5A Methodology for Evaluation and Selection of Water Management Strategies

This section describes the process to determine potentially feasible strategies for Region C and the methods used in evaluation of potentially feasible strategies and the selection of recommended strategies. The steps in the evaluation and selection of water management strategies for Region C include the following:

- Review of previous plans for water supply in Region C, including locally developed plans and the 2012 State Water Plan [(1)]
- Consideration of the types of water management strategies required by Senate Bill One regional planning guidelines [(2)]
- Development of evaluation criteria for management strategies
- Selection for evaluation of potentially feasible water management strategies that could meet needs in Region C
- Environmental evaluation of individual strategies
- Development of cost information for individual strategies
- Input from wholesale water providers and water user groups
- Selection of recommended strategies for Region C

As part of Task 4B (Potentially Feasible Water Management Strategies), Region C produced a memorandum to TWDB dated November 10, 2011 with Subject "Methodology for Evaluating Water Management Strategies for the 2016 Region C Water Plan." The RCWPG approved the methodology laid out in this memo at the October 25, 2011 RCWPG public meeting (Agenda Item III.B.). Region C consultants later presented the RCWPG with a full list of Potentially Feasible Water Management Strategies at the January 26, 2015 RCWPG public meeting (Agenda Item IV.F.). RCPWG approved the potentially feasible and recommended WMSs as part of the Initially Prepared Plan at the April 20, 2015 RCWPG public meeting (Agenda Item IV.A.).

5A.1 Types of Water Management Strategies

Regional Planning guidelines require that certain types of water management strategies be considered as means of developing additional water supplies. The types of strategies that must be considered include the following [(2)]:

- Water conservation and drought response planning
- Reuse of wastewater
- Expanded use or acquisition of existing supplies, including system optimization and conjunctive use
- Reallocation of reservoir storage to new uses
- Voluntary redistribution of water resources
- Voluntary subordination of water rights
- Enhancement of yields of existing sources
- Control of naturally occurring chlorides
- Brush control, precipitation enhancement, and desalination
- Water right cancellation
- Aquifer storage and recovery
- New supply development
- Interbasin transfers
- Other measures.

The Region C Water Planning Group reviewed each of these types of water management strategies and determined whether there were potentially feasible strategies to develop water supply in Region C within each type. Water conservation and drought response planning and reuse strategies are discussed in Section 5E. Drought response planning is discussed in Chapter 7. Other types of management strategies are discussed below, and a more detailed listing of potentially feasible water management strategies for Region C is included in Appendix O. The impacts of potential water management strategies are considered in Appendix P. The methodology used for quantitatively assessing impacts are discussed in Appendix P.

5A.1.1 Expanded Use of Existing Supplies

Reservoir System Operation

System operation is the coordinated use of multiple sources of supply, usually surface water reservoirs. System operation is widely used throughout Region C, and can be implemented for many purposes, including gaining yield, reducing pumping costs, or maintaining acceptable water quality. Most of the

systems in Region C are operated primarily to reduce pumping costs. For the purpose of the Region C planning process, only system operation that results in increased yield will be considered as potentially feasible water management strategies. The following system operations were adopted as potentially feasible strategies to gain additional supplies for Region C:

- Dallas Water Utilities reservoirs
- Tarrant Regional Water District reservoirs
- System operation of Wright Patman Lake and other sources to gain additional yield.

Summary of Decision: System operation is widely used in Region C, primarily to reduce pumping costs. Potentially feasible system operation strategies to provide additional yield should be investigated.

Connecting Existing Supplies

The connection of existing supplies that are not yet being fully utilized was a major element of the 2011 Region C Water Plan [3]. There are several sources of water supply that have long been committed for use in Region C and could be connected to provide additional water supply. Region C water suppliers could also connect to currently uncommitted supplies in other regions, but these supplies are not necessarily available for use in Region C.

Table 5A.1 lists potentially feasible water management strategies for Region C based on the connection of existing sources that would supply over 25,000 acre-feet per year. The volumes of supply listed in this table represent the maximum amount available from the source, which in some cases is greater than the volume that is being recommended in this plan. In addition to the strategies listed in Table 5A.1, smaller potentially feasible strategies to connect existing supplies are listed in Appendix O. There are also several general categories of strategies to connect existing supplies that are considered to be potentially feasible in Region C:

- Connections to other water user groups or wholesale water providers
- Expansion and renovation of existing connections and transmission systems
- New, renewed, and increased contracts for water
- Water treatment plant expansions.

The development (or continued development) of regional water systems was also an important part of the 2011 Region C Water Plan [3]. The following regional systems were in the 2011 Plan and are potentially feasible strategies for this plan:

- North Texas Municipal Water District
- Upper Trinity Regional Water District

- Trinity River Authority Tarrant County Water Supply Project
- Trinity River Authority Ellis County Project
- Cooke County
- Grayson County
- Fannin County
- Walnut Creek SUD.

The expected time to implement strategies connecting to existing supplies can vary greatly depending on the strategy. Strategies such as the construction of a water treatment plant, new/renewed contracts, or renovating an existing transmission system are assumed to take three years or less. Strategies connecting to an existing surface water supply in a river basin different from the basin of use are anticipated to take 5 to 10 years for the permitting process because of the need for an interbasin transfer permit. Construction of a transmission system for projects moving large amounts of water over long distances are expected to take 5 to 8 years.

