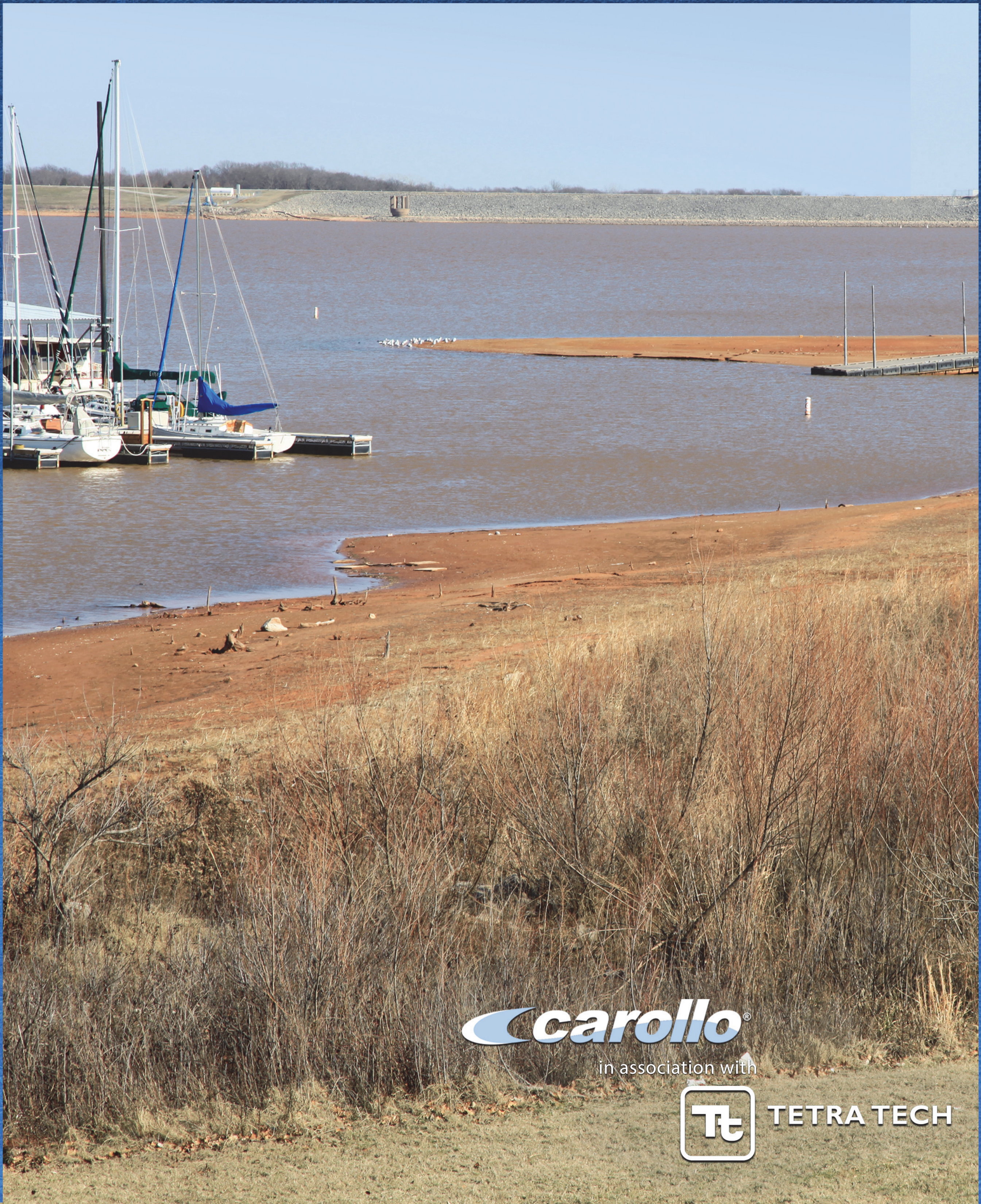
2060 Strategic Water Supply Plan



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2060 STRATEGIC WATER SUPPLY PLAN

NORMAN, OKLAHOMA

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AUGUST 2014

FINAL

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2060 STRATEGIC WATER SUPPLY PLAN

NORMAN, OKLAHOMA

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LIST OF ABBREVIATIONS

$/AF	dollars per acre-foot
$/gal	dollars per gallon
$/gpd	dollars per gallons per day
$/hp	dollars per horsepower
$/in-LF	dollars per inch diameter per linear foot
$/mgd	dollars per million gallons per day
$M	million dollars
2060 SWSP	2060 Strategic Water Supply Plan
AF	acre-feet
AFY	acre-feet per year
AHC	Ad Hoc Committee
BOR	Bureau of Reclamation
Carollo	Carollo Engineers
CCI	Construction Cost Indices
cf	cubic feet
cfs	cubic feet per second
City	City of Norman
COMCD	Central Oklahoma Master Conservancy District
EDC	endocrine disrupting compounds
ENR	Engineering News Record
EPS	equal proportionate share
fps	feet per second
gal	gallon
gpcd	gallons per capita per day
gpd	gallons per day
gpm	gallons per minute
hp	horsepower
IPR	indirect potable reuse
µg/L	micrograms per liter
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MG	million gallons
mg/L	milligrams per liter
mgd	million gallons per day
mL	milliliter
MLSS	mixed liquor suspended solids

MSL	mean sea level
N/A	not applicable
NPR	non-potable reuse
NUA	Norman Utilities Authority
OCWP	Oklahoma Comprehensive Water Plan
OCWUT	Oklahoma City Water Utility Trust
ODEQ	Oklahoma Department of Environmental Quality
OWRB	Oklahoma Water Resources Board
ppb	parts per billion
PWS	public water suppliers
RO	reverse osmosis
SWS	Sensitive Water Supply
TBD	to be determined
U.S.	United States
USACE	U.S. Army Corps of Engineers
USCB	U.S. Census Bureau
USGS	U.S. Geological Survey
UV	ultra-violet
WAS	waste activated sludge
WRF	water reclamation facility; Water Research Foundation
WTP	water treatment plant
WWTP	wastewater treatment plant

EXECUTIVE SUMMARY

Like many communities in Oklahoma, Norman has experienced sustained growth supplied with primarily local sources of water. Today, Norman's portfolio of local groundwater and surface water from Lake Thunderbird is marginally capable of meeting annual demands and seasonal peak demands. Treated water from Oklahoma City is used to augment Norman's supplies when needed to meet demand, using an interconnection with Oklahoma City's potable water distribution system.

Looking ahead, Norman's ability to meet its customers' water needs is further challenged by a confluence of factors facing the City of Norman (City) and the Norman Utilities Authority (NUA):

- Projected growth in the NUA service area.
- Regulatory and permit changes that may reduce the amount of water available from Norman's existing sources.
- Water quality regulations that will force further decisions between treatment investments and alternate supplies.

NUA commissioned the 2060 Strategic Water Supply Plan (2060 SWSP) to examine and thoroughly vet options for future water supply under the context of regulatory uncertainties, identify costs and trigger points for capital projects, and involve the citizens and City leaders throughout the process to shape Norman's water future.

ES.1 PROJECTED DEMANDS AND SUPPLY SHORTAGES

The process and basis of planning are described in Chapters 1 and 2 of this report. A foundation of the 2060 SWSP is updated demand projections for the NUA service area. Demand projections were founded on Norman's existing land use planning and population projections. The lower range of projected demands assume 85 percent of the City's population will continue to be on NUA water service, while high-end projections assume all City residents will have NUA water service by 2060. Supply planning was based on the higher demand values to prepare for the possibility that those conditions could be realized, but with the understanding that new supply projects could be delayed if demands increase at a slower rate. Annual demands were projected to support an analysis of supply needs and sources, while peak seasonal demands were projected for infrastructure planning and costing.

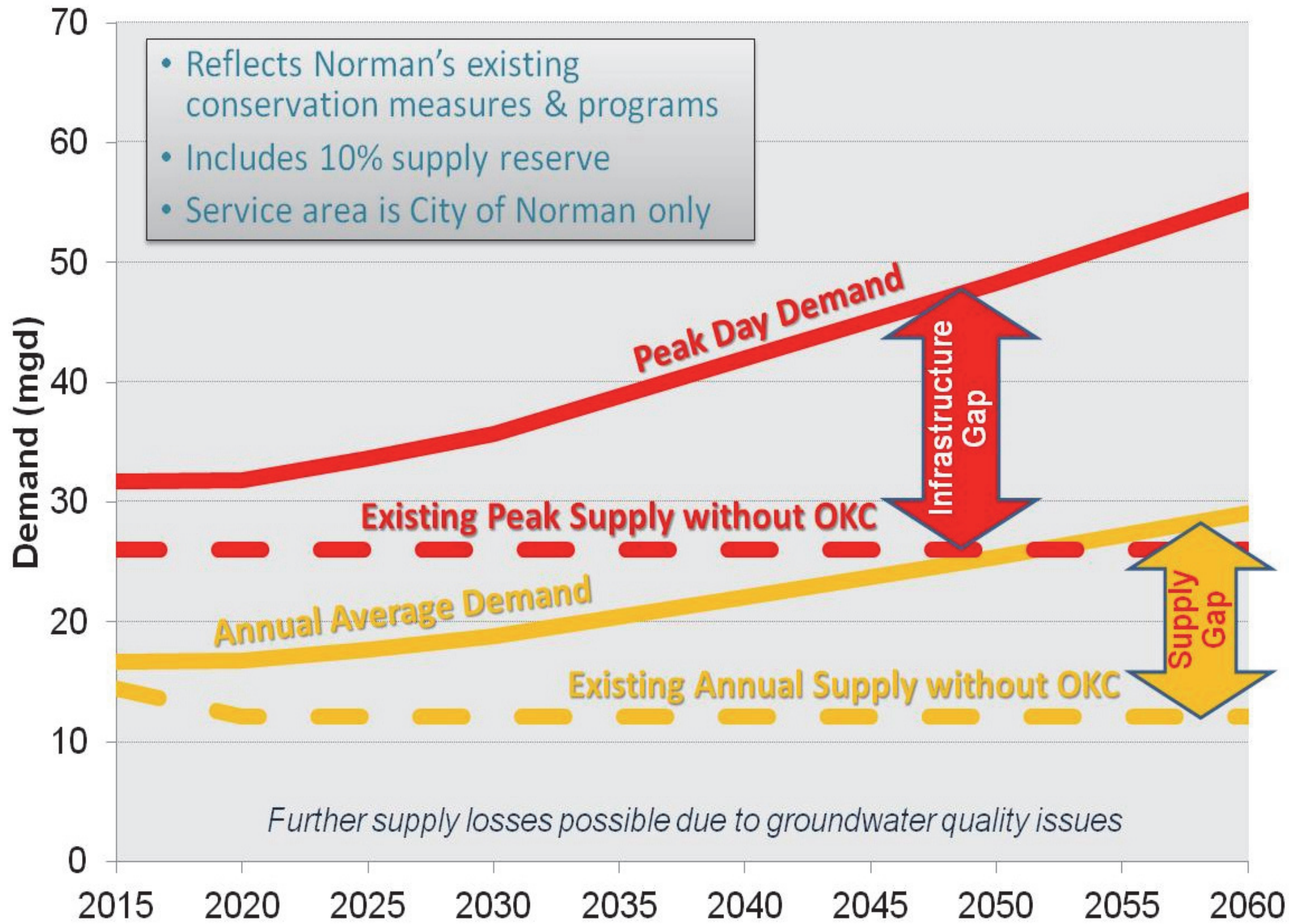
Demand projections are lower than NUA's previous planning values, reflecting the water conservation and reuse successes achieved in recent years by the Norman community. For the 2060 SWSP, demand projections also reflect a 10 percent supply reserve to mitigate potential future conditions that could include changes in per-capita demand (e.g., new industries' water demands), maintenance or rehabilitation of supply sources, or significant drought events such as the 2012-2013 drought that led to supply cutbacks from Lake Thunderbird. This supply reserve could also provide a buffer for unforeseen supply events, like the City's June 2014 shutdown of four wells due to evolving water quality issues at those specific wells.

Figure ES.1 shows that 2060 demands for the NUA service area are projected to be as high as 29.1 million gallons per day (mgd) on an annual average basis, and 55.3 mgd on a 2060 peak summer day – significant increases from today's values of about 14 mgd and 24 mgd, respectively, tracking with anticipated increases in population. The figure also shows NUA's current ability to supply water, excluding water purchases from Oklahoma City. On both an annual basis and a peak day basis, NUA is already unable to meet its current demands consistently using existing local supplies (groundwater wells and Lake Thunderbird allocation). This will worsen over time as demands grow, and as Norman's permitted allocation of Lake Thunderbird supplies is expected to be reduced to reflect actual drought-year lake yields. Continued operation of Norman's existing wells will likely be affected by anticipated new water quality regulations.

ES.2 SUPPLY PORTFOLIOS

A wide range of supplies (Table ES.1) was investigated and screened as part of 2060 SWSP analyses. Chapter 3 of this report describes the individual supply sources and associated evaluation that determined which sources are most viable for addressing Norman's near- and long-term supply shortages.

Table ES.1 Water Supply Sources Evaluated for 2060 SWSP[1]
Existing Sources • **Lake Thunderbird (at firm yield)[2]** • **Garber-Wellington Aquifer Wells (with treatment)[3]** • **Water Conservation and Reuse** • **Purchase Treated Water from Oklahoma City (wholesale)**
New Local Sources • **Additional Water Conservation** • **Additional Non-potable Water Reuse** • **Lake Thunderbird Augmentation (indirect potable reuse)** • Stormwater Capture and Reuse • Canadian River Diversion • Lake Thunderbird Spillage • Groundwater Recharge (indirect potable reuse)
New Regional Sources • **Partner with Oklahoma City as Co-Owner of Infrastructure for Southeast Oklahoma Water (with treatment either by Oklahoma City or by Norman)** • **Scissortail Reservoir** • **Parker Reservoir** • **Kaw Lake**
Notes: (1) The most viable sources retained for portfolio evaluations are indicated in bold font. (2) Includes consideration of dredging the lake or raising the dam for additional storage. (3) Treatment of wells would be triggered by promulgation of national standards for hexavalent chromium; treatment would also allow wells previously shut down for arsenic to be brought back online.



DEMAND PROJECTIONS AND ANTICIPATED SUPPLY SHORTAGES

FIGURE ES.1

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

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The most viable sources were evaluated in further detail by packaging them into "portfolios" of supply, where each portfolio could meet projected 2060 annual and peak-day demands. Chapter 4 describes the fourteen water supply portfolios and their evaluation against a list of objectives developed with input from citizens, City staff, NUA trustees and chairman, and community representatives appointed to the SWSP Ad Hoc Committee.

Applying that input, this process culminated in the identification of two portfolios that best meet Norman's long-term water supply objectives. These portfolios were discussed extensively by the community and its leaders to identify the best long-term supply portfolio for Norman. Referred to as Portfolios 13 and 14, these portfolios are briefly described below, with additional information available in Chapter 5 of this report.

Figure ES.2 lists components of each of these portfolios. Supply values are listed in the figure are the 2060 average annual amounts, but infrastructure was sized to meet the projected 2060 peak day demands, and new supply components would be phased in over time to meet demands.

These two portfolios are similar in many respects, reflecting priority values expressed by the community and its leaders throughout the SWSP public involvement process. They both would include the following supplies for meeting 2060 demands:

- Lake Thunderbird (at an anticipated reduced annual allocation of 6.1 mgd based on firm yield of the reservoir).
- Existing wells with treatment (annual average 8.1 mgd), adding centralized treatment to existing active wells for hexavalent chromium (also referred to as chromium-6) when required by anticipated regulations, and providing the ability to bring currently inactive wells back online with treatment for arsenic.
- Additional conservation (annual average 1 mgd).
- Additional non-potable water reuse for irrigation and industrial uses (annual average 0.8 mgd and 4.6 mgd of peak summer demands).

The above supplies provide an annual average supply of 16 mgd of the projected 2060 annual average day demand of 29.1 mgd. The portfolios differ significantly in how they meet future growth in demands, as detailed below.

- **Partnership with Oklahoma City for Raw Water (Portfolio 13):** Portfolio 13 makes up the balance of water supply needed by partnering with Oklahoma City as a co-owner of infrastructure to deliver raw water from Southeast Oklahoma. This would include paralleling the existing 100-mile Atoka pipeline system and eventually extending diversion infrastructure to the Kiamichi River basin (annual average 2060 supply of 13.1 mgd). Norman's Southeast Oklahoma water deliveries would be treated by NUA in Norman. Portfolio 13 is dependent on Oklahoma City proceeding with the parallel Atoka pipeline system and resolution of outstanding water rights disputes. Figure ES.3 provides a schematic diagram of the Southeast Oklahoma supply infrastructure.

- **New Groundwater Wells and Lake Thunderbird Augmentation (Portfolio 14):** This portfolio focuses on using highly treated water from Norman's Water Reclamation Facility (WRF) to augment Lake Thunderbird supplies for use as potable water supply, with an annual average supply of 11.1 mgd in 2060. This approach is known as indirect potable reuse (IPR), as it reuses a portion of effluent from an advanced WRF process train to augment potable supplies through an environmental buffer. This would require that a portion of flow from the WRF be pumped to Dave Blue Creek, where it would then flow by gravity into Lake Thunderbird and blend with natural-tributary supplies in the lake. Stored water would be diverted from the lake via an expanded intake and transmission to an expanded water treatment plant (WTP). The remaining 2.0 mgd would be met by drilling new Garber-Wellington Aquifer wells. Uncertainties associated with this portfolio include anticipated regulatory requirements for chromium-6 in groundwater and requirements for discharges of water from the WRF into Lake Thunderbird, a state-designated Sensitive Water Supply (SWS) source. Portfolio 14 is dependent on promulgation of rules for IPR by the Oklahoma Department of Environmental Quality (ODEQ) and definition of SWS discharge requirements. Figure ES.4 illustrates the IPR system associated with Portfolio 14.

Table ES.2 summarizes the feedback received during the final series of public, Ad Hoc Committee, and City Council study session meetings held in June 2014 (meeting materials are available in Appendices AD and AE). Public meetings were held throughout the project, but these last meetings were held specifically to review the top two portfolios and determine which portfolio best meets Norman's long-term water supply objectives. Those objectives included several major criteria, each with specific measures for how the portfolios meet the criteria:

- Affordability,
- Long-term supply reliability,
- Phasing potential,
- Timely implementation and certainty,
- Efficient use of water resources,
- Environmental stewardship,
- Treated water aesthetics, and
- Community values.

