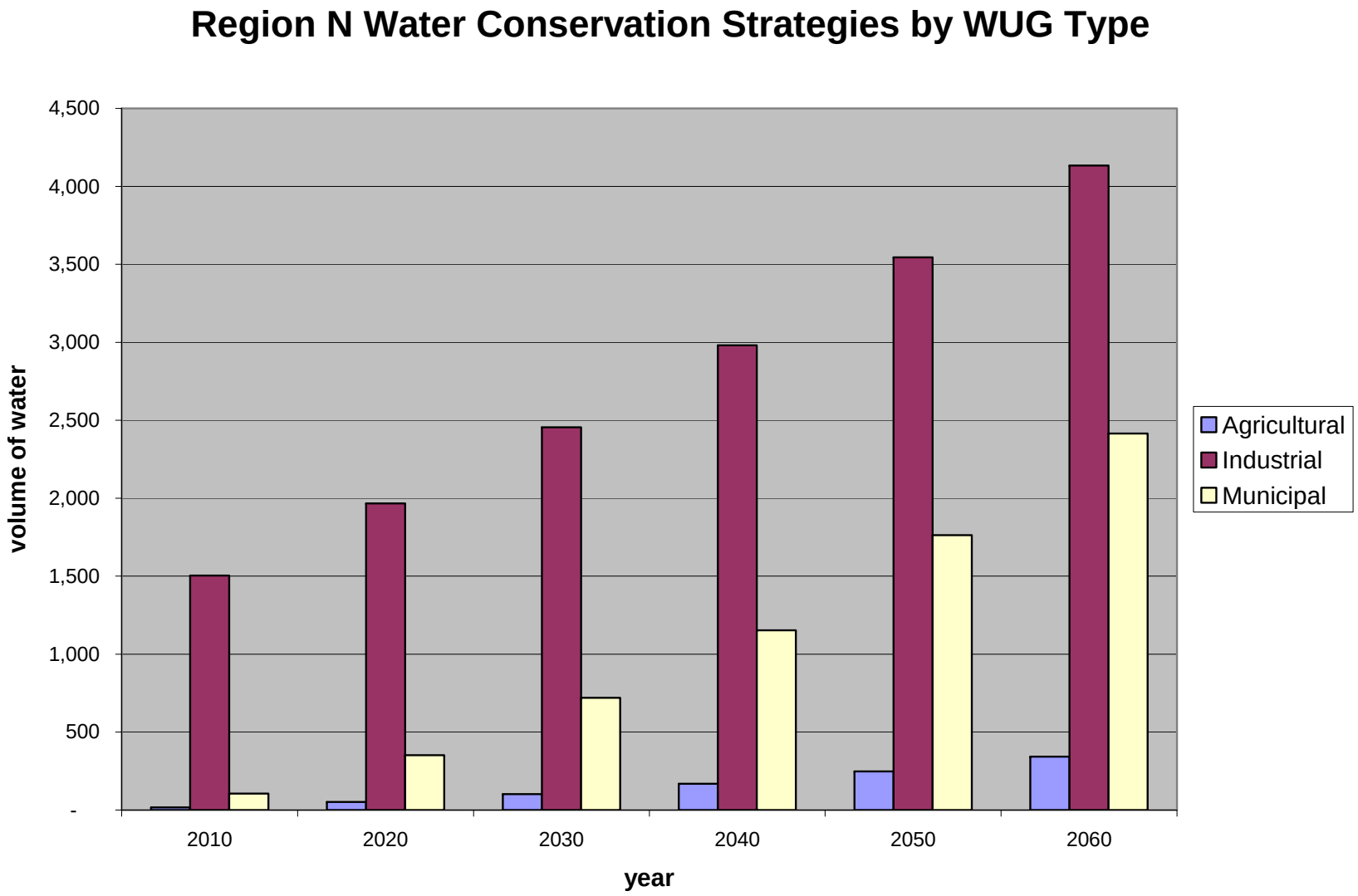
Region J Water Conservation Strategies by WUG Type