Summary of Decision: Include connection of existing supplies as a major component of the Region C plan. Evaluate specific potentially feasible strategies for connection of existing supplies.

Table 5A.1
Major Potentially Feasible Water Management Strategies for Connecting Existing Supplies

Strategy	Potential Sponsor(s) [a]	Maximum Supply [b] Available to Region C from Strategy in Acre-Feet per Year	Recommended Included in 2011 Plan?
Toledo Bend Reservoir	SRA, NTMWD, TRWD, DWU, and UTRWD	600,000 (part of Texas' share)	Yes
Gulf of Mexico with Desalination	DWU, NTMWD, and TRWD	Unlimited [c]	No
Wright Patman pool raise (to 232.5, as part of Sulphur Basin Supplies)	DWU, NTMWD, TRWD, UTRWD, and Irving	127,120 [d]	No
Oklahoma Water	NTMWD, TRWD, UTRWD, and Irving,	165,000 or more	Yes
Lake Texoma – Unauthorized [e]	NTMWD, DWU, and UTRWD	220,000	No
NTWMD Lake Texoma - Authorized	NTMWD	113,000	Yes
Lake Palestine	DWU	110,670	Yes
Wright Patman Lake – Texarkana	DWU, NTMWD, TRWD, UTRWD, or Irving	100,000	No

Strategy	Potential Sponsor(s) [a]	Maximum Supply [b] Available to Region C from Strategy in Acre-Feet per Year	Recommended Included in 2011 Plan?
Carrizo-Wilcox Groundwater (Wood, Smith, Upshur Counties)	DWU	102,930	No
Carrizo-Wilcox Groundwater (Freestone & Anderson Counties)	NTMWD	42,000	No
Cypress River Basin Supplies (Lake O' the Pines)	DWU, NTMWD, or TRWD	unknown [f]	No
GTUA Lake Texoma Already Authorized	GTUA	56,500	Yes
Ellis County Project	TRA / TRWD	74,610	Yes
Expanded NTMWD/GTUA Collin Grayson Municipal Alliance	Multiple	30,000	Yes
Reuse	Multiple	355,118	Yes

Notes:
a. Recommended and alternative strategies for wholesale water providers are discussed in Section 5C.
b. Volumes of supply listed in this table represent the maximum amount available from the source, which in some cases is greater than the volume that is being recommended in this plan.
c. This strategy was evaluated for the transmission of 200,000 acre-feet per year of treated water to the Metroplex.
d. This Wright Patman water supply is not currently permitted or authorized, but could be made available through the reallocation of flood storage.
e. This Texoma water supply is not currently permitted or authorized, but could be made available through the reallocation of hydropower storage.
f. The amount of supply available from Lake O' the Pines is unclear. In past regional plans, supply was assumed to be available, but based on the 2016 Initially Prepared Region D Plan, it appears the region intends to fully utilize this source for future Region D demands. For purposes of this plan, cost estimates for this potential strategy were based on a volume of 87,900 acre-feet per year.

Conjunctive Use of Groundwater and Surface Water

In Region C, only 6 percent of the water used comes from groundwater. Groundwater is sometimes used to meet peak demands in systems that have both groundwater and surface water supplies. This does not, however, increase total supply on an annual basis. Therefore, conjunctive use should not be considered as a potentially feasible water management strategy to provide additional supplies for Region C.

Summary of Decision: Do not include the conjunctive use of groundwater and surface water as a source of additional supplies for Region C. Conjunctive use to meet peak needs is appropriate and should continue.

5A.1.2 Reallocation of Reservoir Storage

There are two types of reallocation of existing reservoir storage. Reallocation among various water supply uses (municipal, industrial, irrigation, etc.) is a relatively simple matter. It is considered to be a minor water right amendment by Texas Commission on Environmental Quality (TCEQ). This type of reallocation should be allowed at the discretion of the owner of the water right and should be considered to be consistent with the Region C plan.

The more complex type of reallocation is to transfer water from other uses such as hydropower generation or flood control to water supply. There are three reservoirs that have the potential for this type of storage reallocation and might provide supplies for Region C:

- Wright Patman Lake in the Sulphur River Basin in Region D has storage allocated to flood control that could be reallocated for municipal use. This would require environmental studies by the Corps of Engineers and Congressional approval.
- In Lake Texoma in the Red River Basin, Congress has already approved the reallocation of 150,000 acre-feet of storage from hydropower to municipal use in Texas and 150,000 acre-feet of storage from hydropower to municipal use in Oklahoma. Actual reallocation requires environmental studies which were completed in May 2006 [(4)]. Storage has been reallocated for municipal use in Texas, and the North Texas Municipal Water District and Greater Texoma Utility Authority have contracted for the storage and obtained Texas water rights for the resulting supplies. The reallocation of water for municipal use in Oklahoma has not yet occurred. Additional reallocation from hydropower storage to conservation storage is possible in Lake Texoma, and this would require additional Congressional approval.
- The reallocation of flood storage to municipal storage in Bardwell Lake in Ellis County has also been considered.

Most other Region C reservoirs with flood control or hydropower storage already have sufficient conservation storage to develop their potential supplies. Therefore, the reallocation of storage in other reservoirs is not likely to provide significant additional supplies for the region.