	Lake Thunderbird Allocation	Existing Groundwater Wells	New Groundwater Wells	Conservation & Non-potable Reuse	Lake Thunderbird Augmentation	Regional Supplies via Oklahoma City
Portfolio 13	6	8		2		13
Portfolio 14	6	8	2	2	11	

Values are 2060 Annual Average Use (mgd)
Regional Supplies via Oklahoma City: deliveries are raw water treated by Norman

PORTFOLIOS 13 AND 14
WATER SUPPLY COMPONENTS

FIGURE ES.2

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2060 STRATEGIC WATER SUPPLY PLAN

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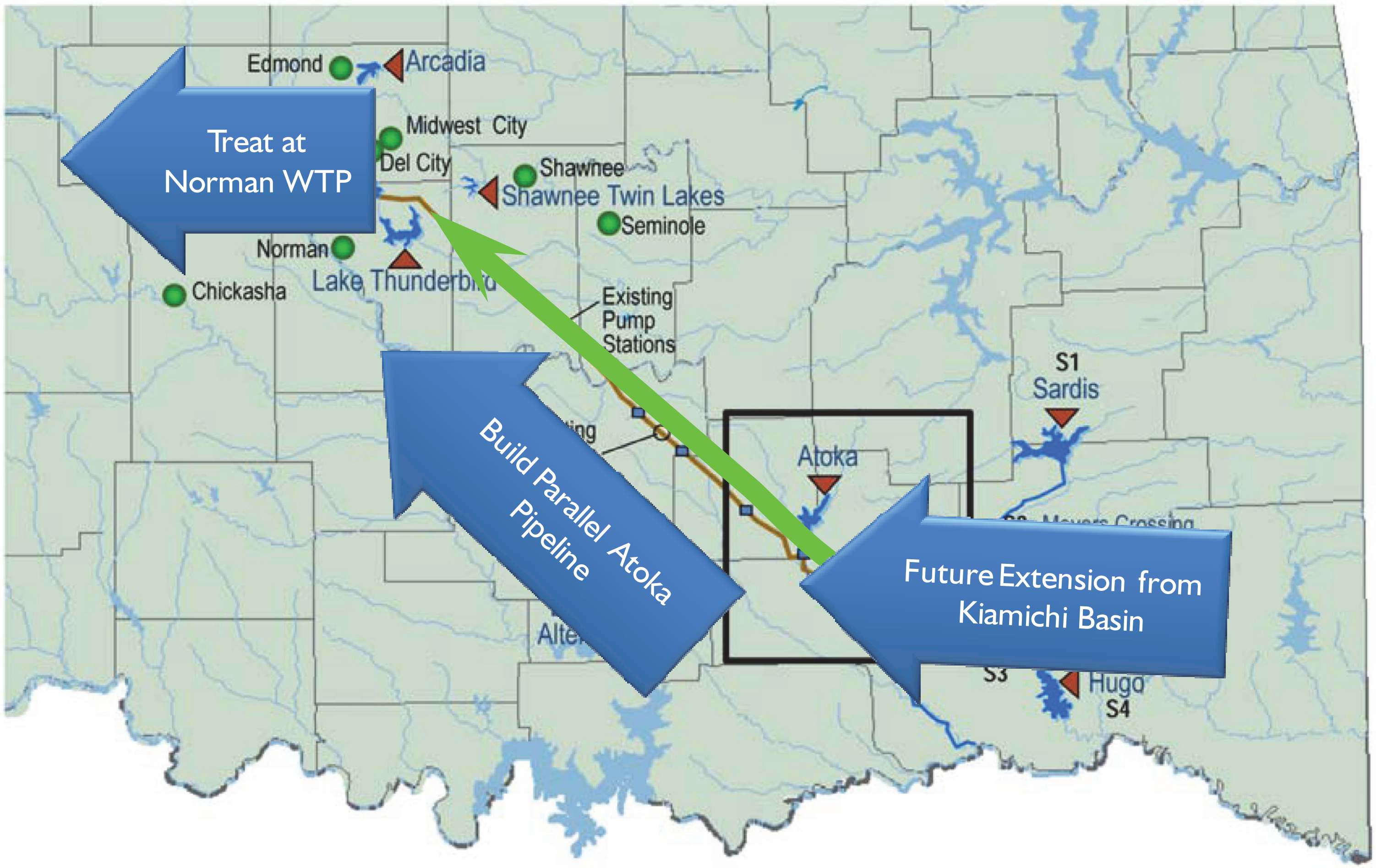
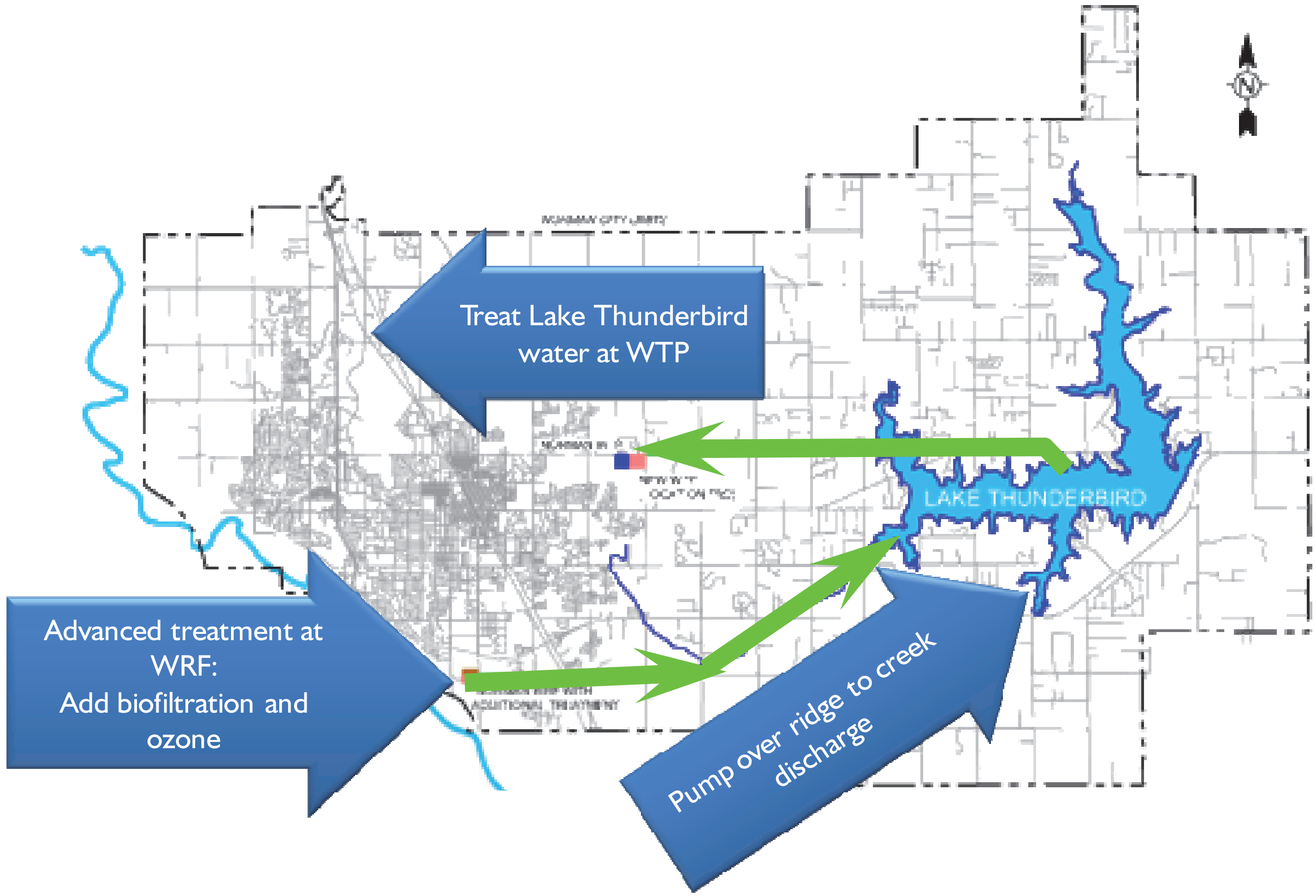


Base map from 2009 Regional Raw Water Supply Study for Central Oklahoma

SCHEMATIC OF SOUTHEAST OKLAHOMA WATER DELIVERIES IN PORTFOLIO 13

FIGURE ES.3

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN



SCHEMATIC OF LAKE THUNDERBIRD AUGMENTATION IN PORTFOLIO 14

FIGURE ES.4

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

Table ES.2 June 2014 Ad Hoc Committee and Public Meeting Feedback	
Portfolio 13: Regional Supply with Oklahoma City	**Portfolio 14: New Wells and Lake Thunderbird Augmentation**
• Interest in maintaining access to this supply in the future • Less local control over supply • Concerns regarding public acceptance of Southeast Oklahoma diversions • Concerns over size of up-front investment • Tribal litigation/mediation issues	• Provides local control of supply • Efficient use of resources • Better phasing potential • Potential for downstream water rights impacts • Public acceptance and outreach for indirect potable reuse • Uncertainty in water quality requirements for discharge to Lake Thunderbird • Concerns about impacts of reuse on Lake Thunderbird (capacity and water quality) • Potential Midwest City and Del City water quality concerns in shared Lake Thunderbird resource

Input from these meetings indicated greater support for Portfolio 14, as it has lower capital costs, better phasing capability, more local control and management of supply sources, and makes effective use of effluent from the City's WRF. Generally, Portfolio 14 aligns more closely with the community's values. Consistent with public feedback, the NUA unanimously adopted Resolution R-1314-146 (Appendix AF) that designates Portfolio 14 for implementation as the City's 2060 Strategic Water Supply Plan.

ES.3 SWSP IMPLEMENTATION

Figure ES.5 illustrates the phased capacity increases for implementation of the SWSP. Actual timing of supply implementation may vary based on external factors. For example:

- Groundwater treatment of active and inactive wells will be triggered by the anticipated federal regulation of chromium-6, which could occur as soon as 2017 or 2018. However, water quality in the active groundwater wells will continue to be monitored for compliance with existing regulations (specifically arsenic and gross alphas [a naturally occurring radioactive element which may negatively impact health through longtime exposure]); exceedances may result in additional wells being removed from service.
- Lake Thunderbird augmentation timing is dependent on ODEQ issuing rules on indirect potable reuse and defining the process for permitting discharges to SWS sources. The proposed non-potable reuse system expansion for irrigation and industrial uses can be implemented upon funding availability, as ODEQ has adopted rules governing those uses.

In the interim, to address ongoing water quality issues with the existing Garber-Wellington wells and to meet demands until the SWSP elements can be phased in, NUA may negotiate with Oklahoma City to more consistently purchase treated water from Oklahoma

City as a wholesale water customer (in place of the current contract which allows for intermittent water purchases).

Figure ES.6 shows the projected annual costs for the SWSP implementation. Significant costs will be incurred to maintain current production levels from NUA's existing sources, address anticipated new water quality regulations, and to develop new supplies. Bond issuances (shown in Table ES.3 are based on the assumptions described in Chapter 2. Actual bond issuances and debt service payments will be based on how projects are packaged and interest rates at time of issuance. Under any bonding strategy (revenue bonds, general obligation bonds, or a combination of these), however, water rates increases will be necessary to fund the investments required to maintain existing sources and develop new supplies.

Altogether, the diverse supply portfolio NUA has designated as its water supply strategy will build on existing resources to provide reliable water service through the 2060 planning period and beyond.

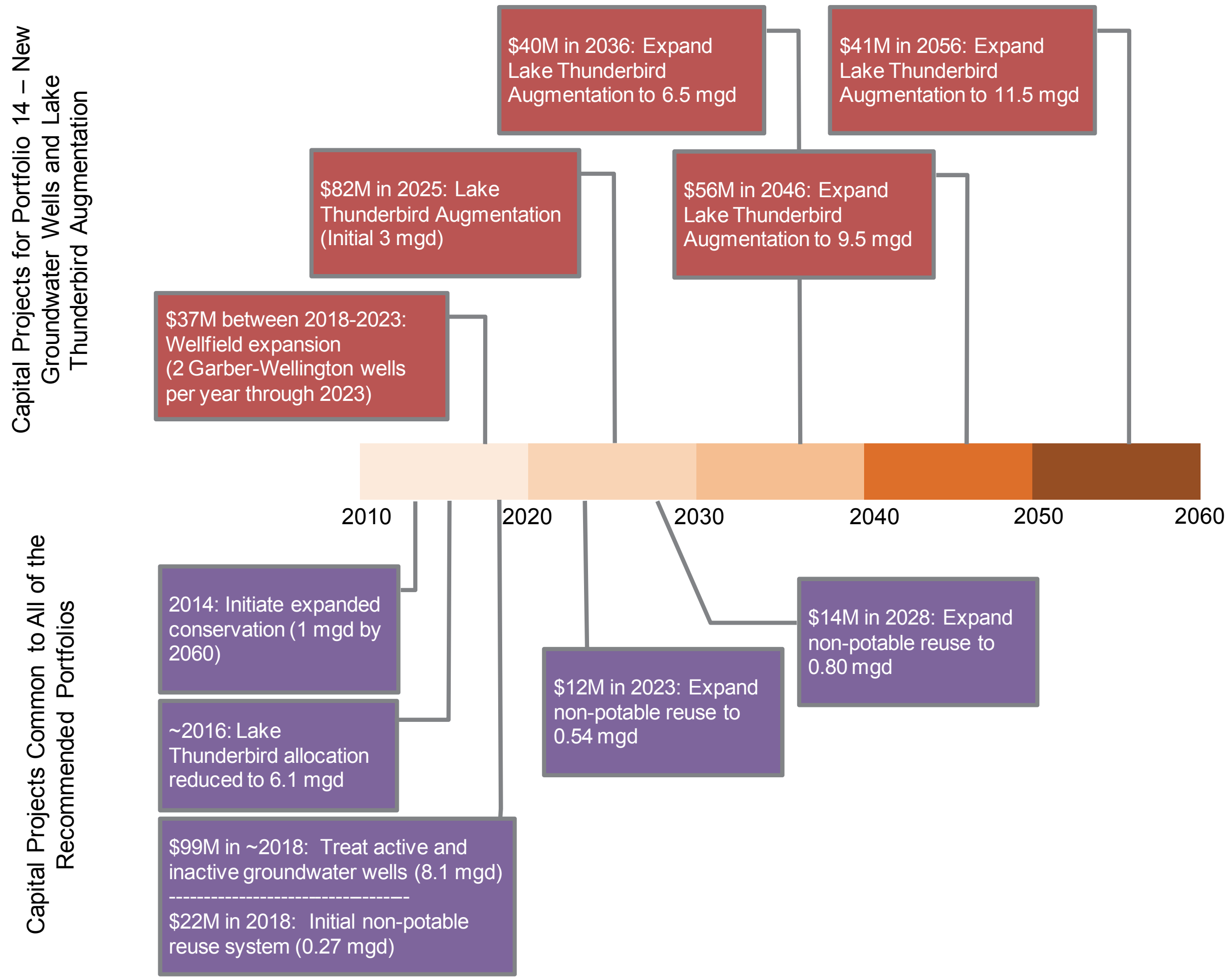
Table ES.3 Bond Issuance Portfolio 14		
Bond Issue Year[3]	**Amount ($M)[1]**	**Capital Projects[2]**
2015	$196	• Lake Thunderbird – Existing WTP disinfection improvements and clarifier rehabilitation • Oklahoma City wholesale – Second connection • Garber-Wellington Wells – 1.0 mgd of new wells, piping network to connect all wells to treatment, and new centralized groundwater treatment facility • Non-potable Reuse – Treatment and initial phase of transmission network expansion
2020	$34.3	• Lake Thunderbird – Intake rehabilitation • Non-potable Reuse – Second phase of transmission network expansion • Garber-Wellington Wells – 2.0 mgd of additional new wells and piping to centralized treatment facility
2025	$99.3	• Non-potable Reuse – Final phase of transmission network expansion, storage tank rehabilitation • Lake Thunderbird Augmentation – 3.0 mgd WRF advanced treatment improvements, transmission to Dave Blue Creek, and 3.0 mgd additional diversion and WTP capacity for increased yield
2035	$193	• Lake Thunderbird – Existing WTP rehabilitation • Garber-Wellington Wells – Treatment rehabilitation • Non-potable Reuse – Treatment and storage tank rehabilitation • Lake Thunderbird Augmentation – Additional 3.5 mgd WRF advanced treatment improvements and additional 5.0 mgd diversion and WTP capacity for increased yield
2045	$136	• Lake Thunderbird – Intake rehabilitation • Non-potable Reuse – Treatment and storage tank rehabilitation • Lake Thunderbird Augmentation – Additional 3.0 mgd WRF advanced treatment improvements and additional 6.5 mgd diversion and WTP capacity for increased yield
2055	$49.4	• Non-potable Reuse – Storage tank rehabilitation • Lake Thunderbird Augmentation – Additional 2.0 mgd WRF advanced treatment improvements and additional 3.0 mgd diversion and WTP capacity for increased yield

Notes:

(1) Costs indicated have been escalated to indicate year of bond issuance.

(2) Capacities shown represent infrastructure sizing that is based on meeting peak day demands.

(3) Bonds typically cover five to ten years of capital project expenditures. For example, the 2015 Bond will cover the existing WTP rehabilitation (2015), new wells, piping and centralized treatment facility for all wells (2018), and first phase of non-potable reuse expansion (2018).



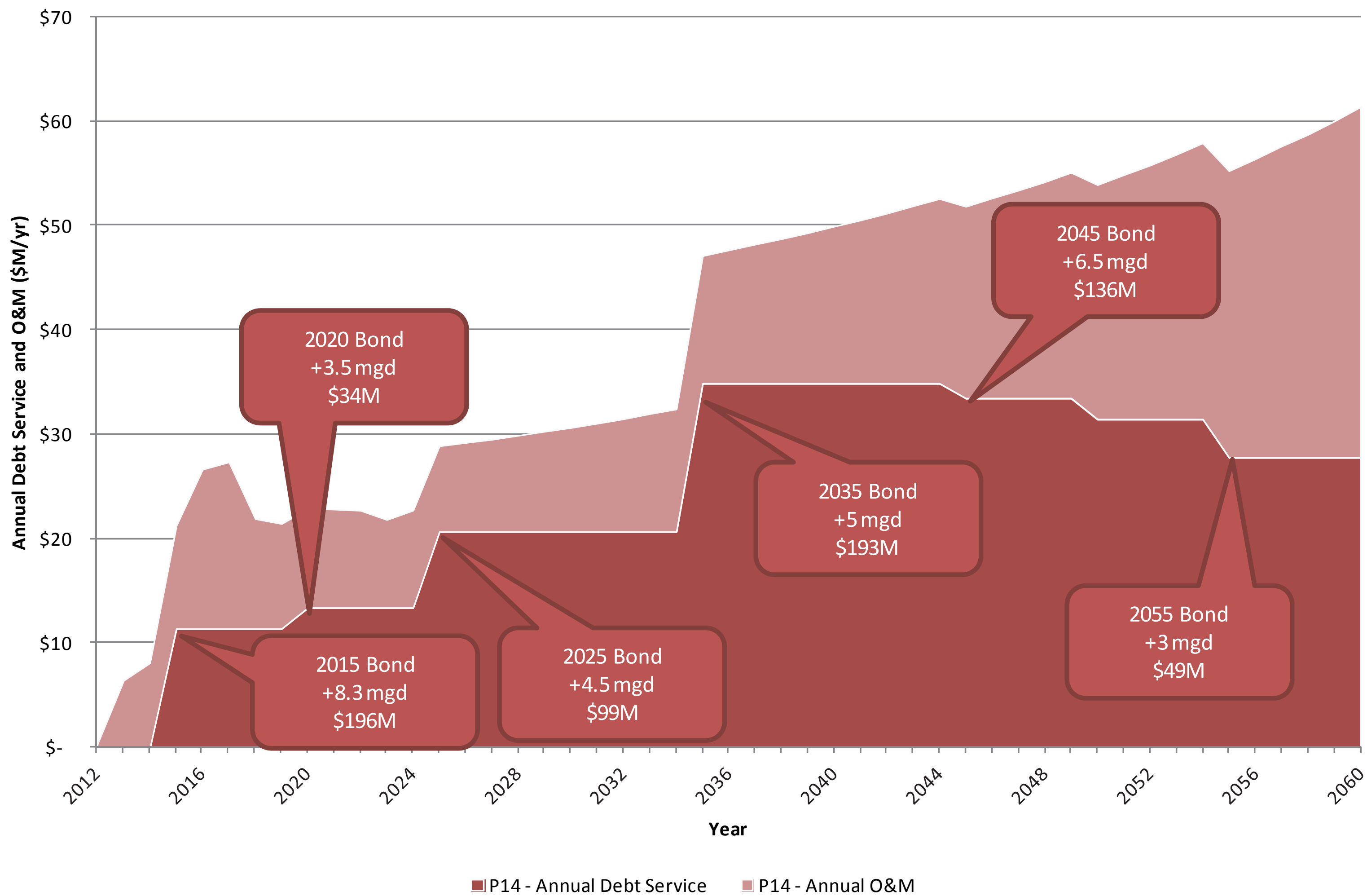
Capital projects common to all recommended portfolios
Capital projects unique to Portfolio 14

Note: All supplies are listed in annual average flow. Rehabilitation/replacement projects not shown. Capital expenditures shown in escalated (future) dollars.

IMPLEMENTATION TIMELINE FOR SWSP INFRASTRUCTURE

FIGURE ES.5

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN



ANNUAL COSTS FOR SWSP

FIGURE ES.6

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

PLANNING PROCESS OVERVIEW

The 2060 Strategic Water Supply Plan (2060 SWSP) builds on previous planning works to determine the most effective way to meet Norman's long-term water supply needs. The 2060 SWSP identifies infrastructure needs to implement the recommended supply strategy and maintain the existing infrastructure to meet Norman's water demands through year 2060. Carollo Engineers, Inc. (Carollo) contracted with the Norman Utilities Authority (NUA) to develop the 2060 SWSP. Tetra Tech, Inc. provided engineering support for the supply options.

1.1 PLANNING HISTORY

The City and NUA have participated in long-range water supply planning for many years. Norman completed a 2040 Strategic Water Supply Plan (2040 SWSP), which estimated the annual average and peak day water demands for the NUA service area through the year 2040 (NUA, 2001). The City has implemented many of the near-term recommendations from the 2040 SWSP, including the development of new local groundwater wells in the decade that followed the report. However, many of the underlying assumptions and regulations have evolved since the 2040 SWSP was developed, prompting the need for a significant update via this 2060 SWSP planning process.