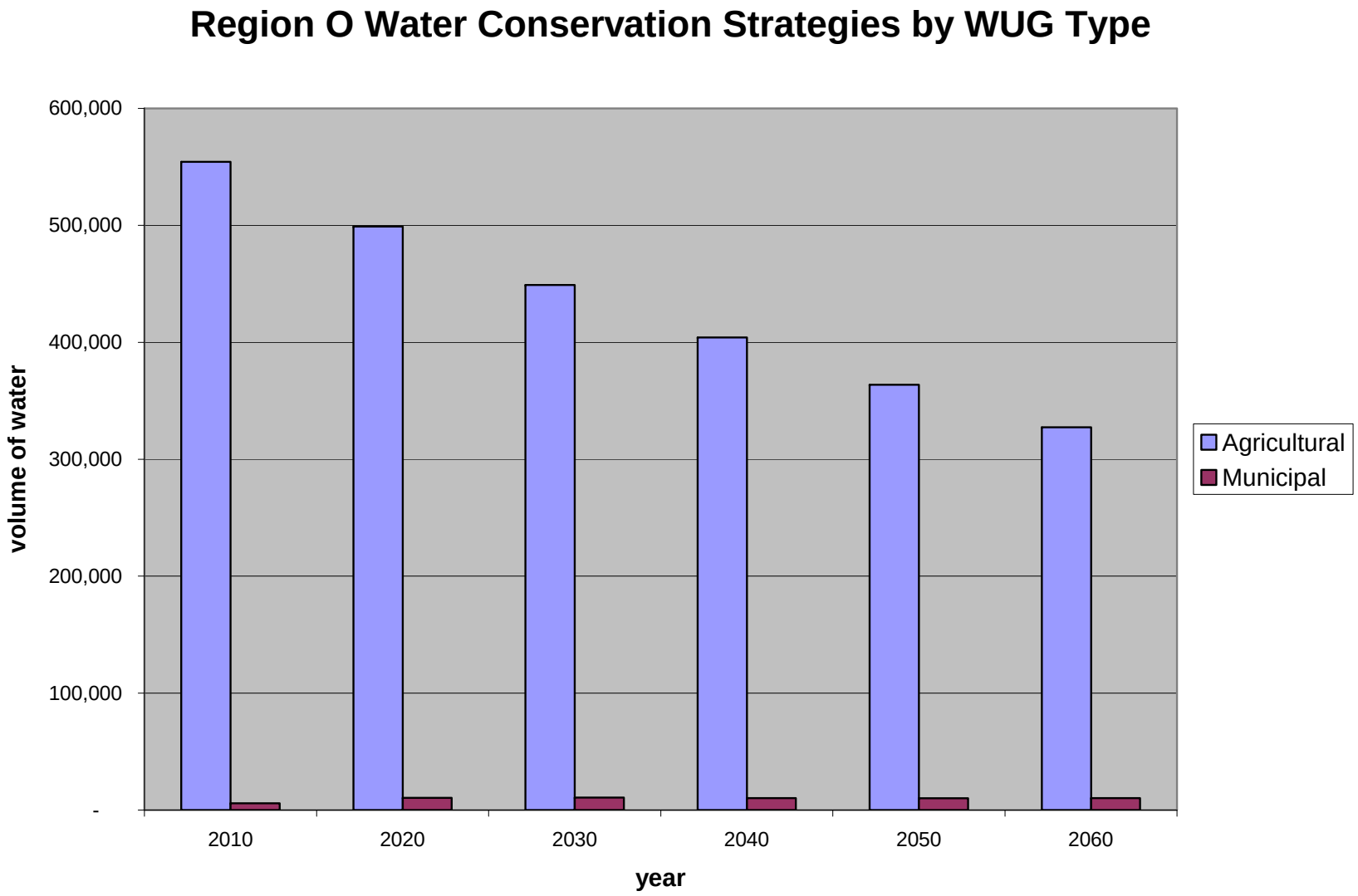



Region K Water Conservation Strategies by WUG Type
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
volume of water
2010
2020
2030
2040
2050
2060
year
Agricultural
Municipal


Region L Water Conservation Strategies by WUG Type
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
volume of water
2010
2020
2030
2040
2050
2060
year
Agricultural
Industrial
Municipal


Region M Water Conservation Strategies by WUG Type
volume of water
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
2010
2020
2030
2040
2050
2060
year
Agricultural
Municipal


Region N Water Conservation Strategies by WUG Type
volume of water
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-
2010
2020
2030
2040
2050
2060
year
Agricultural
Industrial
Municipal


Region O Water Conservation Strategies by WUG Type
600,000
500,000
400,000
300,000
200,000
100,000
-
volume of water
2010
2020
2030
2040
2050
2060
year
Agricultural
Municipal

Region P: No regional data on WUG Type