The implementation of this type of strategy is expected to take between 10 and 15 years depending upon study results and requirement for Congressional action.

Summary of Decision: Permit transfers among types of water use at the discretion of the water right holder. Evaluate reallocation to municipal use for Lake Texoma, Wright Patman Lake, and Bardwell Lake.

5A.1.3 Voluntary Redistribution of Water Resources

In many cases, the connection of existing sources and the development of new sources require the voluntary redistribution of water resources by sale from the owner of the supply to the proposed user.

(This would be true unless the proposed user is also the owner of the supply.) Emergency transfers of non-municipal use surface water are not considered a viable strategy for Region C. The water management strategies involving the voluntary redistribution of water resources are discussed under other categories and the impacts from voluntary redistributions of water supplies are considered in Appendix P.

Summary of Decision: Evaluate potentially feasible strategies involving the voluntary redistribution of water resources under other categories.

5A.1.4 Voluntary Subordination of Water Rights

Voluntary subordination of water rights is most useful where senior water rights limit reservoir yields under the prior appropriations doctrine. Very little additional yield is available for existing reservoirs in Region C by voluntary subordination. This strategy is appropriate for new water supply sources that would have junior water rights. In Region C, subordination of water rights is necessary to obtain the permitted amount for Muenster Lake in Cooke County.

Summary of Decision: Include voluntary subordination of water rights as a source of water supply for Muenster Lake.

5A.1.5 Enhancement of Yields of Existing Sources

Examples of ways to enhance the yield of existing sources might include the following:

- Artificial recharge of aquifers
- System operation of reservoirs
- Conjunctive use of surface water and groundwater

System operation of reservoirs and conjunctive use are discussed separately above. Artificial recharge of aquifers has not been implemented or studied in depth in Region C. If artificial recharge were to be implemented, it would likely be as part of an aquifer storage and recovery (ASR) program, which is discussed separately below.

Summary of Decision: Do not include enhancement of yields of existing sources as a source of water supply for Region C except as discussed under other categories.

5A.1.6 Control of Naturally Occurring Chlorides

The Brazos and Red River Basins have chloride concentrations in excess of desirable levels for municipal use. Much of the chloride in these basins is naturally occurring. Chloride control has been studied in the Brazos and Red River Basins and partially implemented in the Red River Basin. Current plans call for additional chloride control in the Lake Kemp watershed in Region B. If that project is successful, additional chloride control in the Lake Texoma watershed could be possible. However, it does not appear likely that chloride control will have a significant impact on chloride levels in Lake Texoma during the current planning horizon. Chloride control projects should continue to be monitored. The Texas Commission on Environmental Quality and the Texas Railroad Commission should continue efforts to control chloride resulting from man-made conditions.

Summary of Decision: Monitor chloride control projects. Do not include control of naturally occurring chlorides as a source of water supply for Region C.

5A.1.7 Brush Control

Brush control is the process of removing non-native brush from the banks along rivers and streams and upland areas in order to reduce water consumption by vegetation and increase stream flows and groundwater availability. Studies and pilot projects on brush control in West Texas show promising results. The first large-scale projects are currently underway. Undertaking and maintaining brush control is expensive and requires landowner participation.

The Texas State Soil and Water Conservation Board published the updated State Brush Control Plan in 2007 [(5)]. This plan identifies areas that could potentially benefit from brush control programs. Two reservoirs in Region C, Lake Jacksboro and Lake Weatherford, were listed in the State Brush Control Plan as potential watersheds where brush control could enhance supplies. No formal studies have been conducted for either watershed. Given that there is no quantifiable evidence that brush control would increase water supply in either reservoir, brush control is not recommended as a potentially feasible water management strategy for any specific water user group (WUG) in Region C. However, brush control may be a management strategy for localized areas within the region, especially as a means to help meet localized livestock water supply needs.

Summary of Decision: Allow for studies and localized pilot projects to further investigate brush control. Do not consider brush control as a potentially feasible strategy for the development of additional water supplies.

5A.1.8 Precipitation Enhancement

Precipitation enhancement involves seeding clouds with silver iodide to promote rainfall. Such programs are generally located within areas where the rainfall is lower than in Region C. Given that Region C has adequate rainfall, and that there are no studies showing what impact precipitation enhancement would have on streamflow and reservoirs in Region C, precipitation enhancement is not recommended as a potentially feasible water management strategy for Region C. However, there may be localized areas in Region C who might benefit from such a management strategy.

Summary of Decision: Do not include precipitation enhancement as a potentially feasible strategy for the development of additional water supplies. Allow for studies and localized pilot projects to further investigate precipitation enhancement.

5A.1.9 Desalination

The salinity of water in Lake Texoma and the Red River is too high for municipal use, and the water must be desalinated or blended with higher quality water in order to meet drinking water standards. The cost of desalination has decreased in recent years, and the process is being used more frequently. Desalination is a potentially feasible strategy to use supplies from the following sources:

- Lake Texoma and the Red River
- Brackish groundwater
- Water from the Brazos River
- Water from the Gulf of Mexico
- Local projects from other sources, if pursued by water suppliers.

Summary of Decision: Include desalination as a potentially feasible management strategy in order to utilize supplies from the sources listed above.