The City joined other regional municipalities in the development of the Regional Water Supply Plan for Central Oklahoma (OCWUT, 2009) to assess the potential costs and partnerships associated with developing additional supplies in Southeast Oklahoma to meet municipal needs of the study participants. NUA's Water Conservation Plan provides a roadmap that builds upon the community's conservation successes and commitment to efficient use of water resources through the use of additional conservation measures and programs (NUA, 2014). The Central Oklahoma Master Conservancy District (COMCD), as operator and administrator of Lake Thunderbird supplies, completed a study of options for augmenting the lake to increase its reliable yield (COMCD, 2012). That study concluded that augmenting the lake with treated water from local water reclamation facilities (WRF) would be the preferred approach for augmenting Lake Thunderbird yields.

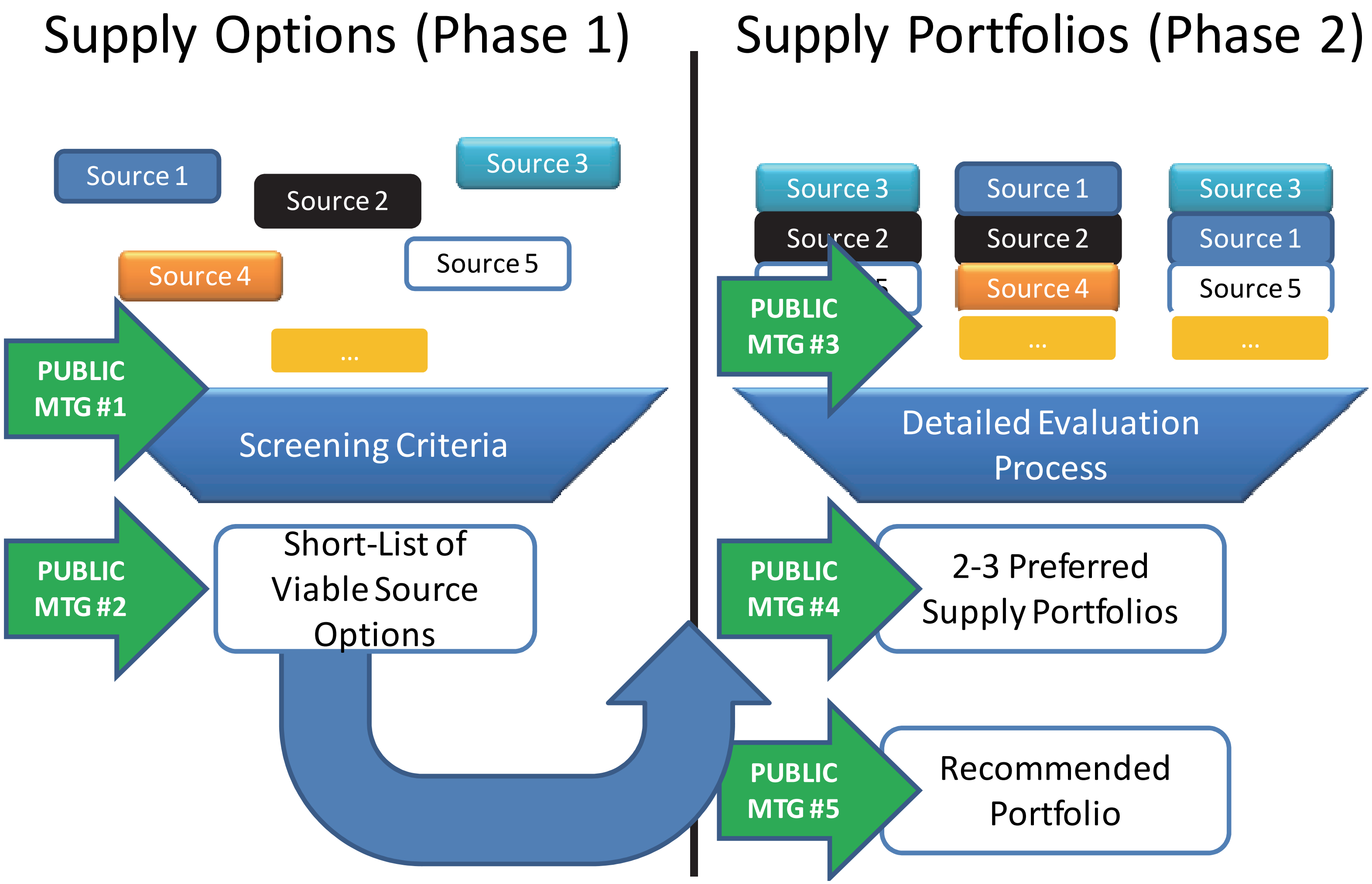
A number of additional studies have been conducted by NUA and other regional entities in recent years, characterizing specific aspects of water supply and treatment. Those studies were used in the development of the 2060 SWSP as described throughout this report.

1.2 2060 SWSP PLANNING PROCESS

Figure 1.1 illustrates the 2060 SWSP planning process. A comprehensive list of existing water sources and potential future sources available to Norman ("supply options") was compiled. Using information on these sources available from previous studies and modified, if necessary, to meet Norman's requirements, preliminary evaluations identified the most viable sources for Norman. These first steps are described in Chapter 3. Using the list of viable source options, several supply portfolios were developed. These portfolios combined viable source options in different combinations that together could meet the 2060 demands of the NUA service area. These combinations were evaluated against a detailed list of objectives to determine which three portfolios best meet the community's long-term needs. This process is described in Chapter 4. Further analysis was completed on these recommended portfolios, including developing implementation plans, and life cycle costs. These results are summarized in Chapter 5.

Public participation was a critical component in the planning process. Five public meetings were held at key project milestones, as illustrated on Figure 1.1. Additionally, the City appointed a SWSP Ad Hoc Committee (AHC) of 15 members representing a diverse range of community interests and viewpoints. The AHC offered guidance and input throughout the planning process through a series of seven AHC meetings that were open to the public. Presentation materials and minutes from each of the public meetings and AHC meetings are included in Appendices S through AE.

The 2060 SWSP is the central document that compares the benefits and needs for all of these projects, and provides a clear, demand-based plan for meeting Norman's long-term water supply needs.



2060 SWSP PLANNING PROCESS

FIGURE 1.1

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

BASIS OF PLANNING

This chapter presents key planning assumptions used in the development of concepts and alternatives for the 2060 SWSP. The basis of planning includes a discussion of the study area, planning horizon, historical and projected water demands, supply project objectives, and portfolio evaluation criteria.

2.1 STUDY AREA

The study area is defined as the City boundary as shown in Figure 2.1. Norman is located in Cleveland County, about 20 miles south of downtown Oklahoma City. NUA is a public trust created pursuant to state statutes for the use and benefit of the City of Norman, The city limits encompass nearly 190 square miles, and NUA's service area includes approximately 36,000 water service connections. The NUA service area population in 2010 was estimated at about 95,000, comprising approximately 85 percent of the City's population of 110,925 (USCB, 2010).

2.2 PLANNING HORIZON

The planning horizon for the City's latest *Norman 2025 Land Use and Transportation Plan* and *2040 Strategic Water Supply Plan* were 2025 and 2040, respectively (Norman, 2004 and NUA, 2001). The City, however, anticipates that future growth and development will continue beyond these years. Moreover, many of the underlying assumptions and regulations have evolved since the 2040 SWSP was developed, prompting the need for a significant update. To provide long-term vision and security of water supplies, NUA selected 2060 as the planning horizon for this SWSP update.

2.3 HISTORICAL POTABLE WATER DEMANDS

The NUA provides potable water to residential and non-residential customers throughout its service area. The NUA has historically served its demands through groundwater from the Garber-Wellington aquifer underlying Norman and surface water from Lake Thunderbird. Since 2000, NUA has intermittently purchased treated water from Oklahoma City. This connection has been used during high-demand periods (summer peaks) and emergencies. This section summarizes recent trends in NUA's average annual demands, peak day demands, and per capita water demands.

2.3.1 Average Annual Water Demands

The average annual potable water demands served by NUA since 1990 are presented in Figure 2.2. These water demands include metered consumption by NUA's customers as well as non-revenue water, defined as water produced by NUA but not recorded at a meter (e.g., system leaks, fire protection use, and other unmetered use). The figure also shows the supply sources used to meet demand each year: surface water from Lake Thunderbird, groundwater from local Garber-Wellington aquifer wells, and treated water purchased from

Oklahoma City. While use from the water supplies varies year to year, the percentage of groundwater to total use has increased recently as NUA has tried to stay within its Lake Thunderbird allocation. As anticipated, demands are higher in drought years (e.g., 2006 and 2011), where outdoor irrigation demands typically are higher than in normal and wet years. Overall, a generally increasing trend corresponding to population growth can be observed, but also shows evidence of moderating in recent years. This is likely attributable to Norman's successes in implementing its conservation, water reuse, and non-potable water supply (untreated wells) programs.

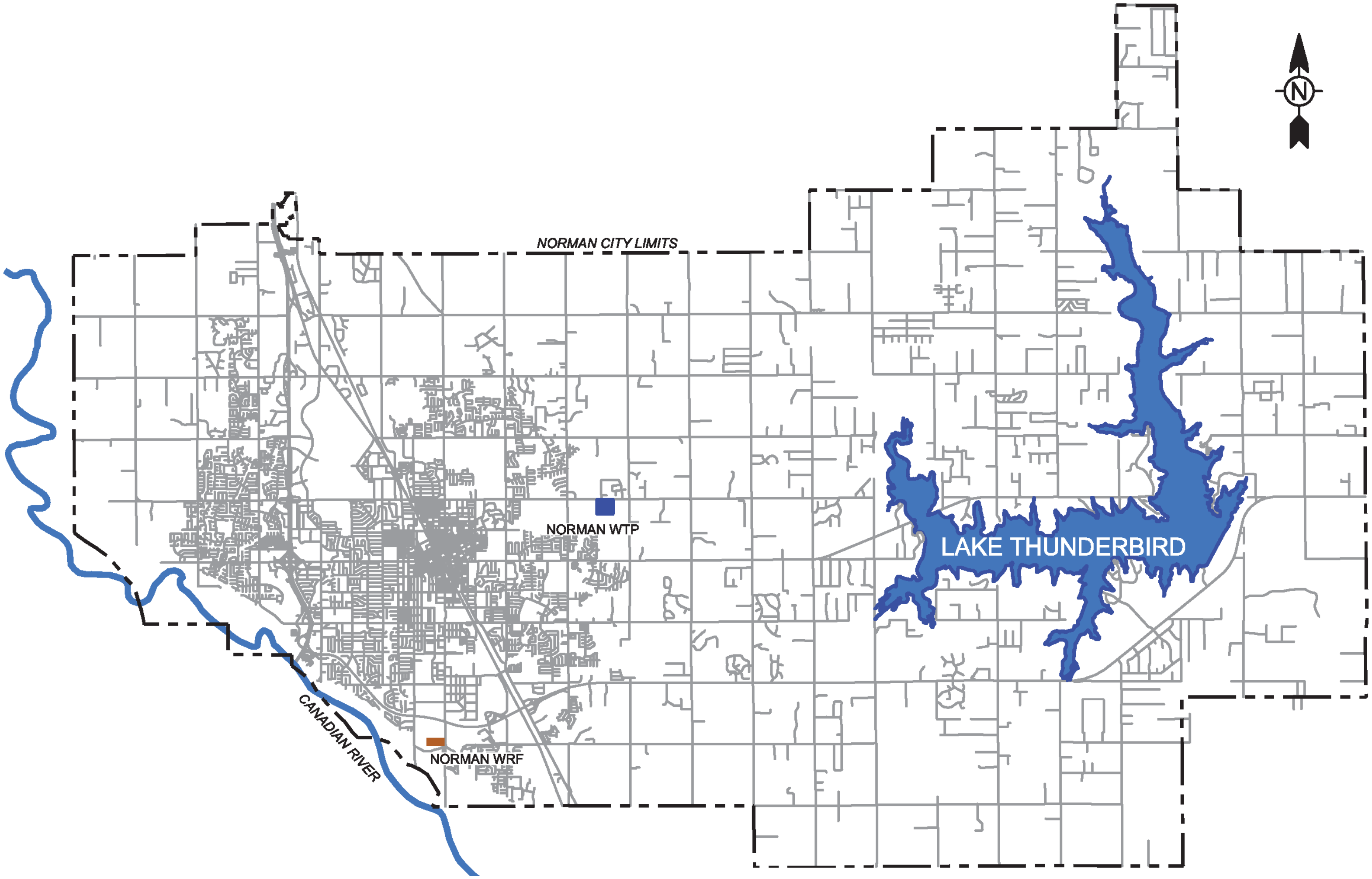
As shown, average annual demands have fluctuated from year to year but generally increased from about 9.4 mgd (10,500 acre-feet per year, AFY) in 1990 to 13.5 mgd (15,100 AFY) in 2011. (One AFY is equal to about 325,850 gallons.) This represents an average annual growth rate of 1.75 percent. However, 2060 SWSP demand projections were based on City population projections in terms of persons per year, not percent growth.

Table 2.1 presents historical supply and demand information between 2000 and 2012. Annual average and peak daily demands are driven by a variety of factors, most of which are unique to an individual community. Examples of these factors are the service area population, type of development prevalent in the service area, the amount and type of commercial and industrial demands served, seasonal and daily climate variability, and the degree to which water conservation and reuse programs are implemented and embraced by the community. Variations in demand over time are thus to be expected.

Table 2.1 Historical Potable Demands

Year	Average Annual Demand[1] (mgd)	Peak Day Demand (mgd)
2000	11.93	24.1
2001	12.27	24.8
2002	11.74	22.1
2003	12.12	24.0
2004	11.95	21.3
2005	13.39	22.5
2006	14.70	24.3
2007	12.61	22.3
2008	12.48	23.4
2009	11.91	22.3
2010	12.23	22.2
2011	13.51	23.9
2012	13.27	24.8

Notes:
(1) The annual production data are generated from daily records provided by NUA operations staff, reflecting the combined total of metered consumption and non-revenue water.



Norman Water Treatment Plant
Norman Water Reclamation Facility

2060 SWSP STUDY AREA

FIGURE 2.1

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

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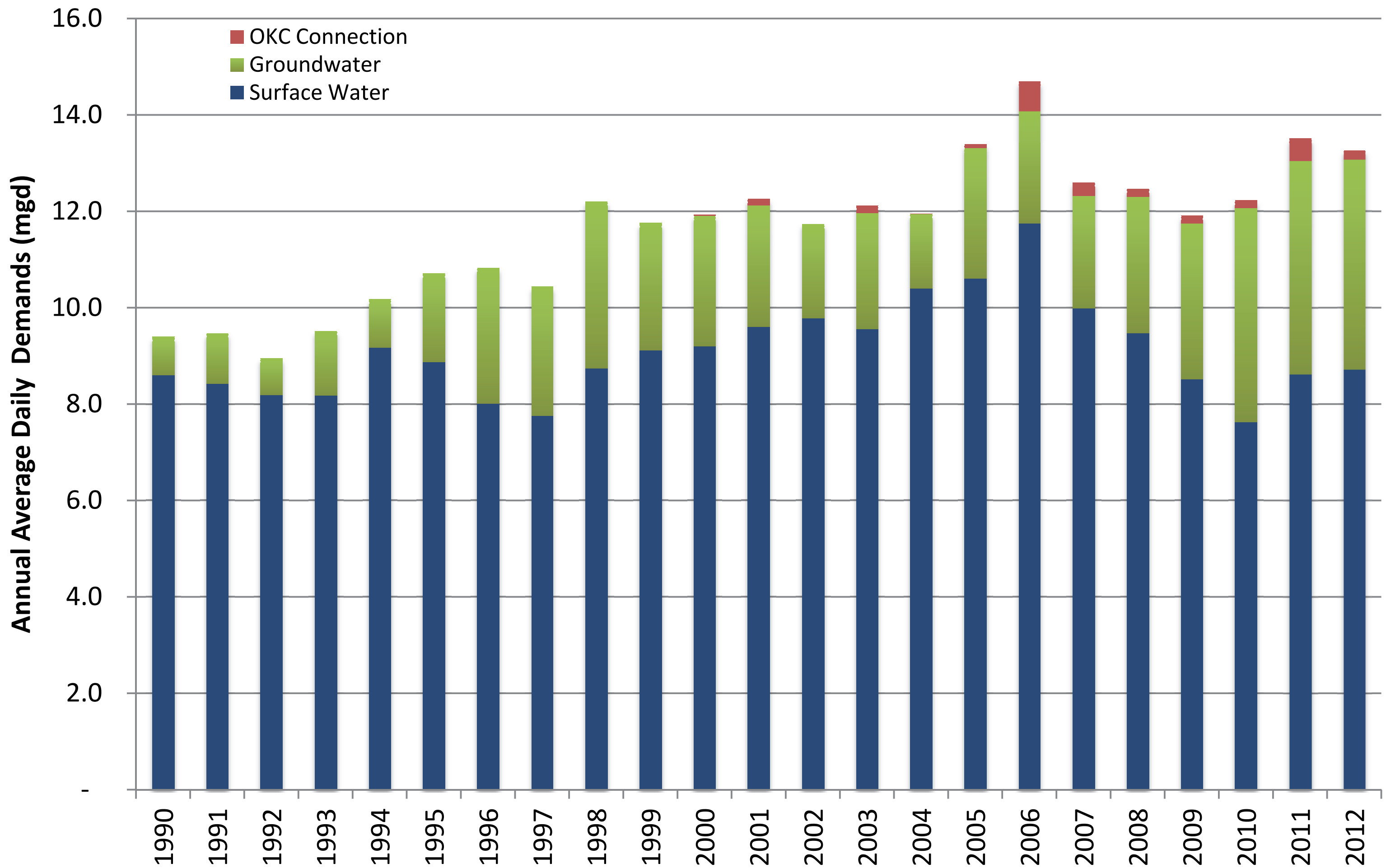


NUA POTABLE WATER DEMANDS 1990 – 2012

FIGURE 2.2

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

2.3.2 Recycled Water System Implementation

Norman has developed and implemented beneficial reuse and non-potable water management practices, which have the effect of reducing potable water demand during peak usage conditions. These systems utilize highly treated water from the WRF, stormwater, and non-potable groundwater from Garber-Wellington aquifer Wells. Since 1995, the University of Oklahoma Golf Course has used treated water from the WRF for irrigation purposes and, beginning in 2009, NUA has used it for maintenance activities onsite at the WRF. NUA also is planning to use of treated water from the WRF for composting operations. The Westwood Golf Course and the Griffin Park Complex have both implemented retention ponds that capture stormwater runoff to use for irrigation purposes. Both of these complexes also make use of Garber-Wellington aquifer wells that are not suitable for drinking water due to water quality concerns, but are suitable for irrigation purposes.

2.3.3 Potable Water Peaking Analysis

As shown in Table 2.1, peak day demands have been relatively constant each year over the past decade. This also is evident from the trends of increasing annual average demand but decreasing daily peaking factors. Daily peaking factors are shown on Figure 2.3. The decrease in peak day demands can be attributed to conservation efforts like wastewater reuse and increased efficiencies in landscape irrigation systems implemented in recent years.

Based on a review of recent years' potable demands and precipitation trends, a daily peaking factor of 1.9 was selected as a basis of planning for the 2060 SWSP. By selecting a value that is among the lowest recent years' observed values, the SWSP reflects the community's recent and ongoing successes in conservation and reuse. This peaking factor is used for sizing future supply projects. Additional water conservation and reuse (beyond existing programs and levels of potable water demand reduction) could further reduce the peaking factor for potable system demands; those options were explored in the 2060 SWSP as individual options for meeting portions of Norman's future demands.

2.3.4 Historical Per Capita Water Demands

Per capita demands, defined as total water use divided by service area population, are a commonly used basis for projecting future demands. However, per capita demands are unique to each community because of unique aspects of the customer base and water use in each community. To determine the per capita demand to use in 2060 SWSP demand forecasts, historical per capita demands were examined.

The City population grew from 95,694 in 2000 to 110,925 in 2010 (USCB, 2010). This is equivalent to an annual growth rate of about 1,500 people per year, consistent with long-term population trends observed in U.S. Census data for Norman. It is difficult to determine precisely what percentage of the City's population has been on the public potable distribution system. However, based on a comparison of City's meter count and the number of housing units, it is estimated that between years 2000 to 2010, about 85 percent of the

City's population was served by the NUA potable water system. This value is consistent with previous estimates by NUA. Those living within the City limits that are not served by NUA's water system are likely supplied by private domestic wells; there are no rural water systems in Norman.