5A.1.10 Water Rights Cancellation

The Texas Commission on Environmental Quality has the power to cancel water rights after ten years of non-use, but this involuntary cancellation authority has seldom been used. The Water Availability Models showed that very little additional supply would be gained from water right cancellation in Region C [(3)].

Therefore, water rights cancellation is not recommended as a potentially feasible water management strategy for Region C.

Summary of Decision: Do not consider water rights cancellation as a potentially feasible strategy for the development of additional water supplies.

5A.1.11 Aquifer Storage and Recovery

Aquifer storage and recovery (ASR) involves storing water in aquifers and retrieving this water when needed. The water to be stored can be introduced through enhanced recharge or more commonly injected through a well into the aquifer. If an injection well is used, Texas law requires that the water be treated to drinking water standards prior to injection. Source water for ASR can include excess surface water, treated wastewater, or groundwater from another aquifer. While some ASR projects are for the purpose of enhancing water supply, other ASR projects are for the purpose of protection of current groundwater by preventing saltwater intrusion, forming a barrier between saline and freshwater aquifers.

The benefits of ASR include:

- Protection of current groundwater supply from saltwater intrusion,
- Storage of large volumes of water at lower costs than traditional surface storage,
- Reduction of evaporation losses,
- Minimization of environmental impacts associated with other new water sources such as new reservoirs, and
- Reduction of storage loss due to sedimentation.

While the concept of ASR is gaining popularity, it is important to recognize that there are numerous factors to be considered when determining whether ASR is a feasible strategy.

- ASR requires suitable geological conditions for implementation. Since geologic conditions vary by location, specific studies must be performed to determine what specific locations would be suitable for ASR.
- Water must be treated to drinking water standards prior to injection and then treated again to drinking water standards after it is retrieved. For surface water or wastewater sources, this means full scale treatment through a conventional water treatment plant, and for groundwater source water this generally means only chlorination.
- If the source water is surface water not already associated with a water right, then a Texas water right permit needs to be obtained. Issuance of this water right by TCEQ requires that use of this water does not interfere with existing permitted water rights, downstream water right holders, or environmental flow needs.

There are only three existing ASR Projects in Texas and they are discussed below.

- The City of El Paso's ASR system injects about 10 MGD of treated wastewater into local aquifers. The primary purpose of this project is to protect El Paso's fresh groundwater supplies, forming a physical barrier of injected water between saline and fresh groundwater supplies.
- San Antonio Water System's (SAWS) ASR program entails pumping water from the Edwards Aquifer when excess water is available under their existing permits, and storing it in the Carrizo Aquifer. The Edwards Aquifer Authority (EAA) regulates pumping from the Edwards Aquifer based on groundwater permits, aquifer levels and spring flow. This ASR program allows SAWS to store Edwards Aquifer water during wet times or low demand seasons, and to recover that water during droughts, peak usage, or when demand on the Edwards Aquifer is high. The project recovered large volumes of stored Edwards Aquifer water to San Antonio during the record-breaking drought between 2011 and 2014.
- The City of Kerrville is the only Texas facility that utilizes the traditional ASR method of taking excess surface water (from the Guadalupe River) and injecting into an aquifer to increase total volume of water supply. Kerrville's water rights from the Guadalupe River for use in the ASR project total 5,922 acre-feet per year.

While several ongoing feasibility studies are being performed within Region C, those studies are not advanced enough to determine the suitability of ASR as a source of supply for Region C at this time. Studies of ASR should continue, and pilot projects should be implemented if the strategy appears to be promising.

Summary of Decision: Studies of ASR should continue, and pilot projects should be implemented if the strategy appears promising. ASR projects determined to be viable should be added to future Regional Water Plans.

5A.1.12 Development of New Water Supplies

Surface Water Supplies

Over the years, many new reservoirs have been considered as sources of water supply for Region C. New reservoirs represent a large source of potential supply for Region C, but environmental impacts of reservoir development are a concern. Potential impacts of reservoir development include:

- Inundation of wetlands and other wildlife habitat, including bottomland hardwoods
- Changes to streamflows and streamflow patterns downstream
- Impacts on inflows to bays and estuaries
- Impacts on threatened and endangered species.

To develop a new reservoir, both a state water right permit and a federal Section 404 permit are required. The permitting process often takes 10 to 20 years, depending upon the project. Design and construction could take up to an additional 10 years. Following the completion of construction, sufficient time is needed to fill the reservoir. Because of the large amount of time needed to implement new reservoir

strategies, long-term planning for these types of strategies is essential for implementation by the time the supply is needed.

In the 2011 Region C Water Plan, the following reservoirs were selected for detailed analysis after a preliminary screening:

- Upper Bois d'Arc Creek Lake
- Lower Bois d'Arc Creek Reservoir
- Lake Tehuacana
- Lake Ralph Hall
- George Parkhouse Lake (North)
- George Parkhouse Lake (South)
- Marvin Nichols Reservoir
- Fastrill Reservoir (later replaced with another strategy)
- Marvin Nichols Lake (1A).

In recent years, there have been several developments in planning for new surface water supply sources for Region C:

- The Upper Trinity Regional Water District has conducted additional studies of Lake Ralph Hall and has received a water right permit from the Texas Commission on Environmental Quality and filed application for a Section 404 permit from the U.S. Corps of Engineers.
- North Texas Municipal Water District is considering supplies from Lower Bois d'Arc Creek Reservoir and has received a water right permit from the Texas Commission on Environmental Quality and is currently seeking a Section 404 permit from the U.S. Corps of Engineers.
- Dallas is considering supplies from Lake Columbia.
- Tarrant Regional Water District is considering supplies from Lake Tehuacana.

Table 5A.2 shows the new reservoirs adopted as potentially feasible sources of additional water supply for Region C by the Region C Water Planning Group.

The Region C Water Planning Group also adopted the additional use of local surface water supplies as potentially feasible if needed and practical.

Summary of Decision: Evaluate Marvin Nichols Reservoir, Lower Bois d'Arc Creek Reservoir, Lake Ralph Hall, George Parkhouse Lake (North and South), Lake Columbia, and Lake Tehuacana as potentially feasible strategies.

Table 5A.2
Potentially Feasible Strategies for New Reservoirs

Strategy	Potential Region C Sponsor(s)	Maximum Supply Available to Region C from Strategy in Acre-Feet per Year	Recommended in 2011 Plan?
Marvin Nichols at elevation 313.5 (as part of Sulphur Basin Supplies)	DWU, NTMWD, TRWD, UTRWD, and Irving	375,240	No (recommended as part of other strategy)
Marvin Nichols Reservoir (elevation 328 msl)	DWU, NTMWD, TRWD, UTRWD, and Irving	489,000	Yes
Lower Bois d'Arc Creek Reservoir	NTMWD	120,200	Yes
George Parkhouse Lake (North)	DWU, NTMWD, UTRWD, or Irving	118,960	No (alternative)
George Parkhouse Lake (South)	DWU, NTMWD, UTRWD, or Irving	108,480	No (alternative)
Tehuacana Reservoir	TRWD	41,600	No (alternative)
Lake Columbia	DWU	56,050	No (alternative)
Lake Ralph Hall	UTRWD	34,050	Yes

Groundwater Supplies

New groundwater supplies within Region C are limited, since the majority of the available supplies are already developed. The Region C Water Planning Group identified a number of relatively small additional groundwater supplies as potentially feasible strategies, and these are listed in Appendix O. The planning group also authorized development of new wells as needed and as groundwater is available as a potentially feasible strategy.

Two major strategies for the importation of groundwater were also identified as potentially feasible:

- Dallas has an alternative strategy of importing up to 27 MGD (30,267 acre-feet pear year) of Carrizo-Wilcox groundwater from Wood, Upshur, and Smith Counties
- NTWMD has an alternative strategy of importing up to 42,000 acre-feet per year of Carrizo-Wilcox groundwater from Freestone and Anderson Counties in cooperation with Forestar.

Summary of Decision: Evaluate the importation of groundwater of the options described above. Evaluate specific potentially feasible groundwater supplies within Region C.

5A.1.13 Interbasin Transfers

Table 5A.3 shows the potentially feasible strategies for Region C that would require interbasin transfer permits. (Under Texas law, interbasin transfer permits are required to transfer surface water from one river basin to another. They are not required for the transfer of groundwater.) Several of the strategies listed in Table 5A.3 have already been granted interbasin transfer permits, including Dallas' Lake Tawakoni pipeline and connection to Lake Palestine and NTMWD's supply from Lake Texoma. Existing sources with the potential to provide supply to Region C that would require interbasin transfer permits include the Brazos River Authority system, Wright Patman Lake, Toledo Bend Reservoir, additional Lake Palestine water, Cypress River Basin water (Lake O' the Pines), Oklahoma reservoirs, and the Gulf of Mexico. Potential new surface water supplies that would need interbasin transfer permits include Marvin Nichols Reservoir, George Parkhouse North and South Lakes, Lower Bois d'Arc Creek Reservoir, Lake Columbia, Neches Run-of-River, and Lake Ralph Hall. Overall water supplies in the Trinity and Brazos River Basins are mostly or completely allocated, while the Red, Sulphur, Cypress Creek, Sabine, and Neches Basins may have supplies in excess of their projected demands. Detailed studies of water needs in the receiving and the source basins will be required as part of the permitting process for new interbasin transfers. Development of adequate supplies for Region C and the other growing areas of Texas will require interbasin transfers.

Summary of Decision: Include interbasin transfers as part of the management strategies considered in the Region C plan.

5A.1.14 Other Measures - Renewal of Contracts

Many of the water users in Region C purchase water from a regional wholesale water provider or from another water supplier through contractual arrangements. For this plan it was assumed that existing water supply contracts will be renewed unless either entity indicated they were not planning to continue the contract. Renewal of a contract was not treated as a specific management strategy. In most cases in Region C, both the seller and the purchaser plan to renew existing contracts, and their long-term plans are based on the renewal of contracts. Contract increases are potentially feasible with the agreement of both parties.

Summary of Decision: Assume that existing contracts are renewed upon their expiration and do not consider renewal to be a water management strategy. Assume an increase in the amount of the contracts to meet projected needs with the agreement of both parties.