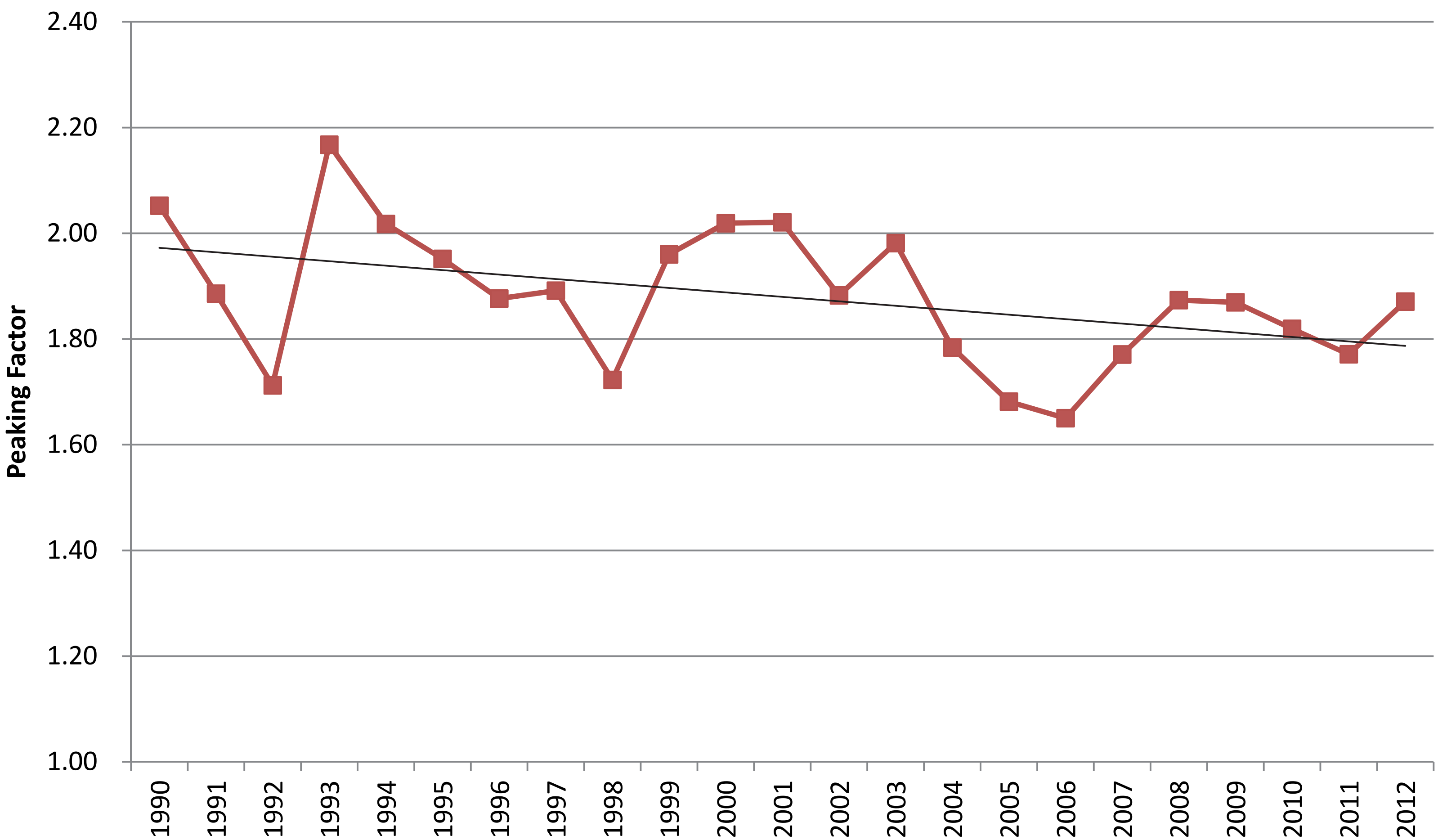
The total City population and NUA service area population between 2000 and 2010 are presented in Table 2.2. City population data for 2001 to 2009 were linearly interpolated from Census data.

Figure 2.4 presents the historical trends of per capita water use, expressed in gallons per capita per day (gpcd). The higher per capita water demands in 2005, 2006, 2011, and 2012 coincide with drought conditions in those years. Drought tends to increase outdoor water use as compensation for low precipitation. To validate this concept, recent years' per capita demands were plotted against annual precipitation (Figure 2.5). General trends are evident, but this approach may over-simplify the dynamic set of factors that affect per capita demands in any given year.

Table 2.2 Historical Population and Potable Demands

Year	City Population(1)	Service Area Population(2)	Average Annual Service Area Demand (mgd)
2000	95,694	81,565	11.93
2001	97,217	82,863	12.27
2002	98,740	84,162	11.74
2003	100,263	85,460	12.12
2004	101,786	86,758	11.95
2005	103,310	88,056	13.39
2006	104,833	89,354	14.70
2007	106,356	90,653	12.61
2008	107,879	91,951	12.48
2009	109,402	93,249	11.91
2010	110,925	94,547	12.23

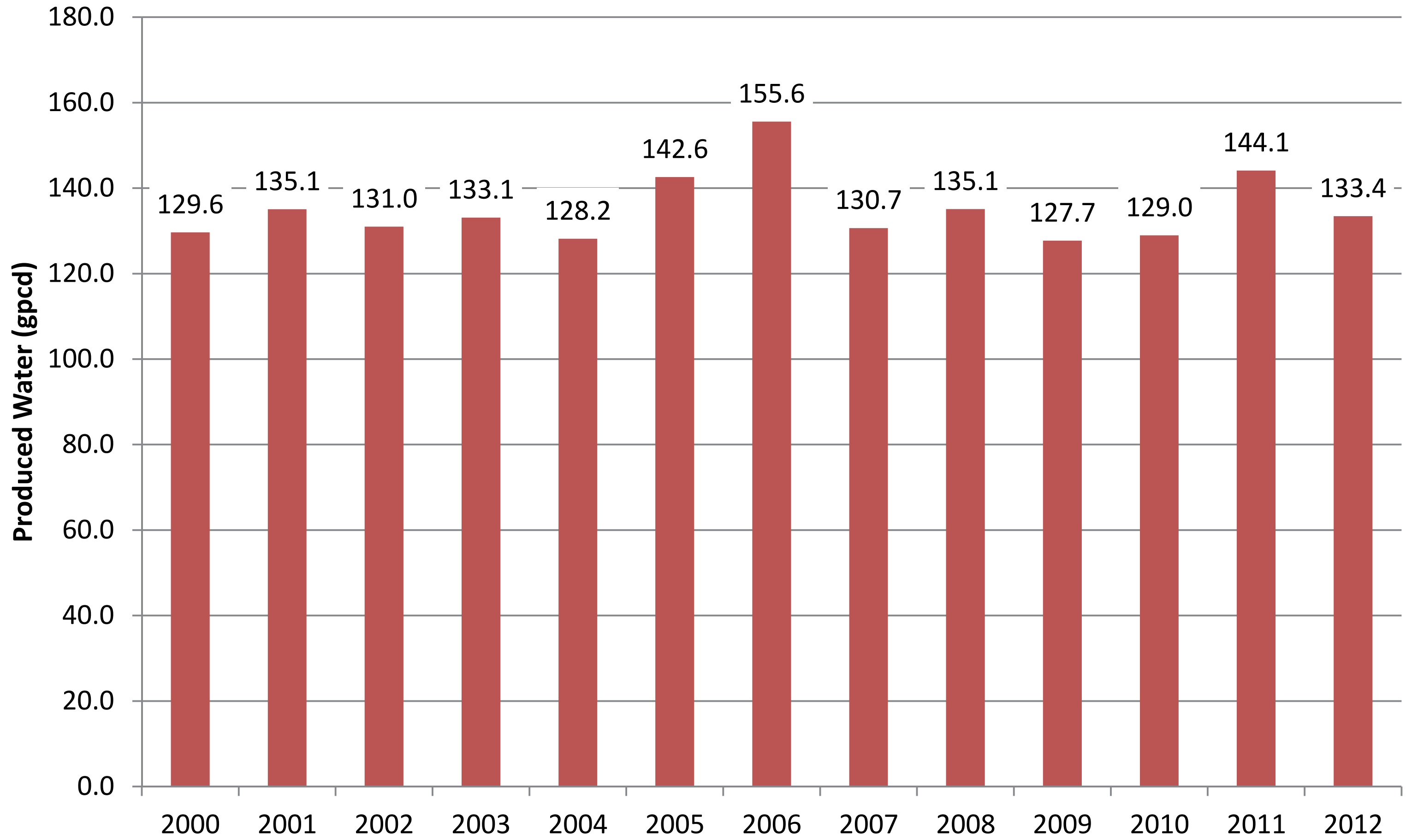
Notes:
(1) The City population for years 2001 through 2009 are interpolated from 2000 and 2010 Census population.
(2) The service area population is assumed to be approximately 85 percent of City population.



HISTORICAL TRENDS OF DAILY PEAKING FACTORS

FIGURE 2.3

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN



Note: Gallons per capita per day (gpcd) is calculated based on treated water (and includes distribution losses and local treatment losses.)

HISTORICAL TRENDS OF PER CAPITA WATER USE

FIGURE 2.4

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

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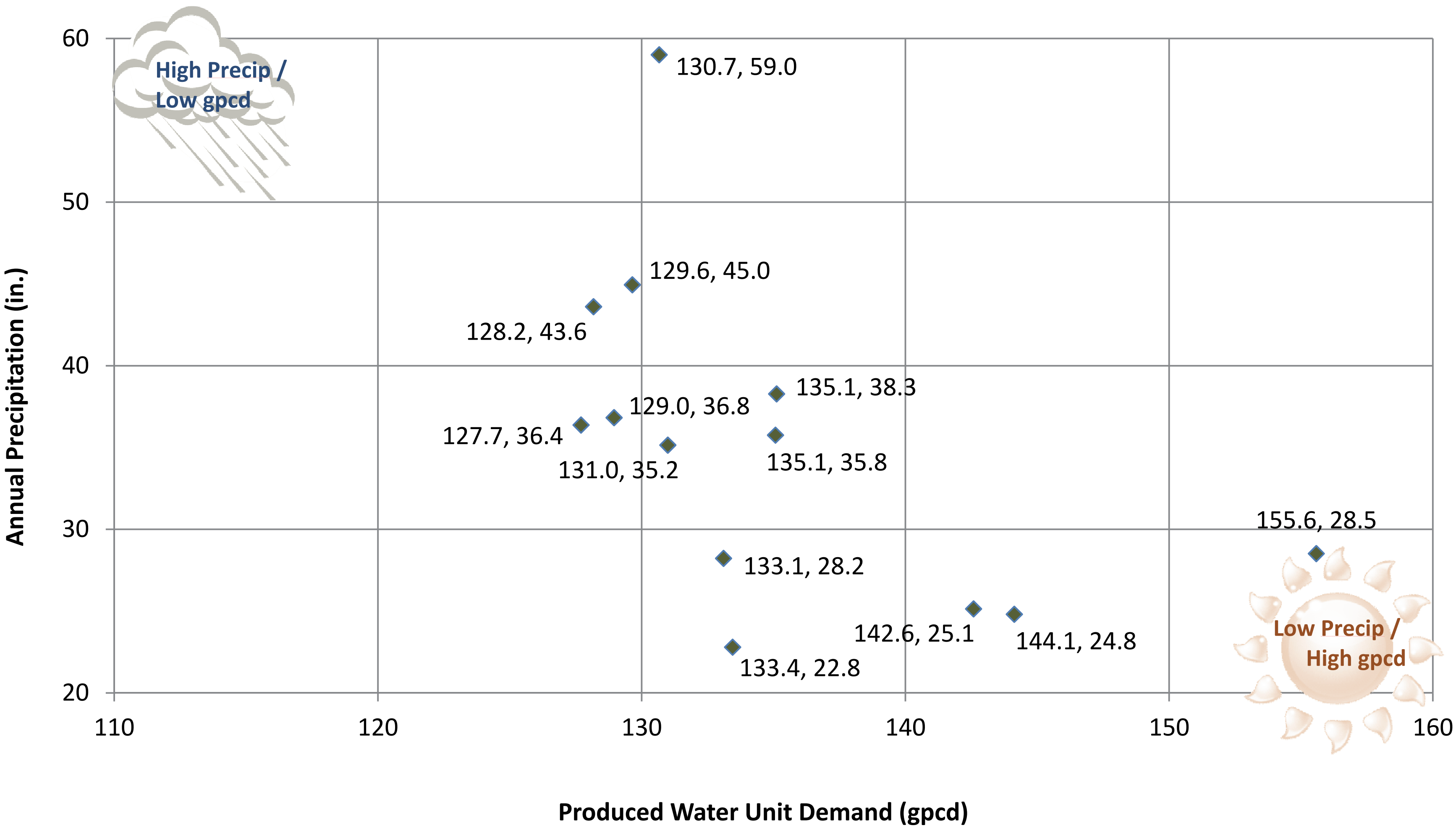

Legend:
◆ Produced Water in gpcd, Annual Precipitation in inches

HISTORICAL DEMAND COMPARED TO PRECIPITATION

FIGURE 2.5

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

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2.4 BASELINE WATER DEMAND PROJECTIONS

2.4.1 Service Area Population Projections

The population of NUA's service area is a primary driver of future water demands. The City's land use plans suggest that at a minimum, around 85 percent of the City's population will continue to be on NUA water service. However, it is possible that a higher percentage of new future development will be served by NUA, and it is also possible that some or all of the population not currently on NUA water could be served by NUA in the future.

In light of those uncertainties, a range of possible service area populations was estimated for current conditions through 2060. The lower bound estimate assumes that none of the future developments in rural areas (approximately 16 percent of total dwelling units in 2025 per Norman's *2025 Land Use and Transportation Plan*) and all of the future developments in urban areas (approximately 84 percent of total dwelling units in 2025) will be served by NUA. The higher bound estimate assumes citizens of Norman that are not currently on NUA water will be converted to NUA service over time, and the entire City population will be served by the NUA potable water system by 2060.

City population projections through 2025 were taken directly from the City's most recent land use planning document, the *2025 Land Use and Transportation Plan*. The City has not adopted population projections beyond 2025. In lieu of such projections, the 2060 SWSP assumes that the City's total population will increase after 2025 by a constant number of people per year, equal to the annual growth rate cited in that plan from 2020 through 2025 (about 1,750 people per year). That growth rate is comparable to the past several decades of population growth in Norman, per U.S. Census records.

For each planning year through 2060, the service area population was calculated as a percent of City population. As described above, those ratios range from about 85 percent (lower bound service area population growth) to 100 percent by 2060 (higher bound service area population growth). As shown in Table 2.3, the lower bound service area population increases from approximately 94,500 in 2010 to 168,000 in 2060. The higher bound service area population increases from approximately 94,500 in 2010 to about 198,500 in 2060.

Table 2.3 NUA Service Area Population Ranges						
Year	**City Population(1)**	**Annual Population Growth**	**Percent Served (low est.)**	**Service Area Population (low est.)**	**Percent Served (high est.)**	**Service Area Population (high est.)**
2010	110,925	1,304	85.2%	94,547	85.2%	94,547
2015	120,152	1,845	85.1%	102,298	86.7%	104,186
2020	128,404	1,650	85.1%	109,230	88.2%	113,237
2025	137,147	1,749	85.0%	116,574	89.7%	122,973
2030	145,890	1,749	84.9%	123,918	91.1%	132,966
2040	163,376	1,749	84.8%	138,606	94.1%	153,727
2050	180,862	1,749	84.8%	153,294	97.0%	175,521
2060	198,348	1,749	84.8%	167,983	100%	198,348

Notes:

(1) The City population for year 2010 is from the 2010 Census population while for years 2015-2025 population estimates are from the Norman 2025 Plan. For years 2030-2060, constant growth rate of 1,749 people per year is assumed (continuing the 2020-2025 persons/year growth rate projected in the Norman 2025 plan).

2.4.2 Water Demand Projections

Water demand projections were developed using historical water demands, reserve capacity, and passive conservation savings.

The unit water demand used in 2060 SWSP projections has two components. The first is based on recent historical unit water demands. To determine the appropriate planning demand, historical per capita demands (2000 to 2012 from Figure 2.4) were analyzed.

2006, 2011, and 2012 were dry years and have higher per capita water demands as would be expected. Otherwise, no significant trend in Norman’s per capita demands is evident in recent years’ data. 145 gpcd was selected as the basis for 2060 SWSP demand projections, as it represents water savings from Norman’s recently implemented conservation programs, but also reflects the potential for drought-year demands to be higher than normal years. As a result, the 2060 SWSP would allow NUA to meet demands under a wide range of hydrologic conditions. Potable water demands may also be reduced by the implementation of additional water conservation and reuse measures. Those concepts were evaluated alongside other supply options for meeting near- and long-term demand.

The second component of the unit water demand used in 2060 SWSP analyses is a reserve supply that accounts for uncertainties in demand projections and supply availability (e.g., new industries or water supply emergencies). A reserve capacity equal to about 10 percent of the total water demand was selected for 2060 SWSP analyses, correlating to a reserve of 15 gpcd.

Altogether, a total unit water demand of 160 gpcd was thus used as the basis for 2060 SWSP demand projections. In normal and wet years, demands will likely be lower than projected here, allowing NUA greater flexibility in how the supply sources are operated in those years. For example, NUA may choose to “rest” its groundwater wells more in normal and wet years, and then use all sources to their full capacity in drought years.

Anticipated reductions in water demand associated with passive conservation were deducted from the baseline demand projections. Passive conservation is defined as water savings that are the direct result of state and federal implementation of plumbing codes requiring water efficient plumbing fixtures. While post-1992 development should be 100 percent compliant with these codes, higher-flow fixtures in older homes and businesses are gradually replaced over time. Using Cleveland County estimates in the Oklahoma Water Resource Board (OWRB) *Oklahoma Comprehensive Water Plan 2012 Update* reports on water demand and conservation projections (OWRB, 2011), passive conservation savings were estimated for Norman. Passive conservation savings are expected to be fully realized in Norman by 2030.

Table 2.4 summarizes the annual average demand projections developed in the 2060 SWSP, reflecting growth in the service area, existing conservation and reuse programs, and anticipated reductions in demand associated with passive conservation. The high estimate was used in determining water supply needs. Figure 2.6 illustrates both the annual average and peak day demands that were used in 2060 SWSP analyses. Water supply transmission, storage, and treatment infrastructure was sized to handle projected peak day demands. Supply planning was based on the higher demand values to prepare for the possibility that those conditions could be realized, but with the understanding that new supply projects could be delayed if demands increase at a slower rate.

Table 2.4 NUA Service Area Demand Projections

Year	Unit Water Demand (gpcd)(1)	Unit Reserve Capacity (gpcd)(2)	Passive Conservation Savings (AFY)(3)	Demand Projections – low est. (AFY)(4)	Demand Projections – low est. (annual avg. mgd)(4)	Demand Projections – high est. (AFY)(5)	Demand Projections – high est. (annual avg. mgd)(5)
2015	145	15	0	18,300	16.4	18,700	16.7
2020(6)	145	15	1,600	18,000	16.1	18,800	16.7
2025	145	15	2,200	18,700	16.7	19,800	17.7
2030	145	15	2,800	19,400	17.3	21,000	18.8
2040	145	15	2,900	22,000	19.6	24,700	22.1
2050	145	15	3,000	24,500	21.8	28,500	25.4
2060	145	15	3,100	27,100	24.2	32,500	29.1

Notes:
(1) Based on recent historical trends in water demand. Includes non-revenue water and reflects existing conservation and reuse programs, but does not account for post-2010 passive conservation.
(2) Approximately 10% of total water use.
(3) Approximately 60% of passive conservation savings for Cleveland County per the OCWP 2012 Update.
(4) Based on low service area population projection, which assumes that NUA serves approximately 85% of the City's 2060 population.
(5) Based on high service area population projection, which assumes that NUA serves 100% of the City's 2060 population.
(6) By 2020, water savings from passive conservation is realized and a small reduction in demand is seen even though population has increased since 2015.

2.5 POTENTIAL EFFECTS OF CLIMATE CHANGE ON SUPPLY AND DEMAND

Among the uncertainties facing water supply planning is the potential impacts of climate change. Significant research has been conducted in recent years and is ongoing. Efforts are increasingly targeted toward understanding the potential type and degree of impacts at the local level, but the level of accuracy in such projections is generally understood to be significantly lower than projections at a regional level of analysis.

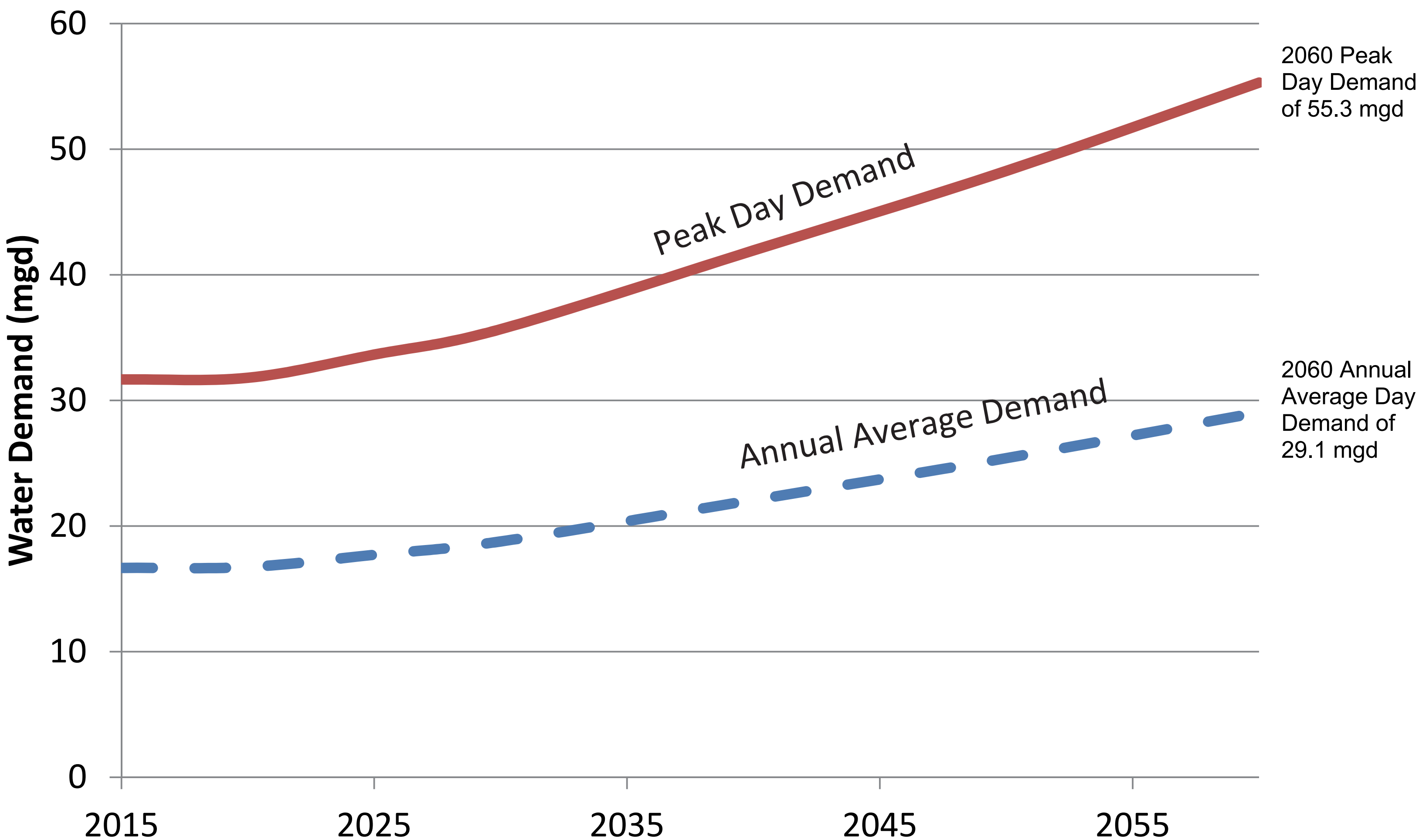
Increasing temperature can generally be expected to drive increases in demand, particularly where outdoor water use and irrigation drives a significant portion of demand. Thus, outdoor use in communities like Norman, and irrigation uses in the agriculture industry, has the greatest potential to be affected by climate change impacts on demand.

There is less certainty in the scientific community regarding how climate change could affect water supplies. Regional differences in the types and amount of impacts are expected to be significant. Precipitation effects may range from increasing annual amounts, decreasing annual amounts, and/or in the frequency and severity of precipitation and related weather events. The 2012 OCWP assessed a range of potential climate change impacts on demand and supply across Oklahoma. Those findings also suggest a wide range of potential impacts, with significant uncertainty.

The OCWP analyses indicate that Cleveland County demands on public water supply systems could increase from a 2060 baseline amount (no climate change impact) of about 47,100 AFY to between about 49,000 and 52,000 AFY under different climate change scenarios (OWRB, 2012). Assuming that Norman's demands trend in line with county-level projections, this could translate to as much as a 10 percent increase in annual demand for NUA by 2060, increasing annual demands from the 2060 projection of 29.1 mgd to as much as about 32 mgd.

OCWP analyses of precipitation and supply availability bracketed a range of potential conditions, from warmer/wetter to hotter/drier, as detailed in OCWP reports. Under the hot/dry scenario, precipitation in central Oklahoma was estimated to decrease by about 3.5 to 4 inches per year by 2060, relative to historical precipitation, with greater impacts toward the southeastern part of the state. Under the warm/wet scenario, little or no change in precipitation is predicted for central Oklahoma, but increases of around 3 inches per year are predicted for northeast Oklahoma by 2060 (OWRB, 2012).

The range of potential future precipitation trends – potentially increasing or potentially decreasing – presents a challenge for water supply planning. It can be anticipated that surface water and alluvial groundwater (physically connected to surface water) supplies will be more directly affected than bedrock groundwater supplies because there is less of a direct relationship between bedrock groundwater recharge rates and daily or seasonal precipitation.



WATER DEMANDS USED IN THE 2060 SWSP

FIGURE 2.6

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

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Any potential impact on Norman's supplies will be a function of which climate change scenario is eventually realized, and also a function of which part of Oklahoma Norman's supplies are sourced. For example, if Norman chooses to use water from Kaw Reservoir located in northern Oklahoma, this source may receive additional precipitation and runoff under the warmer/wetter scenarios. In contrast, Lake Thunderbird in central Oklahoma may not see any change under that scenario but could see a reduction in runoff and yield under a hotter/drier scenario.

Overall, we can anticipate that increasing temperatures may increase demands (especially with outdoor water use, which drives peak day demands and water infrastructure), and we can anticipate that the effects on surface water supplies might affect their availability and firm yield (with either increasing or decreasing supplies). That could affect the timing and phasing of additional supply projects are needed to meet Norman's demands. Together, this suggests a need to revisit climate change implications on an ongoing basis, including in the next update to the SWSP. For the 2060 SWSP, potential climate change impacts were not integrated into the analyses, in light of the significant uncertainty in the type, degree, and timing of those potential impacts.

2.6 COST ESTIMATING ASSUMPTIONS

Planning level capital cost estimates were developed for each of the supply options and portfolios. These capital cost estimates are generally consistent with a Class 5 Order-of-Magnitude estimate appropriate for use in concept screening, as defined by the Association for the Advancement of Cost Engineering. The expected accuracy range is between +50 percent to -30 percent. Annual costs and life cycle cost estimates were developed for supply portfolios.

2.6.1 Capital Costs

The unit cost assumptions were based on *Regional Water Supply Plan for Central Oklahoma* (OCWUT, 2009), recent studies of projects similar to those being developed (examples include Scissortail Reservoir and Lake Thunderbird augmentation), and historical cost information provided by the City. Costs from other studies were updated to 2012 dollars using the *Engineering News Record (ENR) Construction Cost Indices (CCI)*. All unit costs below are expressed in terms of 2012 dollars (ENR 5416), reflecting the most recent ENR data available at the time the cost estimates were prepared.

- Capital Costs (2012 dollars):
  - All unit costs list below include approximately 25 percent contingency for construction, 20 percent for engineering, and 20 percent for easement acquisition.
  - Unit costs expressed as dollars per inch diameter per linear foot ($/in-LF) were developed for installed pipelines in rural areas of $12/in-LF and urban areas of $14/in-LF.
  - Unit cost of $88/in-LF was used for tunneling and boring pipelines.
  - Unit cost of $20/in-LF was used for pipelines crossing water bodies.

- An estimate was made on the type of installation conditions (rural, urban, open cut, tunneling, etc.) using aerial maps. Detailed pipeline routing was not completed as part of this project.
- Unit costs expressed as dollars per horsepower ($/hp) of $3,700/hp were used to estimate pump station costs.
- Unit costs expressed as dollars per million gallons per day of capacity ($/mgd) of $43,000/mgd were used for intake structures.
- For Scissortail Reservoir and Parker Reservoir, a unit cost of $800 per acre-foot ($/AF) was used to determine source development costs. This is the ENR-CCI adjusted source development cost from the Final Comprehensive Report Compilation, Phases I, IA, II and III, Proposed Scissortail Reservoir Feasibility Study).
- For terminal storage reservoirs, a unit cost of $5,500/AF was used. This higher cost reflects the likely urban location and lower economy of scale for a smaller, terminal storage reservoir.
- Water treatment unit costs expressed as dollars per gallons per day of capacity ($/gpd) are as follows:
  - Conventional treatment - $1.85/gpd.
  - Conventional treatment with softening (new water treatment plant [WTP]) - $2.00/gpd.
  - Conventional treatment with softening (expanded NUA Vernon Campbell WTP) - $1.85/gpd.
  - Conventional treatment with pre-sedimentation - $2.25/gpd.
  - Reverse osmosis (RO) treatment - $6.00/gpd.
  - Blend of conventional treatment and RO (new WTP) - $4.50/gpd.
  - Blend of conventional treatment and RO (expanded NUA Vernon Campbell WTP) - $4.34/gpd.
  - Arsenic and chromium-6 removal at centralized WTP - $3.08/gpd.
  - Single pass RO with UV disinfection - $8.44/gpd.
  - WRF Treatment Improvements necessary for Lake Thunderbird Augmentation - $2.78/gpd.
- Water storage unit costs expressed as dollars per gallon ($/gal) of $1.00/gal was used.
- A unit cost of $630,000 per new well was used.
- Treatment, intake, and pumping infrastructure are rehabilitated every 25 years. Rehabilitation costs were assumed to be approximately equal to 75 percent of new infrastructure costs.

2.6.2 Life Cycle Costs

Life cycle costs were developed for only the recommended portfolios. The following assumptions were used in the life cycle cost analysis.

- Costs developed in 2012 dollars and escalated at 3 percent each year except wholesale rates for Oklahoma City treated water that are escalated at 6 percent each year (initial value based on rate sheets provided by Oklahoma City and attached here as Appendix F).
- New projects come online just before capacity is needed.
- Rehabilitation and/or Replacement:
  - 1.3 percent of pipelines assumed rehabilitated each year (equal to 75-year life).
  - One well rehabilitated/replaced each year.
  - Treatment, intake, and pumping infrastructure rehabilitated/replaced every 25 years.
  - Storage tanks rehabilitated every 10 years.
  - Rehabilitation costs are approximately 75 percent of new infrastructure costs.
- Debt Service on Capital Costs:
  - Bonds issued for all of capital costs and can cover multiple projects anticipated within a 5 to 10-year period.
  - Bond interest rate of 4 percent until 2024 and 6 percent from 2025 to 2060.
  - Bonds issued under 30-year term and 1 percent cost of issuance.
- Operation and Maintenance Costs:
  - Water Treatment:
    - Fixed costs - $3,300,000/year (conventional, conventional with softening, conventional with pre-sedimentation).
    - Variable costs - $0.40/1000 gal (includes power) (conventional, conventional with softening, conventional with pre-sedimentation).
    - Additional Variable Cost if using Ozone - $0.02/1000 gal.
    - Well treatment - $1.68/1000 gal.
    - WRF fixed costs - $2,000,000/year (above existing WRF operating costs).
    - WRF variable costs - $0.24/1000 gal (above existing WRF operating costs).
  - Groundwater wells:
    - Fixed costs - $250,000/year.
    - Variable costs - $0.33/1000 gal (includes power).
  - Storage Tanks:
    - Cleaning - $2,000/year.
  - Continued use of Lake Thunderbird includes payments to COMCD who maintains and operates the raw water conveyance facilities based on the amount of water withdrawn from Lake Thunderbird by NUA.
    - Power Costs - $0.09/kWh.

SOURCE OPTION CHARACTERIZATION AND INITIAL SCREENING

The individual water supply sources evaluated as part of this project are listed in Table 3.1 below. The new local and outside (or regional) sources were characterized and compared using preliminary screening criteria, described in Section 3.4. Based on results of the initial screening, the most viable new sources along with Norman's existing sources were used to develop water supply portfolios (i.e., "packages" of supplies that together will meet Norman's future water demands) as detailed in Section 5.

Table 3.1 Water Supply Sources Evaluated for 2060 SWSP(1)
Existing Sources
• **Lake Thunderbird (at firm yield)(2)**
• **Garber-Wellington Aquifer Wells (with treatment)**
• **Water Conservation and Reuse**
• **Purchase Treated Water from Oklahoma City (wholesale)**
New Local Sources
• **Additional Water Conservation**
• **Additional Non-potable Water Reuse**
• **Lake Thunderbird Augmentation (indirect potable reuse)**
• Stormwater Capture and Reuse
• Canadian River Diversion
• Lake Thunderbird Spillage
• Groundwater Recharge (indirect potable reuse)
New Regional Sources
• **Co-owner with Oklahoma City for Southeast Oklahoma Treated Water**
• **Co-owner with Oklahoma City for Southeast Oklahoma Raw Water**
• **Scissortail Reservoir**
• **Parker Reservoir**
• **Kaw Lake**
Notes: (1) Most viable sources retained for portfolio evaluations are indicated in bold font. (2) Includes consideration of dredging the lake or raising the dam for additional storage.

The following key assumptions were made to evaluate the individual water supply sources.

- Firm yield (the amount of water Norman could rely on in an extended drought) was estimated on the following basis:
  - If the source has available firm yield that is equal or greater than Norman's projected 2060 annual average day demand (29.1 mgd), the yield was set at 29.1 mgd.

- If the source has available firm yield that is less than Norman’s projected 2060 annual average day demand (29.1 mgd), the yield was set equal to the maximum amount of firm yield available from that source.
- For certain supply sources, the firm yield was set lower than the maximum available supply based on balancing yield with costs. An example of this is the capture of Lake Thunderbird spillage. For the 2060 SWSP, the spillage was limited to 20 percent of Norman’s projected 2060 demands even though more supply could be captured. The cost Lake Thunderbird spillage is high (relative to other supply sources).
- For certain supply sources, the firm yield was set lower than the maximum available supply based on potential customers’ projected water use. For example, non-potable reuse supply was limited to the projected needs of likely customers. Costs for treatment and infrastructure closely match the anticipated demand for this source water

- Lake Thunderbird cannot be reliably used for terminal storage of new local or regional supplies, because its conservation pool is at times already full from storage of runoff from its tributary watersheds. If a water supply needs storage to secure firm yield or minimize size of raw water conveyance infrastructure, a new terminal storage reservoir is included in the source cost. The exception to this assumption is Lake Thunderbird augmentation, which does “store” reclaimed water in the reservoir. Storage of reclaimed water in the reservoir can be managed to increase the yield of the lake, taking advantage of low lake levels by managing the timing and quantity of flows pumped from Norman’s Water Reclamation Facility (WRF) to Dave Blue Creek.
- Terminal storage sizing is based on a mass balance calculation that accounts for inflows, withdrawals, and evaporation. Calculations are performed on a monthly time step. Terminal storage was sized to provide a reliable annual yield from each source. It was assumed that reliability (i.e., a firm yield that would be available even in multi-year droughts) is paramount for each source, to avoid the need for redundant supplies to cover times when the source would be unable to provide the intended yield.
- Pipelines were sized to achieve a maximum in-pipe flow velocity of 6 feet per second (fps).
- Treatment capacity is based on Norman’s recent usage trends (with peak day demands equal to 1.9 times annual average demands), except for non-potable reuse that is based on irrigation users’ unique demand patterns (i.e., high summer peak demands).
- Treatment process selection was based on available water quality information. In the absence of historical water quality data, assumptions are made given general knowledge of source water quality.
- To provide a consistent basis of comparison, unit costs for pipelines, pump stations, reservoir, storage, and treatment were used to develop project costs for each supply source, described in Section 2.6.

- Water availability for regional sources was assessed using data from the 2012 Update of the Oklahoma Comprehensive Water Plan, as revised in early 2013 (OWRB 2013), including relevant Watershed Planning Region Reports and basin-level data.

The sections below summarize individual water supply sources that were evaluated as part of the 2060 SWSP. More detailed information on each source is available in Appendices A and C through Q.

3.1 EXISTING SOURCES

This section describes existing water supply sources used by NUA and modifications necessary for the continued use of these sources. Existing water conservation and reuse programs were assumed to continue at their current levels. Additional water conservation and water reuse measures are examined in Section 3.2 as new local sources.

3.1.1 Lake Thunderbird

Lake Thunderbird is located in OCWP Central Watershed Planning Region, Basin 62. The lake is entirely located within Norman's city limits. Construction was completed by the U.S. Department of Interior's Bureau of Reclamation (BOR) in 1965. Lake Thunderbird is managed by COMCD for the benefit of its member cities Norman, Del City, and Midwest City. The lake's water supply yield is shared between Norman, Del City, and Midwest City in proportion to their cost obligation in constructing the dam. Norman's allocation is 43.8 percent of the permitted yield for Lake Thunderbird. Midwest City's allocation is 40.4 percent, and Del City has the remaining 15.8 percent of the total allocation.

3.1.1.1 Description of Current Use

Lake Thunderbird currently is permitted based on its conjunctive yield, which is defined as the total of firm yield from Lake Thunderbird plus water from the Garber-Wellington Aquifer that supplements the supply during summer peaks and times of drought. This conjunctive yield was originally established at 21,600 AFY. This corresponds to an allocation for Norman equal to 9,460.8 AFY (or 8.45 mgd average). Midwest City and Del City have not always utilized their full allocation; however, Norman has exceeded its allocation 17 times in the last 25 years. Norman's 25-year average annual withdrawal is 9,951 AF or 8.88 mgd on average. The peak daily withdrawal for Norman is 15.99 mgd, which occurred on August 2, 1999.

Water from Lake Thunderbird is pumped to NUA's Vernon Campbell WTP through approximately 6 miles of 33-inch concrete pipe followed by approximately 2.5 miles of 30-inch concrete pipe. NUA recently paralleled the existing 30-inch portion with a new 48-inch fiberglass pipeline. The increase in transmission capacity will remove the hydraulic constraint on the Thunderbird raw water supply compared to the WTP capacity. This 48-inch pipeline is anticipated to be in service in the fourth quarter of 2013. With the new pipeline in service, the peak raw water transmission capacity for Lake Thunderbird supplies will be 17 mgd.

The Vernon Campbell WTP has a peak treatment capacity of 17.0 mgd and utilizes conventional treatment with softening. It will be rehabilitated within the next 5 years under the “Phase II WTP upgrades” to address water quality issues related to new regulatory mandates and to mitigate taste and odor events. According to the City’s budgetary figures, the Phase II upgrades are expected to cost approximately $33 million, and funds have been allocated to cover these expenses.