Table 5A.3
Potentially Feasible Interbasin Transfers for 2016 Region C Plan

Source	Basin of Origin	Receiving Basin	Maximum Amount[a] (Ac-Ft/Yr)	Comments
Lake Palestine	Neches	Trinity	110,670	Already permitted. 114,337 af/y is the permitted amount; 2030 WAM yield is 110,670 af/y.
Toledo Bend Reservoir	Sabine	Trinity	600,000	Connection of Existing Supply
Oklahoma Water	Red	Trinity	>165,000	Connection of Existing Supply
Marvin Nichols at elevation 313.5 (as part of Sulphur Basin Supplies)	Sulphur	Trinity	375,240	New Surface Water
Wright Patman pool raise (to 232.5, as part of Sulphur Basin Supplies)	Sulphur	Trinity	127,120	Connection of Existing Supply, Reallocation
Wright Patman – Texarkana	Sulphur	Trinity	100,000	Connection of Existing Supply,
Forest Grove Reservoir	Trinity	Neches	2,500	Connection of Existing Supply
Gulf of Mexico Desalination	Gulf of Mexico	Trinity	unlimited	Connection of Existing Supply, Desalination
NTWMD Lake Texoma-Authorized	Red	Trinity	113,000	Already permitted. Connection to Existing Supply, Desalination or Blend
GTUA Lake Texoma and Grayson County Project	Red	Trinity	56,500	Already permitted. Connection to Existing Supply, Desalination
Lake Texoma-Unauthorized	Red	Trinity	220,000	Connection of Existing Supply, Reallocation, Desalination or Blend
Cypress River Basin Supplies	Cypress	Trinity	unknown [b]	Connection of Existing Supply
Marvin Nichols Reservoir (328 msl)	Sulphur	Trinity	489,000	New Surface Water
Lower Bois d'Arc Creek Reservoir	Red	Trinity	120,200	New Surface Water
Lake Ralph Hall	Sulphur	Trinity	34,050	New Surface Water
George Parkhouse North Lake	Sulphur	Trinity	118,960	New Surface Water
George Parkhouse South Lake	Sulphur	Trinity	108,480	New Surface Water
Neches River Run-of-River Supplies	Neches	Trinity	47,250	18,000 af/y of interbasin transfer is already permitted (CA 06-3254C).
Lake Columbia	Neches	Trinity	56,050	New Surface Water

Notes: a. Volumes of supply listed in this table represent the maximum amount available from the source, which in some cases is greater than the volume that is being recommended in this plan.
b. The amount of supply available from Lake O' the Pines is unclear. See footnote for Table 5A.1.

5A.1.15 Other Measures

Groundwater Conservation Districts

Texas law allows for the establishment of groundwater conservation districts to help control the development and use of groundwater resources. Groundwater conservation districts can control well size and use, well spacing, and groundwater pumping. There are currently seven active groundwater

conservation districts in Region C. These groundwater conservation districts may be an appropriate way to share a limited resource in areas where groundwater use exceeds or approaches the long-term reliable supply. Participation in such districts is a local decision and should be considered by water suppliers and government officials in areas of heavy groundwater use.

Summary of Decision: Local water suppliers and government officials should consider becoming active participants in groundwater conservation districts in areas of heavy groundwater use.

Supplemental Wells

In prior Region C Plans, supplemental wells (or replacement wells) were included as recommended water management strategies for all WUGs and WWPs that had a groundwater supply. Capital costs associated with these strategies reflected replacement of existing wells during the 50 year planning period. However, in this fourth cycle of regional planning, the regional planning rules explicitly prohibit the inclusion of replacement of existing infrastructure that does not provide additional volume of supply. These rules are specifically laid out in Section 5.1.2.3 of the Regional Planning Guidelines. It is Region C's understanding that supplemental wells are not permitted to be included in the 2016 Regional Water Plans. Because of this TWDB rule, supplemental wells have not been included in this plan and are no longer considered a WMS. However, the Region C Planning Group believes that the replacement of aging infrastructure, like wells, is an important part of maintaining an adequate water supply. Such projects should be considered consistent with this plan and supported by adequate state funding, where needed.

Summary of Decision: Do not include supplemental wells for groundwater users in Region C.

Sediment Control Structures

The accumulation of sediment in existing reservoirs can have a significant impact on the reliable supply from those reservoirs over time. For reservoirs in Region C, there is a projected reduction in reservoir yield of 43,000 acre-feet per year over the 50-year period from 2020 to 2070. For reservoirs outside Region C that supply water to Region C, there is a projected reduction in yield of 36,600 acre-feet per year over the same period.

Since the 1950s numerous dams and structures in Texas have been constructed to help reduce the amount of sediment carried downstream into water supply sources. Many of these structures are approaching the end of their useful life and will require rehabilitation or new structures. Studies conducted by the Tarrant Regional Water District in the Trinity River Basin estimate that existing Natural Resources

Conservation Service (NRCS) control structures provide considerable reductions in sediment loading to downstream reservoirs. In the West Fork System watershed, the cost per acre-foot of sediment retained was estimated by the District at $435. Based on the projected sediment accumulation in the lakes and the corresponding reduction in yield, the cost of water saved would be about $200 per acre-foot. This indicates sediment control structures can be very cost effective in selected watersheds. The control of sediment by these NRCS structures can also have water quality benefits for downstream streams and reservoirs.

Summary of Decision: Recommend the state support both federal and state efforts to rehabilitate existing sediment control structures and encourage funding and support for the construction of new structures in watersheds that would have the greatest benefits.

5A.1.16 Summary of Potentially Feasible Strategies

Appendix O includes a listing of potentially feasible water management strategies for Region C for Wholesale Water Providers and for all Water User Groups by County. Table 5A.4 lists potentially feasible strategies that would supply over 25,000 acre-feet per year for Region C. As the table shows, Region C considered and evaluated a wide variety of potentially feasible water management strategies. The results of the evaluation and the recommended strategies for Region C are discussed in Sections 4D, 4E, and 4F, and summarized in Appendix P. The methodology for the evaluation is discussed below.

5A.2 Methodology for Evaluating Water Management Strategies

The TWDB guidelines set forth certain factors that are to be considered by the regional water planning groups in the evaluation of water management strategies [(2)]:

- Evaluation of quantity, reliability, and cost of water delivered and treated
- Environmental factors including:
  - Environmental water needs
  - Wildlife habitat
  - Threatened and endangered species
  - Cultural resources
  - Bays and estuaries
- Impacts on other water resources
- Impacts on threats to agricultural and natural resources
- Other factors deemed relevant by the planning group

- Equitable comparison of all feasible strategies
- Consideration of interbasin transfer requirements in the Texas Water Code and other regulatory requirements
- Consideration of third party social and economic impacts of voluntary redistributions of water.

This subsection discusses the specific evaluation factors selected by the Region C Water Planning Group for the potentially feasible water management strategies, including the environmental evaluation of alternatives and the development of costs. Additional details on the environmental evaluations, the development of costs, and the evaluation of strategies are included in various appendices.

Table 5A.4
Potentially Feasible Water Management Strategies for Region C
Supplying 25,000 Acre-Feet per Year or More

Strategy	Potential Sponsor(s)	Maximum Supply [a] Available to Region C in Acre-Feet per Year	Recommended in 2011 Plan?
Conservation (not including built-in conservation savings)	Multiple	135,991	Yes
Reuse (Including reuse projects listed below)	Multiple	355,118	Yes
Toledo Bend Reservoir	SRA, NTMWD, TRWD, DWU, and UTRWD	600,000	Yes
Gulf of Mexico with Desalination	DWU, NTMWD, and TRWD	Unlimited	No
Sulphur Basin Supplies (Marvin Nichols (313.5 msl) and reallocation of Wright Patman)	DWU, NTMWD, TRWD, UTRWD, and Irving	502,360	No
Marvin Nichols Reservoir (at elevation 328)	DWU, NTMWD, TRWD, UTRWD, and Irving	489,000	Yes
Lake Texoma – Unauthorized (Blend or Desalination)	NTMWD, DWU, or UTRWD	220,000	No (alternative)
Oklahoma Water	NTMWD, TRWD, UTRWD, and Irving	165,000 or more	Yes
Main Stem Trinity River Pump Station & Balancing Reservoir (Reuse)	DWU	149,093	No
TRWD Integrated Pipeline and Reuse	TRWD	123,100	Yes
Lower Bois d'Arc Creek Reservoir	NTMWD	120,200	Yes
George Parkhouse Lake (North)	NTMWD and UTRWD	118,960	No (alternative)
NTWMD Lake Texoma – Authorized (Blend)	NTMWD	113,000	Yes
Lake Palestine (Integrated Pipeline with TRWD)	DWU	110,670	Yes
George Parkhouse Lake (South)	NTMWD and UTRWD	108,480	No (alternative)
Wright Patman Lake – Texarkana	DWU, NTMWD, TRWD, or UTRWD	100,000	No
Carrizo-Wilcox Groundwater (Smith, Wood, Upshur Counties)	DWU	102,930	No
Cypress River Basin Supplies (Lake O' the Pines)	DWU, NTMWD, or TRWD	unknown	No
Ellis County Water Supply Project	TRA/ TRWD/Ellis County Suppliers	74,610	Yes
Lake Columbia	DWU	56,050	No
Main Stem Trinity River Pump Station – TRA Reuse	NTWMD	53,088	Yes, with different source
Neches River Run-of-River	DWU	47,250	No
Tehuacana Reservoir	TRWD	41,600	No (alternative)
GTUA Lake Texoma (Desalination)	GTUA	56,500	Yes

Strategy	Potential Sponsor(s)	Maximum Supply [a] Available to Region C in Acre-Feet per Year	Recommended in 2011 Plan?
Lake Ralph Hall with Reuse	UTRWD	52,437 [c]	Yes
Carrizo-Wilcox Groundwater (Freestone and Anderson Counties)	NTWMD	42,000	No
TRA Contract with Irving for Reuse	TRA and Irving	28,025	Yes
NTMWD/GTUA Collin Grayson Municipal Alliance	Multiple	30,000	Yes

Notes: a. Volumes of supply listed in this table represent the maximum amount available from the source, which in some cases is greater than the volume that is being recommended in this plan.
b. The amount of supply available from Lake O' the Pines is unclear. See footnote for Table 5A.1.
c. Includes ultimate reuse amount.