3.1.1.2 Impacts on Continued Use

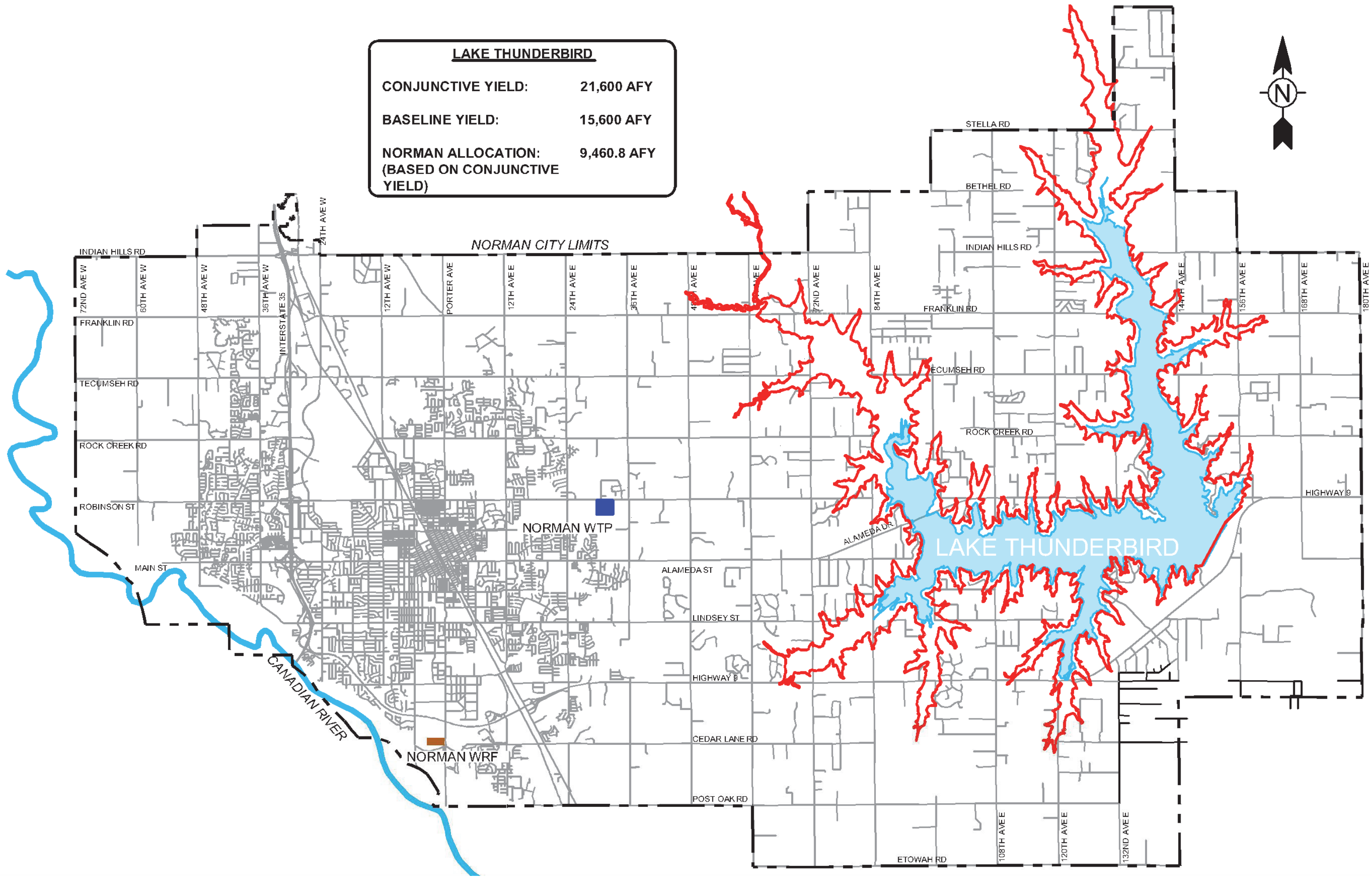
To eliminate double counting of groundwater yields and clarify the expected firm yield of the lake without groundwater, the BOR and COMCD are considering modifications to the member cities’ Lake Thunderbird supply allocations. It is anticipated that the total of the revised allocations will be equal to the firm yield for the lake. The BOR has previously calculated the firm yield at 15,600 AFY.

This could reduce Norman’s allocation to 6,833 AFY (6.1 mgd annual average). For the 2060 SWSP, a reduced allocation of 6.1 mgd was assumed for evaluation and planning purposes and it was assumed that a reduced allocation would go into effect in 2016.

3.1.1.2.1 *Raising the Norman Dam*

Raising the Norman Dam to increase available water supply was considered as a potential means of increasing supplies from Lake Thunderbird. It is estimated that for each foot of dam height added, approximately 6,000 AF of storage could be gained.

As an initial basis of analysis, several supply options were considered in terms of their ability to meet at least 20 percent of NUA’s projected 2060 annual average demand (29.1 mgd), i.e., 5.8 mgd. In order to recognize an additional 5.8 mgd of firm yield from Lake Thunderbird, the conservation pool elevation would need to be increased from 1,039 feet above mean sea level (MSL) to 1,051.5 feet MSL. This would expand the surface area of Lake Thunderbird as shown in Figure 3.1. The amount of infrastructure required to capture this water and extent of property impacted within the inundated area are significant concerns. Additionally, it is unknown if the existing earthen dam can be raised without reconstruction. Land acquisition costs, road and bridge reconstruction costs, and dam reconstruction costs are expected to be very high. Given the uncertainties, significant property impacts to adjacent development, and costs, raising the dam was not considered a viable option within the planning period and is not considered further. However, as the reservoir approaches its useful life toward the end of the SWSP planning period, significant dam and outlet works rehabilitation may be required. Raising the dam could be reconsidered in conjunction with those efforts.



EL=1049 EXISTING TOP OF FLOOD CONTROL POOL
EL=1062 NEW TOP OF FLOOD CONTROL STORAGE POOL
EL=1068 EXISTING TOP OF SURCHARGE POOL
EL=1081 NEW TOP OF SURCHARGE POOL
EL=1071 EXISTING DAM CREST
EL=1084 NEW DAM CREST
Norman Water Treatment Plant
Norman Water Reclamation Facility

LAKE THUNDERBIRD INUNDATION MAP

FIGURE 3.1

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

3.1.1.2.2 *Dredging Lake Thunderbird*

Dredging Lake Thunderbird also was considered as a potential means of increasing yield from the reservoir. The BOR's firm yield calculations for Lake Thunderbird assumed that storage equal to 100 years of sediment accumulation is unavailable for water storage. Recent bathymetric surveys indicate that the sediment accumulation to date closely tracks with the projected sedimentation rate. Dredging a reservoir is a very expensive and unproven approach, and requires a considerable amount of land to dry and dispose of the dredged material. Moreover, dredging would provide only temporary storage and yield benefits, until such time as sedimentation re-filled the dredged volume. Dredging Lake Thunderbird is not considered a viable option for the 2060 SWSP planning period. Similar to raising the dam, significant dam and outlet works rehabilitation may be required in the future, and dredging could be reconsidered in conjunction with those efforts.

3.1.1.3 Opinion of Costs

There are no new capital costs associated with continued use of Lake Thunderbird for storage through the 2060 SWSP planning period, other than rehabilitation and maintenance. Norman's debt on Lake Thunderbird and Norman Dam is paid for in full. However, the Norman Dam will require rehabilitation or partial reconstruction in the coming years. Until a more in depth study is performed on the current condition of the dam, rehabilitation costs are relatively unknown. Additionally, lakeshore maintenance or rehabilitation may be required in the next 50 years. Finally, as the reservoir reaches the end of its anticipated service life, consideration must be given to either dredging the lake or raising the dam in order to maintain its firm yield or the firm yield must be reduced to account for reaching the siltation limit allowed in the yield study. These costs are not included in this study, as they will be common to any future use of the lake. Continued use of Lake Thunderbird was included as a component of each 2060 SWSP recommended portfolio, as detailed in the remaining sections of this report.

3.1.1.4 Summary of Individual Source

Table 3.2 summarizes information regarding the continued use of Lake Thunderbird. Other than the reduction in permitted withdrawal amount (based on the actual firm yield of the reservoir) and rehabilitation/maintenance activities, there are no significant challenges with continued use of Lake Thunderbird through the 2060 planning horizon. However, rehabilitation and replacement of Norman's infrastructure for diversion, conveyance, and treatment of Lake Thunderbird supplies was included in the detailed financial analyses of the recommended portfolios. Costs associated with augmenting Lake Thunderbird supplies were considered separately.

Table 3.2 Existing Water Supply Source – Lake Thunderbird		
Existing Yield Available to Norman[1]	AFY	9,461
	mgd	8.45
Anticipated Future Firm Yield Available to Norman[2]	AFY	6,833
	mgd	6.1
Percent of projected 2060 demands supplied by firm yield[3]	Percent	21
Raw Water Transmission Distance	Miles	8.5
Water Treatment Process		Conventional with softening
Known Long-term Reliability Issues		Dam maintenance/rehabilitation
Known Implementation Issues		None
Opinion of Capital Costs	2012 $	$0
Unit Capital Cost of Source[4]	$/AFY	$0

Notes:
(1) Existing yield based on Norman's portion of Lake Thunderbird conjunctive yield.
(2) Firm yield based on Norman's portion of Lake Thunderbird's firm yield.
(3) Proposed firm yield divided by Norman's projected 2060 demands (29.1 mgd).
(4) Unit capital cost is capital cost associated with source divided by proposed firm yield. Rehabilitation/replacement costs were not assessed in initial source screening.
(5) Summed and converted values may vary slightly due to rounding.

3.1.2 Garber-Wellington Aquifer Wells

The OCWP characterized the Garber-Wellington Aquifer as follows (OWRB, 2013):

- Underlies a large portion of central Oklahoma and is considered a major bedrock aquifer;
- Consists of fine-grained sandstone interbedded with siltstone and shale;
- Has generally good water quality, but in some areas, concentrations of nitrate, arsenic, chromium, and selenium may exceed drinking water standards; and
- Is administered via temporary permits under an equal proportionate share (EPS) of 2.0 AFY per acre of land dedicated to the wells.

OWRB is currently conducting a study of the Garber-Wellington Aquifer that is expected to result in a reduction to the EPS. The Garber-Wellington Aquifer has an estimated recharge rate of 1.6 inches per year (OWRB, 2013), but Oklahoma water law allows EPS to be set at rates greater than the rate of recharge. The final EPS approved by OWRB in light of the study will govern the future permanent permits and may require NUA to dedicate more land to its existing wells to maintain their permitted capacity.

3.1.2.1 Description of Current Use

NUA operates 36 active bedrock groundwater wells in the Garber-Wellington Aquifer. In addition, NUA owns 12 groundwater wells that are offline (inactive) because of levels of arsenic that exceed the regulatory maximum contaminant level (MCL) limit of 10 parts per billion (ppb or µg/L). Of these 12 inactive wells, one was repurposed for irrigation at Griffin Park and at one NUA operates a wellhead arsenic removal project (effectively, there are 10 wells available to be reinstated if treatment is provided).

The active wells are estimated to have an annual average yield of approximately 6,720 AFY (or 6.0 mgd annual average). Historical flow data indicate that approximately 9.0 mgd can be achieved during maximum withdrawal rates from active wells; however, this rate cannot be continuously maintained (as indicated by reduced well production rates after periods of running at higher aquifer pumping rates). NUA has observed recovery in water table levels and well yields after reducing pumping rates, suggesting an ability of the aquifer to recover from intensive pumping activity.

The inactive wells are estimated to have an annual average yield of approximately 2,340 AFY (or 2.1 mgd annual average). Historical flow data indicates that approximately 2.7 mgd can be achieved during maximum withdrawal rates; however, this rate cannot be continuously maintained due to close spacing of some of the inactive wells and reduced well production rates after periods of running at these higher rates.

Available data for arsenic and chromium-6 concentrations in water pumped from the existing wells were reviewed. A summary of the available data, including the well identification number, the well flow rate, the arsenic concentration, and the chromium-6 concentration for the 48 wells is summarized in Table 3.3.

Currently, total chromium is regulated by the EPA with an MCL of 100 ppb, and no specific limit has been set for chromium-6. It is anticipated that EPA will release a draft assessment for chromium-6 for public comment that could set a path toward establishing a future MCL for chromium-6. The effect of a range of potential future MCLs for chromium-6 was investigated and is summarized in Section 3.1.2.2.

3.1.2.2 Impacts on Continued Use

There are several factors that affect the continued use of the Garber-Wellington Aquifer wells as a water source. Changes to the permitted withdrawal rate, anticipated regulations on chromium-6, and options to address existing arsenic regulations are discussed in this section.

Table 3.3 Garber-Wellington Aquifer Well Data			
Well No.[3]	**Average Flow Expected (gpm)[2]**	**Arsenic Concentration (ppb)[2][4]**	**Chromium-6 Concentration (ppb)[1][2]**
1	161	637	58.5
2	224	8.3	58.5
3A	121	3.6	43
4[1]	249	20-100	--
5	146	N/A	74
6	190	6.9	37
8	225	6.1	55
11[1]	112	45-90	--
12[1]	164	90-100	--
13[1]	190	30	--
14[1]	177	30-80	--
15[1]	215	15-50	--
16[1]	143	15-30	--
18[1]	136	10-20	--
19	191	4.5	23
20	144	8.7	32.5
21[1]	144	20-50	--
31	159	4.9	32.7
32[1]	182	20-40	--
33	214	6.4	65
34	162	<2	55
35	142	<2	51.5
36	82	<2	70.5
37	120	<2	52.5
38	189	<2	36
39	197	9.8	79.5
40	168	5	45
HP2[1]	150	>200	--
HP3[1]	160	37	--
41	179	3.9	32
43	173	<2	28.7

Table 3.3 Garber-Wellington Aquifer Well Data

Well No.(3)	Average Flow Expected (gpm)(2)	Arsenic Concentration (ppb)(2)(4)	Chromium-6 Concentration (ppb)(1)(2)
44	167	<2	6.3
45	146	<1	67
46	216	2.4	51
47	179	<2	9
48	145	8.8	94.3
49	202	5	89.2
51	150	<10	18
54	117	<10	50
55	150	<10	27.7
56	120	<5	14
57	167	<10	47.7
58	150	<10	26
59	325	<10	45.3
60	240	<10	38.1
61	200	6	46.2
Total	**7,883(5)**	**N/A**	**N/A**

Notes:

(1) Indicates inactive well due to arsenic levels. Arsenic levels reported include the range of arsenic samples recorded at different times. Chromium-6 data were not available for inactive wells.

(2) Flow, arsenic concentration, and chromium-6 concentration data were provided by City staff based on historical readings and trends.

(3) Well 23 is used for irrigation and Griffin Park and is not available as a future water supply.

(4) “<” or less than means that the sample result was lower than the detection limit of the testing method. Similarly,” >” or greater than means that the sample result was higher than the detection limit of the testing method.

(5) The total historical average flow from the active and inactive wells is approximately 11.3 mgd. However, based on discussions with staff, average annual and peak day supplies of 6.0 and 9.0 mgd from active wells and 2.1 and 2.7 mgd from inactive wells were used in the SWSP.

As mentioned previously, OWRB is conducting a study on the Garber-Wellington Aquifer that is expected to replace the temporary EPS of 2.0 AFY per acre with a lower permanent value. No definitive information is available on what the new EPS will be, but under Oklahoma water law, Norman could dedicate more land to its well permits in order to compensate for a reduction in the EPS. Based on preliminary feedback of possible permanent EPS values and calculations of land that Norman could dedicate to its wells, permitted withdrawal is not expected to limit Norman’s ability to use its existing active and inactive Garber-Wellington Aquifer wells.

EPA issued the final Arsenic Rule in January 2001 and it became fully effective in June 2006. The rule applies to all public water suppliers (PWS) regardless of size. The revised rule establishes an unenforceable MCL goal (MCLG) of zero and an enforceable MCL of 10 µg/L. Norman has 12 wells offline due to elevated arsenic levels. The 2060 SWSP evaluated bringing the currently inactive wells back online using appropriate treatment to remove arsenic and chromium-6 to below current arsenic standards and assumed future chromium-6 standards.

Total chromium (sum of trivalent chromium and chromium-6) is regulated by EPA with an MCL of 100 µg/L. There is currently no specific limit for chromium-6. California issued a MCL for chromium-6 of 10 µg/L in 2014. While it is unclear when EPA will develop a MCL or what the MCL level will be, it is prudent in long-term planning to address the potential issue of treating chromium-6 in the Garber-Wellington Aquifer wells. For purposes of the 2060 SWSP, based on available information and industry insights, it was assumed that federal MCL for chromium-6 would become effective in 2018. The effect of potential future MCLs for chromium-6 of 20 ppb, 10 ppb, and 5 ppb was investigated.

- A future MCL of 20 ppb would result in all but four of the existing active wells exceeding the MCL, or a maximum potential loss of 5,560 gpm (8.0 mgd). This would reduce the groundwater source to approximately 650 gpm (0.9 mgd) if treatment were not implemented.
- A future MCL of 10 ppb would result in all but two of the existing active wells exceeding the MCL, or a maximum potential loss of 5,850 gpm (8.4 mgd). This would reduce the groundwater source to approximately 350 gpm (0.5 mgd) if treatment were not implemented.
- A future MCL of 5 ppb would result in all of the existing active wells exceeding the MCL, or a maximum potential loss of 6,200 gpm (8.9 mgd). Without treatment, this would likely eliminate the use of all Garber-Wellington Aquifer wells for potable supply in Norman.

For the 2060 SWSP, a new centralized treatment plant was evaluated to address both arsenic (at its MCL of 10 µg/L) and chromium-6 (at an assumed future MCL of 5 µg/L). While most of NUA's wells do not require treatment for arsenic, a need to implement treatment of virtually all wells would be driven by such a chromium-6 standard. This presents an opportunity to use the new raw water collection piping and groundwater treatment facility to also convey and treat water from wells currently inactive because of arsenic. This approach leverages NUA's past investments in both existing active and inactive well infrastructure.

It is anticipated that ion exchange using media specific to arsenic and chromium-6 removal will be employed in series, followed by chlorination prior to entering the water distribution system. More information on possible arsenic and chromium-6 treatment is available in Appendix D. Treatment selection was based on local projects for arsenic removal and ongoing assessments of chromium-6 treatment at Glendale Power and Light in California (Norman, 2002, Norman, 2010 and WRF, 2011).

Upon implementation of federal chromium-6 MCLs, all of NUA's groundwater would be conveyed through a network of new untreated well water collection piping to a single common treatment facility, a new centralized North Water Treatment Plant, before being distributed to customers. Figure 3.2 illustrates the modifications needed to continue use of this source.

Detailed WTP siting investigations were not conducted in the 2060 SWSP. A general location for a centralized treatment plant was assumed in order to determine approximate pipeline lengths that would be required to convey untreated well water to the new WTP and from seven southern wells to the existing Vernon Campbell WTP. It is estimated that approximately 40 miles of new untreated well water pipelines will be required. The majority of the pipelines will be 12 inches in diameter, feeding into larger mainlines that terminate at the new North WTP. The required capacity of the new WTP is estimated to be 10.4 mgd, which covers the assumed maximum daily withdrawal of the active and inactive well field, not including 1.5 mgd of capacity from seven southern wells. The seven southern groundwater wells are assumed to be blended with treated surface water from NUA's existing Vernon Campbell WTP to meet the arsenic and anticipated chromium-6 MCLs.

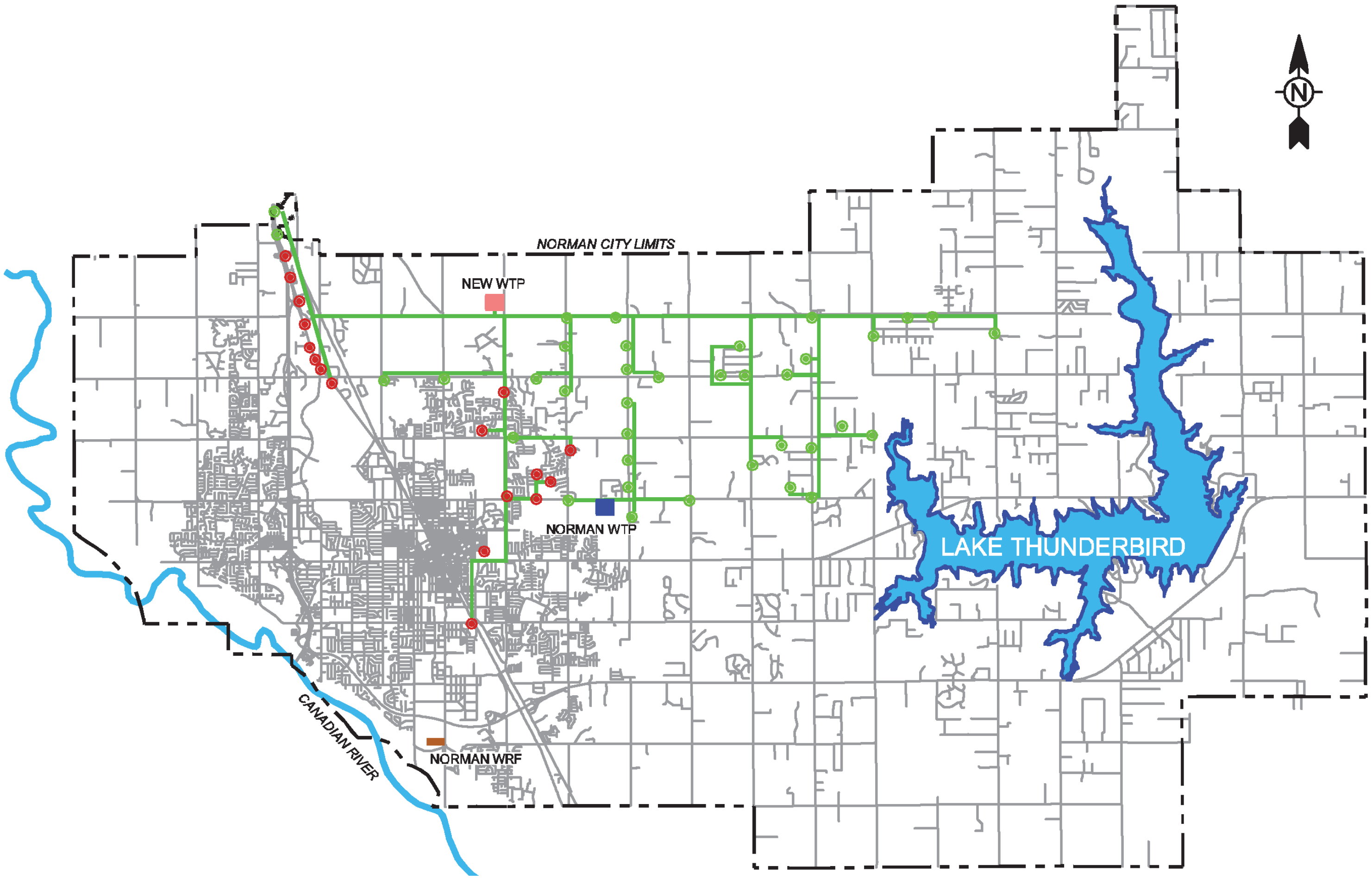
3.1.2.3 Opinion of Costs

Capital costs for continued use of the Garber-Wellington Aquifer include costs for a new raw water collection system to convey water from each well to a new centralized North WTP and for water from seven wells to be conveyed to the Vernon Campbell WTP site. Additionally, costs were developed for drilling new wells for scenarios that included expansion of wellfield production (again assuming treatment for arsenic and chromium-6 at the North WTP, with expanded treatment capacity as appropriate). Costs were based on assumptions listed in Section 2.6.