5A.2.1 Factors Considered in Evaluation

Table 5A.5 sets out the factors specifically considered by the Region C Water Planning Group in the evaluation of potential water management strategies. As required, the evaluation of water management strategies includes the quantitative reporting of quantity, reliability, costs and environmental factors. While the quantitative reporting of water made available and the unit cost of delivered and treated water can readily be developed, data for the quantitative reporting of environmental factors are limited. The detailed quantitative assessment of environmental factors requires data from site-specific studies, which are often not conducted at the planning level. Available data for environmental factors are used in the evaluation.

Consistency with plans of Region C water suppliers is an important factor in the evaluation of strategies. It is the intent of the Region C Water Planning Group to build the Region C Water Plan considering the existing plans of the water suppliers in the region, especially the regional wholesale water providers.

Equitable comparison of all feasible strategies is not included as an explicit evaluation factor because it describes the way that the entire evaluation was conducted. This factor was considered in the development of the methodology for evaluations. Interbasin transfer requirements in the Texas Water Code were considered in the development of strategies. Appendix P gives more details on the evaluation of potentially feasible water management strategies for Region C.

Table 5A.5
Factors Used to Evaluate Water Management Strategies for Region C

Quantity of Water Made Available
Reliability of Supply
Unit Cost of Delivered and Treated Water
Environmental Factors
- Total Acres Impacted
- Wetland Acres
- Environmental Water Needs
- Wildlife Habitat
- Threatened and Endangered Species
- Cultural Resources
- Bay and Estuary Flows
- Water Quality
- Other
Impacts on Agricultural and Rural Areas
Impacts on Natural Resources
Impacts on Other Water Management Strategies and Possible Third Party Impacts
Impacts to Key Water Quality Parameters
Consistency with Plans of Region C Water Suppliers
Consistency with Other Regions

5A.2.2 Environmental Evaluation

The environmental evaluation of potentially feasible management strategies is summarized in Appendix P. Factors reported quantitatively include the total acres impacted by the strategy and the number of threatened and endangered species listed in the counties of the proposed water source. For existing water sources, only the species that are water dependent are included in the count of threatened and endangered species. Other factors were assigned a high, moderate, or low rating based on existing data and the potential to avoid or mitigate each of the environmental categories listed in Table 5A.5. These evaluations were summarized in an overall environmental evaluation for the strategy. Certain management strategies were evaluated as a category rather than individually because their environmental effects do not vary greatly. Examples of evaluation by category include purchasing water from another provider and development of new wells in aquifers with additional water available.

5A.2.3 Agricultural Resources and Other Natural Resources

The evaluation of impacts to agricultural resources and rural areas assesses the ability to continue current agricultural and livestock activities. Strategies that move considerable amounts of water from rural to urban areas were also considered under this category. The impacts of recommended strategies on these factors are discussed in more detail in Chapter 6.

Impacts to other natural resources include potential impacts to water resources that are not the direct source for the strategy and impacts to mineral resources, oil and gas, timber resources, and parks and public lands. (Impacts to the water resources that are the source for the strategy are included under environmental factors.) The considerations of the impacts to agricultural and natural resources are used to assess how the regional water plan is consistent with the protection of the state's resources. This discussion is summarized in Chapter 6 of the plan.

5A.2.4 Costs of Water Management Strategies

Appendix Q contains more detailed information on the development of cost estimates for individual water management strategies. Development of cost estimates followed guidelines provided by the Texas Water Development Board. The assumptions used for the cost estimates are outlined in Appendix Q. For equitable comparison of the water management strategies, capital costs for all strategies were assumed to be financed by 20–year bonds, with the exception of reservoirs which were financed by 40-year bonds. The discounted present value of each potentially feasible strategy will be calculated by the Texas Water Development Board. The costs shown in Appendix Q are the unit costs during and after payment of debt service.

5A.2.5 Recommended Water Management Strategies

Water management strategies are recommended based on the overall factors set forth in the strategy evaluations. As discussed above, consistency with the on-going water development plans of regional water providers is an important factor in the strategy selection. All factors listed in Table 5A.5 were considered in the selection process. The recommended strategies are based on the ability to supply the quantity of water needed at a reasonable cost, while providing long-term protection of the state's resources. Recommended strategies for Region C are discussed in the following Sections 5C and 5D.

SECTION 5A
LIST OF REFERENCES

(1) Texas Water Development Board: *Water for Texas – 2012*, Austin, January 2012.

(2) Texas Water Development Board: Chapter 357, Regional Water Planning Guidelines, Austin, August 12, 2012.

(3) Freese and Nichols, Inc., Alan Plummer Associates, Inc., CP&Y, Inc., and Cooksey Communications, Inc.: 2011 Region C Water Plan, prepared for the Region C Water Planning Group, Fort Worth, October 2010.

(4) U.S. Army Corps of Engineers, Tulsa District, Final Environmental Assessment, Lake Texoma Storage Reallocation Study, Lake Texoma, Oklahoma and Texas, Tulsa, May 2006. Available URL: http://www.swt.usace.army.mil/library/Lake%20Texoma%20Reallocation%20Study/2006/FINAL%20LAKE%20TEXOMA%20EA%20060106.pdf

(5) Texas State Soil and Water Conservation Board, State Brush Control Plan, Temple, [ONLINE], Available URL: http://www.tsswcb.state.tx.us/files/docs/brush/statebrushplans/Brush_Control_Plan_2007_0.pdf, 2007.