3.1.2.4 Summary of Individual Source

Table 3.4, Table 3.5, and Table 3.6 summarize information regarding the continued use of the Garber-Wellington Aquifer by category:

- Existing Garber-Wellington Aquifer wells with centralized treatment.
- Bringing currently inactive Garber-Wellington Aquifer wells online using centralized treatment.
- New Garber-Wellington Aquifer wells with centralized treatment.



Active Water Well
Inactive Water Well
New Raw Water Line
Norman Water Treatment Plant
Norman Water Reclamation Facility

CONCEPTUAL GARBER-WELLINGTON AQUIFER WELLS WITH CENTRALIZED TREATMENT

FIGURE 3.2

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

carollo — TETRA TECH

Table 3.4 Existing Water Supply Source – Active Wells with Arsenic and Chromium-6 treatment at Centralized WTP		
Existing Yield Available to Norman	AFY	6,721
	mgd	6.0
Proposed Firm Yield Available to Norman	AFY	6,721
	mgd	6.0
Percent of projected 2060 demands supplied by firm yield(1)	Percent	21
Raw Water Transmission Distance	Miles	34.2
Water Treatment Process(3)		Arsenic and chromium-6 removal followed by chlorination
Known Long-term Reliability Issues		Concerns about withdrawing water at unsustainable rate
Known Implementation Issues		Unknowns regarding future water quality trends and regulations on chromium-6 and other possible contaminants
Opinion of Capital Costs	2012 $	$68,300,000
Unit Capital Cost of Source(2)	$/AFY	$10,200

Notes:

(1) Proposed firm yield divided by Norman's projected 2060 demands (29.1 mgd).

(2) Unit capital cost is capital cost associated with source divided by proposed firm yield. Rehabilitation/replacement costs were not assessed in initial source screening.

(3) Seven southern wells will be blended with finished water from the Norman WTP. All other existing wells will receive treatment listed.

(4) Summed and converted values may vary slightly due to rounding.

Table 3.5 Existing Water Supply Source – Inactive Wells with Arsenic and Chromium-6 treatment at Centralized WTP		
Existing Yield Available to Norman	AFY	0
	mgd	0
Proposed Firm Yield Available to Norman	AFY	2,341
	mgd	2.1
Percent of projected 2060 demands supplied by firm yield(1)	Percent	7
Raw Water Transmission Distance(4)	Miles	6.5
Water Treatment Process		Arsenic and chromium-6 removal followed by chlorination
Known Long-term Reliability Issues		Concerns about withdrawing water at unsustainable rate
Known Implementation Issues		Unknowns regarding future water quality trends and regulations on chromium-6 and other possible contaminants
Opinion of Capital Costs	2012 $	$17,600,000
Unit Capital Cost of Source(2)	$/AFY	$7,500

Notes:

(1) Proposed firm yield divided by Norman's projected 2060 demands (29.1 mgd).

(2) Unit capital cost is capital cost associated with source divided by proposed firm yield. Rehabilitation/replacement costs were not assessed in initial source screening.

(3) Summed and converted values may vary slightly due to rounding.

(4) Assumes that the active well raw water collection system has been established and inactive wells will connect to this system.

Table 3.6 Existing Water Supply Source – One New Well with Arsenic and Chromium-6 treatment at Centralized WTP		
Existing Yield Available to Norman	AFY	0
	mgd	0
Proposed Firm Yield Available to Norman	AFY	187
	mgd	0.2
Percent of projected 2060 demands supplied by firm yield(1)	Percent	1
Raw Water Transmission Distance(4)	Miles	1
Water Treatment Process		Arsenic and chromium-6 removal followed by chlorination
Known Long-term Reliability Issues		Concerns about withdrawing water at unsustainable rate
Known Implementation Issues		Unknowns regarding future water quality trends and regulations on chromium-6 (and other possible contaminants)
Opinion of Capital Costs	2012 $	$2,600,000
Unit Capital Cost of Source(2)	$/AFY	$14,100

Notes:

(1) Proposed firm yield divided by Norman's projected 2060 demands (29.1 mgd).

(2) Unit capital cost is capital cost associated with source divided by proposed firm yield. Rehabilitation/replacement costs were not assessed in initial source screening.

(3) Summed and converted values may vary slightly due to rounding.

(4) Includes costs to drill and equip new wells. Assumes that the active well raw water collection system has been established and new wells will connect to this system.

3.1.3 Purchase Treated Water from Oklahoma City (Wholesale)

Since 2000, Norman has occasionally purchased treated (also referred to as "finished") water from Oklahoma City, primarily to meet peak day demands. This section describes the current use of wholesale water from Oklahoma City and long-term options for using this source.

3.1.3.1 <u>Description of Current Use</u>

Norman has a 12-inch turbine meter that can receive treated water from Oklahoma City via a 24-inch water main. This connection is located near the northwest boundary of the Norman City limits. The amount of water available through this connection varies based on the pressure differential between the Oklahoma City and Norman distribution systems, but is estimated to have a maximum capacity of 9.0 mgd and an average capacity of 6.0 mgd.

The amount of treated water NUA purchases from Oklahoma City varies from year to year. It is only used when Norman's local water sources cannot meet system demands, and is generally the last source NUA chooses to use since its cost is greater than what Norman's current rate structure would support on a continual basis. Typically, this has resulted in purchases of Oklahoma City water during the summer months to meet peak day demands. The amount of water purchased has fluctuated significantly from year to year, ranging from as little as 2.4 million gallons in calendar year 2004 to as many as 227 million gallons in calendar year 2006, with an average annual purchase of approximately 70 million gallons between 2000 and 2011. Using historical data between 2000 and 2012, the highest recorded single day water purchase was 7.35 million gallons.

Norman currently purchases treated water from Oklahoma City under Oklahoma City's designated Demand Service Plan. Under this plan, there is no minimum monthly usage that the customer is obligated to use (or pay for), but the per-gallon fees are the highest of the three wholesale plans offered by Oklahoma City. Currently, Oklahoma City has three different water service plans that municipal water users can select from: the Demand Service, Take-or-Pay, and Service Availability. Appendix F has more information on available Oklahoma City wholesale water service plans and associated fee structures. Oklahoma City is planning to revamp its wholesale rate structures, which will affect the cost to Norman for use of these supplies. The revised rate structures will be phased in over the next few years.

3.1.3.2 Impacts on Continued Use

If Norman continues to purchase treated water as a wholesale customer to Oklahoma City, it is important for Norman to consider how best to use this source. Currently, Norman is using treated Oklahoma City water intermittently under the Demand Service Plan, Oklahoma City's highest wholesale water rate. This plan is appropriate for Norman's current strategy of purchasing Oklahoma City water only when necessary and minimizing the overall annual cost of treated water purchases.

Long-term, however, Norman may choose to rely on this source to meet its water needs differently, relying on water from Oklahoma City to meet a year-round, or "base load" demand, instead of using it exclusively for peak day supplemental supply. Under the Service Availability Plan, Norman could purchase a more consistent amount of water (to support average day needs) taking advantage of lower rate structures. Under the Service Availability Plan, Norman's strategy for Oklahoma City water purchases must be one that includes a predetermined minimum amount of water to be purchased each month.

Regardless of which purchasing plan is selected, Oklahoma City wholesale rates are expected to increase more rapidly than overall rates of inflation. In Oklahoma City's latest water rate ordinance, Oklahoma City laid out rates for fiscal years 2010-2014, and in each year rates increased by approximately 4 percent (Oklahoma City, 2010). Beyond 2014, Oklahoma City has not set water rates. Its rates are expected to increase annually by 4 percent to 7 percent for at least the next 10 years to accommodate Oklahoma City's anticipated development of additional water supply sources and continued investment in infrastructure (OCWUT, 2012).

3.1.3.3 Opinion of Costs

Most of the costs associated with continued use of wholesale treated water from Oklahoma City will come from the monthly or annual costs paid to Oklahoma City for water access and use. Capital costs for this source are limited to increasing supply capacity by constructing a second connection point. A second connection would include a limited length of water pipeline, flow meters, control valves, and an underground vault for housing equipment. This second connection would offer the ability to receive more water than currently available and offer a degree of redundancy when one of the connections is offline.

3.1.3.4 Summary of Individual Source

Table 3.7 summarizes information on purchasing treated water from Oklahoma City as a wholesale customer.

Table 3.7 Existing Water Supply Source – Purchase Treated Water from Oklahoma City (Wholesale)

Existing Yield Available to Norman	AFY	6,726
	mgd	6.0
Proposed Firm Yield Available to Norman(1)	AFY	13,451
	mgd	12
Percent of projected 2060 demands supplied by firm yield(2)	Percent	41
Raw Water Transmission Distance(4)	Miles	6
Water Treatment Process		N/A
Known Long-term Reliability Issues		
Known Implementation Issues		There are known permitting issues regarding use of water from Southeast Oklahoma (one of several sources used by Oklahoma City) that are currently unresolved.
Opinion of Capital Costs	2012 $	$14,100,000
Unit Capital Cost of Source(3)	$/AFY	$1,000

Notes:
(1) Proposed firm yield of 12 mgd used for preliminary screening.
(2) Proposed firm yield divided by Norman's projected 2060 demands (29.1 mgd).
(3) Unit capital cost is capital cost associated with source divided by proposed firm yield. Rehabilitation/replacement costs were not assessed in initial source screening.
(4) Assumed distance to connect Norman's distribution system to Oklahoma City's distance. When an exact connection location is determined, this distance should be revisited.
(5) Summed and converted values may vary slightly due to rounding.

3.2 NEW LOCAL SOURCES

Several new local supplies were considered for future water supply for Norman. These options include indirect potable reuse (using highly treated water from Norman's WRF for Lake Thunderbird augmentation or groundwater recharge), non-potable reuse, stormwater capture and reuse, diversions from the Canadian River, and capturing Lake Thunderbird spillage. This section describes these potential new local water sources.

3.2.1 Additional Water Conservation

This section describes Norman's current conservation measures and potential additional water use reductions through new programs.

3.2.1.1 <u>Description of Current Efforts</u>

Norman adopted its current Water Conservation Plan in 2014. The plan provides information on Norman's water system, current permanent conservation programs, and temporary demand reducing methods (such as even/odd watering restrictions) that are used during drought conditions. Norman implements several permanent conservation programs, some of which affect all users (like rate structures) while others are targeted to specific user categories.

Norman established an inclining block rate structure with base rate for residential customers in 2006. Under an inclining block rate structure, each "block" of water use above base monthly usage costs more on a thousand-gallons-used basis than the previous block of usage. Non-residential customers have a flat usage rate with base fee. Unlike other communities in Oklahoma, any change in Norman's water rates requires a majority vote of the public.

The City employs a "lead by example" approach for water conservation. For example, the City utilizes drip irrigation on medians and in other applicable areas to minimize overspray. In 2005, Norman passed an ordinance that requires installation of a rain sensor and freeze gauge on all new automatic irrigation systems. This promotes water conservation by shutting off irrigation systems when irrigation needs are low or zero. Additionally, Norman city codes require low flow fixtures in new construction (via Norman's adoption of the 1997 International Plumbing Code for non-residential construction and 1995 Council of American Building Officials for residential construction).

Norman meters all of its customers (including water used at City facilities) and periodically tests and replaces meters. In a recent testing/replacement program, Norman recognized a revenue increase due to more accurate water use measurements. Through leak detection training of meter readers, customer service, and public utilities staff, non-revenue water has been reduced to about 8 to 9 percent of total production.

Norman implemented design standards requiring strategically located isolation valves, in addition to a valve exercising and replacement program. Both of these activities reduce water lost to leaks. Building upon historical leak tracking, Norman has stopped using ductile iron pipe (prone to leaks due to soil corrosion) and executes a hot soil and urban pipe replacement program to prevent future water leaks.

During construction of new water transmission lines, Norman encourages efficient water use by limiting contractors on how much free water they can use for flushing of new mains; if additional flushes are required, contractors are charged for water used. Norman provides and requires the use of hydrant meters by contractors, and imposes fines for non-use. Farmers and smaller contractors have access to a coin-operated system for water truck filling.

Collectively, these current conservation programs have helped reduce the per capita water use. While exact water savings are difficult to determine, evidence of the community's response to Norman's conservation program can be seen in recent years' demand data as detailed in Chapter 2. Importantly, continuation of the existing programs (with continued savings at current levels) is reflected in the demand projections described in Chapter 2.

3.2.1.2 Impacts of Expanded Conservation Programs

To determine effects of expanding or adding new conservation programs, information developed as part of the OCWP was reviewed. Two conservation scenarios were studied. OCWP Scenario I evaluated moderately expanded conservation and represents programs that are most likely to be implemented based on cost and ease of implementation (OWRB, 2011). Water savings are included from passive conservation (those that will happen because of current state and federal plumbing codes that Norman has adopted), additional metering, conservation pricing (or increasing tiered rate structure), improved leak detection to decrease non-revenue water, and expanded education programs to decrease demand by 3 percent (OWRB, 2011). OCWP Scenario II evaluated substantially expanded conservation. Scenario II includes all programs from Scenario I plus additional improvements to achieve 100 percent metering, improved leak detection to further decrease non-revenue water, additional education to reduce demands by 5 percent, and implementation of higher-efficiency plumbing codes (OWRB, 2011).

The OCWP estimated conservation savings by county. In counties like Cleveland County, where Norman has already implemented portions of Scenarios I and II programs, projected reductions in demand only considered the programs not already in place in the county. This approach tailored the projected savings to each county, avoiding over-estimation of projected savings associated with implementation of Scenarios I or II.

For the 2060 SWSP, it was assumed that Norman will expand existing programs and/or implement new programs to achieve water reductions of 1.0 mgd by 2060 (i.e., a level between OCWP Scenario I and Scenario II). Table 3.8 summarizes conservation savings for Norman using OCWP data and estimates used in the 2060 SWSP.

Table 3.8 Conservation Savings for Norman (Post 2010)			
Year	Estimated Water Savings for Scenario I (mgd)[1]	Estimated Water Savings for Scenario II (mgd)[1]	Estimated Water Savings for 2060 SWSP (mgd)
2020	0.70	1.6	0.15
2030	0.74	1.9	0.36
2040	0.77	2.3	0.57
2050	0.79	2.5	0.78
2060	0.81	2.6	1.0

Notes:

(1) Norman's savings based on 60 percent of the 2012 Update to the OCWP estimates for Cleveland County, based on NUA's service area as a percent of total Cleveland County population that is served by a public water supply system.

3.2.1.3 Opinion of Costs

Conservation programs are not free, and may or may not be the most cost-effective "supply" depending on local conditions. The 2060 SWSP considered costs associated with additional conservation programs to be annual costs, rather than one-time capital costs. Evidence from Norman's existing programs, Norman's 2014 Water Conservation Plan, and communities throughout the country suggest that costs are generally associated with costs that are incurred annually. Examples include staff salaries, rebates for low-flow fixtures or appliances, and other annual costs driven by the level of implementation by members of the community.

3.2.1.4 Summary of Individual Source

Passive conservation (through low-flow fixture retrofits driven by plumbing code) is already integrated into the 2060 demand projections for NUA's service area. Because active conservation measures are only as effective as the degree to which they are adopted by the community, it is difficult to guarantee a specific level of conservation. Experience in states adjoining Oklahoma suggests that communities with no active conservation program can, in many cases, reasonably achieve a 10 percent reduction in demand through active conservation programs. With Norman's existing programs and successes in conservation, at least some of this 10 percent reduction has already been achieved. Thus, a lower value is recommended for purposes of long-range planning, until such time as the Conservation Plan is again updated.

The 2060 SWSP assumes a demand reduction of 1 mgd (annual average; peak day savings of 1.5 mgd) by 2060 through expansion of the City's existing water conservation programs. This corresponds to a savings of about 3 percent of total demand by 2060. To the degree that additional active conservation measures are adopted more rapidly by the community, demand projections can be revised accordingly. This may in turn allow for supply expansion projects to be delayed or deferred.

3.2.2 Additional Non-Potable Reuse

Non-potable reuse (NPR) uses highly treated water from a WRF to replace water used for irrigation (with or without restrictions depending on level of treatment) or some non-potable industrial uses. In 2012, the Oklahoma Department of Environmental Quality (ODEQ) finalized formal regulations for NPR in Oklahoma, governing the treatment, water quality, and application and management requirements specific to numerous types of NPR. NPR is already in place in Norman, with treated effluent from Norman's WRF used to irrigate the University of Oklahoma's golf course and with additional non-potable use at the WRF site itself.

3.2.2.1 Description of Supply Source

To support an analysis of potential candidates for conversion from potable supply to NPR, NUA provided a list of its top 200 highest water users and monthly water use amounts. The ratio of summer water use to winter water use was calculated for each of these users. Customers with high ratios were initially identified as potential candidates for non-potable irrigation reuse, and validated to confirm their likelihood of significant outdoor water use. Next, a list of potential industrial customers (those that could use non-potable water for cooling or other processes) was developed. These irrigation and industrial potential customer lists were combined with known future developments to create a comprehensive potential customer list showing location, along with average and peak day expected non-potable water use.

Potential customers located near the WRF were identified as conceptual candidates for a first-phase NPR expansion project. Sites closer to the WRF – the source of the water supply – can be served by reuse systems with less piping and pumping infrastructure and associated capital and operating costs.

The project proposes to serve approximately 21 customers using three main distribution pipelines. Phase I of the expanded NPR system, illustrated in Figure 3.3, would have an average day demand of 0.8 mgd and peak day demand 4.6 mgd. However, the piping associated with Phase I was sized for future flows (based on estimates of potential Phase II customers' needs that are located farther away from the WRF). Upgrades to the existing WRF would be needed, only for the portion of WRF that would be distributed to NPR customers on a peak day, in accordance with ODEQ regulations. Approximately 6.5 million gallons of system storage is proposed to reduce the WRF reuse treatment process capacity needed to approximately 2.7 mgd.

3.2.2.2 Challenges Associated with Non-Potable Reuse

NPR is gaining acceptance in the public and is increasingly an important component of how communities in Oklahoma efficiently meet their water demands. Because Norman already has an NPR program in place, many of the challenges have already been addressed. However, by implementing this supply option, the amount of flow discharged from the Norman WRF to the Canadian River would be reduced. The minimum amount of flow, if any, that would need to be discharged to the Canadian River may be subject to analyses by, and negotiation with, OWRB. In addition, future instream flow programs adopted and implemented in Oklahoma, if any, could affect the amount that would need to be discharged and thus affect the amount available for NPR. Overall, the amount of water that would be reused under this supply option is a small portion of the total effluent generated at the WRF, suggesting that this may not be a significant challenge for this supply option.

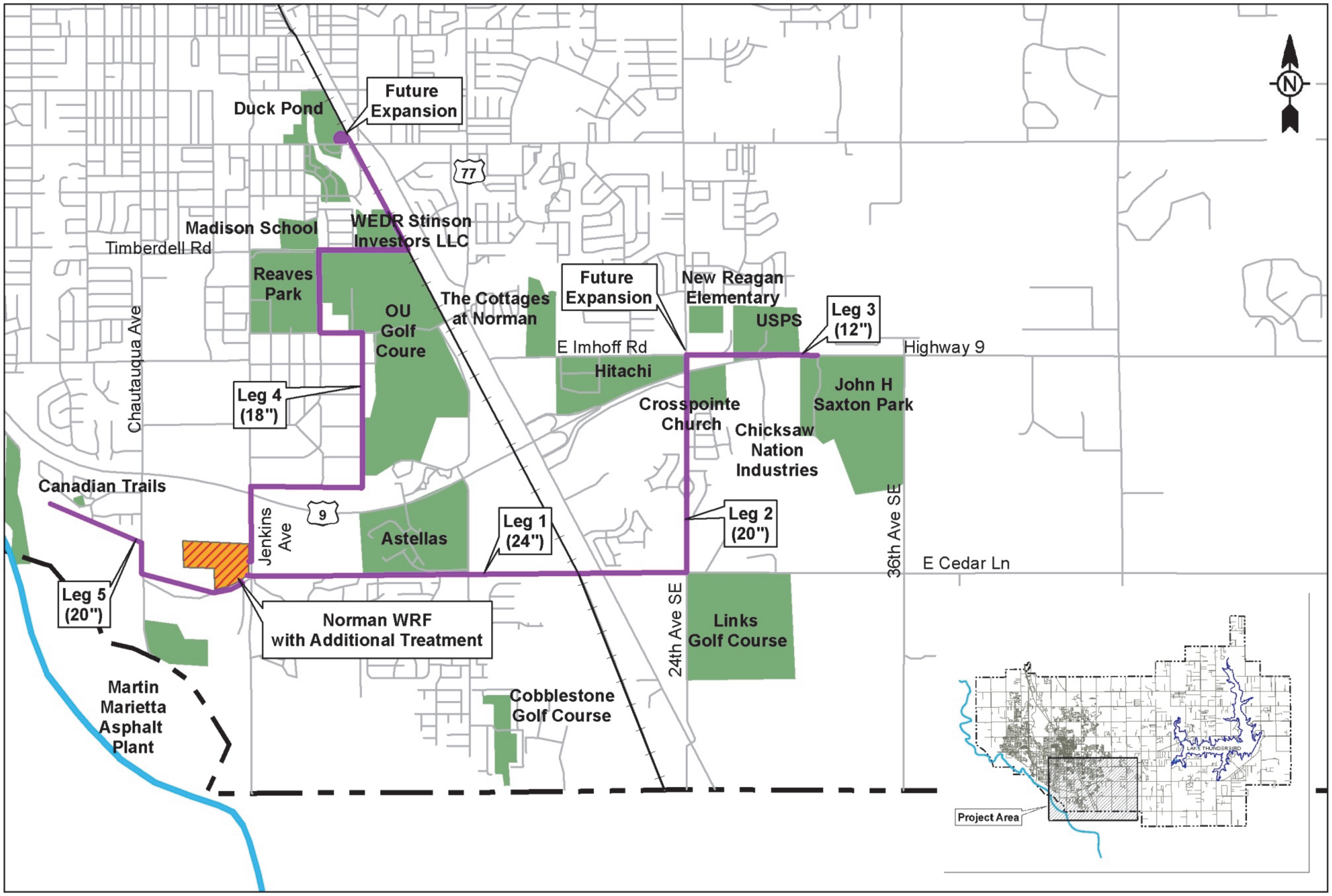
However, the availability of reclaimed water from the WRF is fairly certain. Even with continued/increased conservation, there will always be a relatively constant daily flow of wastewater treated at the Norman WRF. Evaluations of this source assumed that Phase I NPR expansion would occur in the southern and central portions of Norman delivered via conveyance infrastructure from the existing WRF on Norman's south side. However, if a North WRF were constructed, it would become more cost-effective to serve candidate NPR sites in the northern portion of the city as part of a Phase II expansion.

3.2.2.3 Opinion of Capital Cost

Capital costs associated with the upgrades and expansions at the WRF are associated with WRF process upgrades, based on improvements described in the Engineering Report Phase II Wastewater Treatment Plant Improvements (Norman, 2011). This report proposed using liquid sodium hypochlorite and filtration to meet ODEQ Category 2 reuse requirements. ODEQ's Category 2 allows essentially unrestricted use for turf irrigation. Costs were taken from this report and escalated to 2012 dollars then adjusted to reflect different treatment process sizing as described in Chapter 2. Approximately 6.5 million gallons of storage is incorporated in the system, which allows the treatment process train for the NPR portion of plant flows to be sized for 2.8 mgd instead of matching the peak NPR demand of 4.6 mgd. Additionally, pumping and new distribution piping are required for distributing water into the NPR system. Costs for those facilities were estimated for the Phase I NPR system expansion as part of the 2060 SWSP.

3.2.2.4 Summary of Supply Option

Table 3.9 summarizes information on expanded NPR using reclaimed water from the Norman WRF.



New DNPR Pipeline

Storage Tank

CONCEPTUAL PHASE I NON-POTABLE WATER REUSE

FIGURE 3.3

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

carollo — TETRA TECH

Table 3.9 New Local Water Supply Source – Non-potable Reuse		
Existing Demand Reduction Available to Norman	AFY	N/A
	mgd	N/A
Proposed Demand Reduction Available to Norman[1]	AFY	850
	mgd	0.8
Percent reduction in projected 2060 demands[2]	Percent	5
NPR Transmission Distance	Miles	8
Water Treatment Process[4]		Advanced wastewater treatment to meet ODEQ Category 2 reuse
Known Long-term Reliability Issues		WRF effluent is highly reliable
Known Implementation Issues		ODEQ rules are in place for non-potable reuse. Significant ability to control implementation locally. Potential requirements for continued discharges from WRF to Canadian River.
Opinion of Capital Costs	2012 $	$37,000,000
Unit Capital Cost of Source[3]	$/AFY	$22,000

Notes:

(1) Sized based on potential customers for Phase I NPR expansion project (0.8 mgd annual average) plus excess pipeline capacity for future customers (total 1.5 mgd annual average). Phase I peak day demand reduction is estimated at 4.6 mgd.

(2) Proposed demand reduction divided by Norman's projected 2060 demands (29.1 mgd).

(3) Unit capital cost is capital cost associated with source divided by proposed firm yield. Rehabilitation/replacement costs were not assessed in initial source screening.

(4) WRF upgrades assumed are described in the Engineering Report Phase II Wastewater Treatment Plant Improvements (Norman, 2011).

(5) Summed and converted values may vary slightly due to rounding.

3.2.3 Lake Thunderbird Augmentation (IPR)

This source evaluates augmenting, or supplementing, water supplies in Lake Thunderbird with highly treated water from Norman's WRF, with a primary goal of increasing the reliable yield from the lake. This is one type of indirect potable reuse (IPR), defined as potable reuse because it is used to augment potable water supply sources that are treated to drinking water standards, and designated as indirect reuse because it includes discharge to a water body where dilution and natural attenuation of certain parameters can occur before it is diverted from that water body for further treatment to potable standards.

In contrast, direct potable reuse would involve directly piping treated water from a WRF, with advanced treatment directly to the water treatment plant then into the potable distribution piping network. Direct potable reuse is not widely practiced in the U.S., but is being intensively researched with regard to treatment requirements, water quality requirements, process reliability, and public acceptability.

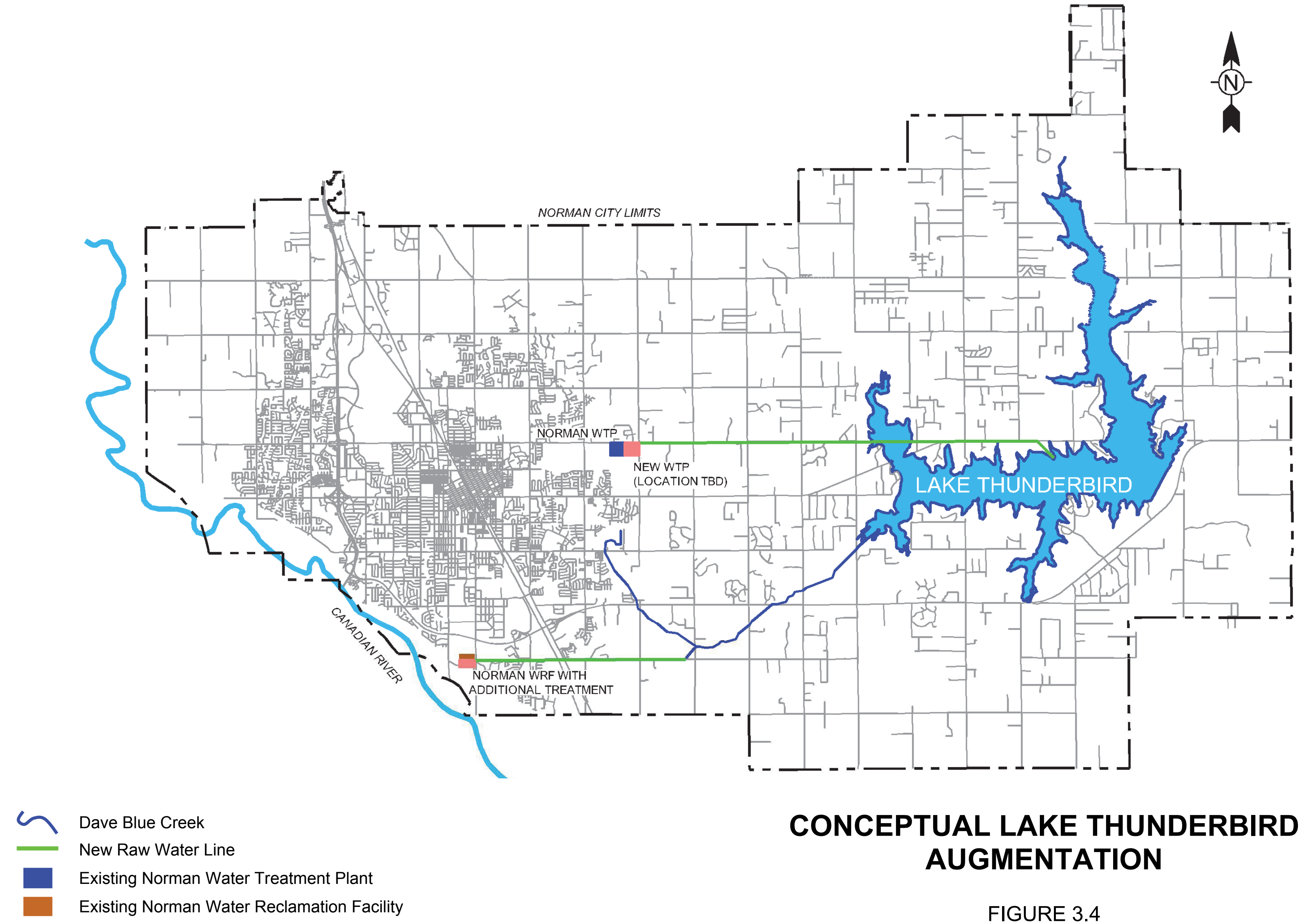
3.2.3.1 Description of Supply Source

The 2060 SWSP evaluation of Lake Thunderbird augmentation was based on a recent COMCD study that evaluated augmenting Lake Thunderbird using 15 mgd of reclaimed water from the City of Moore and/or Norman (COMCD, 2012). The COMCD study recommended augmenting Lake Thunderbird with 15 mgd of treated water from WRFs ((5 mgd from the Moore Wastewater Treatment Plant (WWTP) and 10 mgd from the Norman WRF)), phased in 5-mgd increments over the course of approximately 20 years. The COMCD study estimated that this augmentation would provide an additional yield of 15 mgd from Lake Thunderbird. The COMCD study did not estimate losses due to seepage and evaporation in Dave Blue Creek, which may lower the firm yield of this source for Norman slightly.

For the 2060 SWSP, analyses were based on augmenting Lake Thunderbird using only reclaimed water from the Norman WRF, as illustrated in Figure 3.4. Consistent with the COMCD study, it was assumed that the amount of water delivered to Lake Thunderbird would be available for raw water use (meaning seepage and evaporation losses were assumed to be negligible). It was assumed that augmentation with treated water from the WRF would be carefully managed to maximize the net additional yield from Lake Thunderbird.

Norman is projected to have wastewater flows totaling nearly 21 mgd by 2060 (Norman, 2011), with approximately 17 mgd in the southern collection basin (i.e., tributary to Norman's existing WRF). For preliminary screening of supply sources, it was assumed that 15 mgd would be available to augment and then be recovered from Lake Thunderbird. However, for portfolio development (Chapter 4), other augmentation quantities may be used. More advanced treatment would be required at the Norman WRF to produce high quality water necessary for augmentation, particularly given the state's designation of Lake Thunderbird as a SWS.

The COMCD study assumed WRF improvements including the conversion of the primary clarifiers to anaerobic zones, the construction of a new anoxic basin, the addition of new recycle pumps and piping for mixed liquor suspended solids (MLSS) between reactors, the addition of a centrifuge for waste activated sludge (WAS) thickening, the addition of diamond cloth filtration, the addition of a new chemical system, and other miscellaneous piping and pumps (COMCD, 2012). Endocrine disrupting compounds (EDCs) include a variety of compounds commonly present in municipal wastewater, and/or those that may pose a potential human health concern depending on their concentration levels and based on current toxicological understanding. While EDCs are not currently regulated at the state or federal level, the 2060 SWSP assumed additional treatment using biofiltration and ozone for the portion of WRF flow that would be reclaimed and sent to Lake Thunderbird. These assumptions were made to address concerns about the impacts of EDCs in reclaimed water used for potable supply augmentation, and to provide a conservatively high estimate of capital and operating costs for the Lake Thunderbird augmentation project.



CONCEPTUAL LAKE THUNDERBIRD AUGMENTATION

FIGURE 3.4

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

carollo — TETRA TECH

Treated water would be pumped approximately 4 miles from the Norman WRF to Dave Blue Creek, which feeds Lake Thunderbird by gravity (COMCD, 2012). Lake Thunderbird would serve as a terminal storage reservoir for the augmented supply. From Lake Thunderbird, water would be withdrawn using a new intake, then pumped through a new 42-inch, 15-mile long raw water pipeline parallel to the existing pipeline from Lake Thunderbird to an new WTP that uses conventional treatment with softening. To meet 2060 demands, the new WTP peak capacity would be sized at 28.5 mgd.

3.2.3.2 Challenges Associated with Lake Thunderbird Augmentation

There are several specific challenges associated with augmenting Lake Thunderbird.

- There are currently no state or federal regulations governing IPR, but ODEQ has been tasked by the legislature with developing rules for IPR.
- Lake Thunderbird is listed as a SWS, meaning that no discharges will be allowed that increase the load of any pollutant. ODEQ has not established protocol for evaluating or demonstrating compliance with this requirement, as further discussed in the COMCD Lake Thunderbird Augmentation study (COMCD, 2012). NUA staff has initiated discussions with ODEQ, OWRB, members of the legislature, and other regional partners in further defining how discharges could be implemented at Lake Thunderbird and other designated SWS water bodies.
- COMCD, who has responsibility for operating and maintaining facilities at Lake Thunderbird, is actively pursuing augmenting Lake Thunderbird (immediately using raw water purchased from Oklahoma City and long-term through IPR). An intergovernmental agreement with COMCD and the other two member cities would be necessary to use Lake Thunderbird as storage for reclaimed water. Among other things, it is anticipated that such an agreement would establish the terms of the supply augmentation (quantity and quality), the increased allocation of reservoir yield to Norman, and the methodology for allocating costs of maintaining and operating the reservoir in light of Norman's increased use of the lake.
- Seepage and evaporation are concerns with discharging treated water from the WRF into Dave Blue Creek to transport it to Lake Thunderbird. Lake evaporation is a function of the surface area of the water stored in the lake at any given time, which may not be significantly increased with the proposed augmentation of supplies. The COMCD study did not account for these losses, and thus the additional yield will likely be some amount less than flow sent to the reservoir.
- By implementing this supply option, the amount of flow discharged from the Norman WRF to the Canadian River would be reduced. While there is some reuse in place in Oklahoma, there is no precedent in the state for redirecting a major proportion of existing WRF discharges for beneficial reuse. The minimum amount of flow, if any, that would need to be discharged to the Canadian River would be subject to analyses by, and negotiation with, OWRB. In addition, future instream flow programs adopted and implemented in Oklahoma, if any, could affect the amount that would need to be discharged and thus affect the amount available for Lake Thunderbird augmentation.

- Public outreach will be critical for gaining acceptance of IPR, particularly given the lack of IPR precedent in Oklahoma. Extensive research at the national level and experience in other states where IPR is increasingly common can be used as a guide for establishing treatment protocol, treated water quality standards, and securing public support.

These challenges collectively may affect the timing and amount of source development. However, if and when the source is developed, the availability of reclaimed water from the WRF is fairly certain. Even with continued/increased conservation, there will always be a relatively constant daily flow of wastewater treated at the Norman WRF. Evaluations of this source assumed that all augmentation of Lake Thunderbird would occur via pumped discharges from the existing WRF. However, if a North WRF is constructed in the future, discharges into the lake by gravity would be possible, reducing capital and operating costs slightly.

3.2.3.3 Opinion of Capital Cost

Capital costs would be associated with the upgrades at the WRF, a new WTP, and the transmission infrastructure to get water to and from Lake Thunderbird. Depending on the final contractual requirements, Norman's reservoir use and maintenance costs may increase for using additional storage in Lake Thunderbird, but these costs are unknown at this time and were not included in the 2060 SWSP.

3.2.3.4 Summary of Supply Option

Table 3.10 summarizes information on augmenting Lake Thunderbird with reclaimed water from the Norman WRF.

Table 3.10 New Local Water Supply Source – Lake Thunderbird Augmentation

Existing Yield Available to Norman	AFY	N/A
	mgd	N/A
Proposed Firm Yield Available to Norman[(1)]	AFY	16,809
	mgd	15
Percent of projected 2060 demands supplied by firm yield[(2)]	Percent	52
Raw Water Transmission Distance	Miles	11
Water Treatment Process[(4)]		WRF upgrades (biofiltration and ozone for lake augmentation flow) and WTP expansion (conventional with softening)

Table 3.10 New Local Water Supply Source – Lake Thunderbird Augmentation		
Known Long-term Reliability Issues		WRF effluent is highly reliable. Potential requirements for continued discharges from WRF to Canadian River could limit source availability.
Known Implementation Issues		Lack of IPR rules in Oklahoma, and designation of Lake Thunderbird as a SWS brings uncertainty in discharge water quality requirements. An agreement with COMCD and other member cities for discharges and additional storage and diversions may be necessary. Costs for increased use of the lake's capacity have not been established. Public outreach will be necessary to secure public acceptance.
Opinion of Capital Costs	2012 $	$138,000,000
Unit Capital Cost of Source(3)	$/AFY	$8,200

Notes:

(1) Proposed firm yield of 15 mgd used for preliminary screening, consistent with COMCD 2012 study. Higher or lower flow rates could be achieved, and source availability will grow over time as population increases result in additional flows at Norman's WRF.

(2) Proposed firm yield divided by Norman's projected 2060 demands (29.1 mgd).

(3) Unit capital cost is capital cost associated with source divided by proposed firm yield. Rehabilitation/replacement costs were not assessed in initial source screening.

(4) WRF upgrades assumed are described in the COMCD reuse study (COMCD, 2012).

(5) Summed and converted values may vary slightly due to rounding.

3.2.4 Stormwater Capture and Reuse

Stormwater capture and reuse would capture and divert urban stormwater runoff to beneficial reuse, instead of historical practices of conveying the stormwater flow to receiving water bodies such as streams, lakes, and rivers.

3.2.4.1 <u>Description of Supply Source</u>

For the 2060 SWSP, stormwater reuse was analyzed by assessing a system where it would be captured and conveyed through a network of pipes to a new terminal storage reservoir. With treatment, it could be used as a water supply source. Four drainage basins that currently discharge stormwater to the Canadian River were identified as potential sources for new raw water supply, as shown in Appendix I. These basins are relatively close to the Norman WTP, and existing stormwater collection infrastructure transports runoff to a central location. The 2060 SWSP project would collect water at these centralized locations and transport it for treatment as illustrated in Figure 3.5. Runoff in basins naturally tributary to Lake Thunderbird were not considered for capture and reuse, as that would reduce the available supply from the lake.

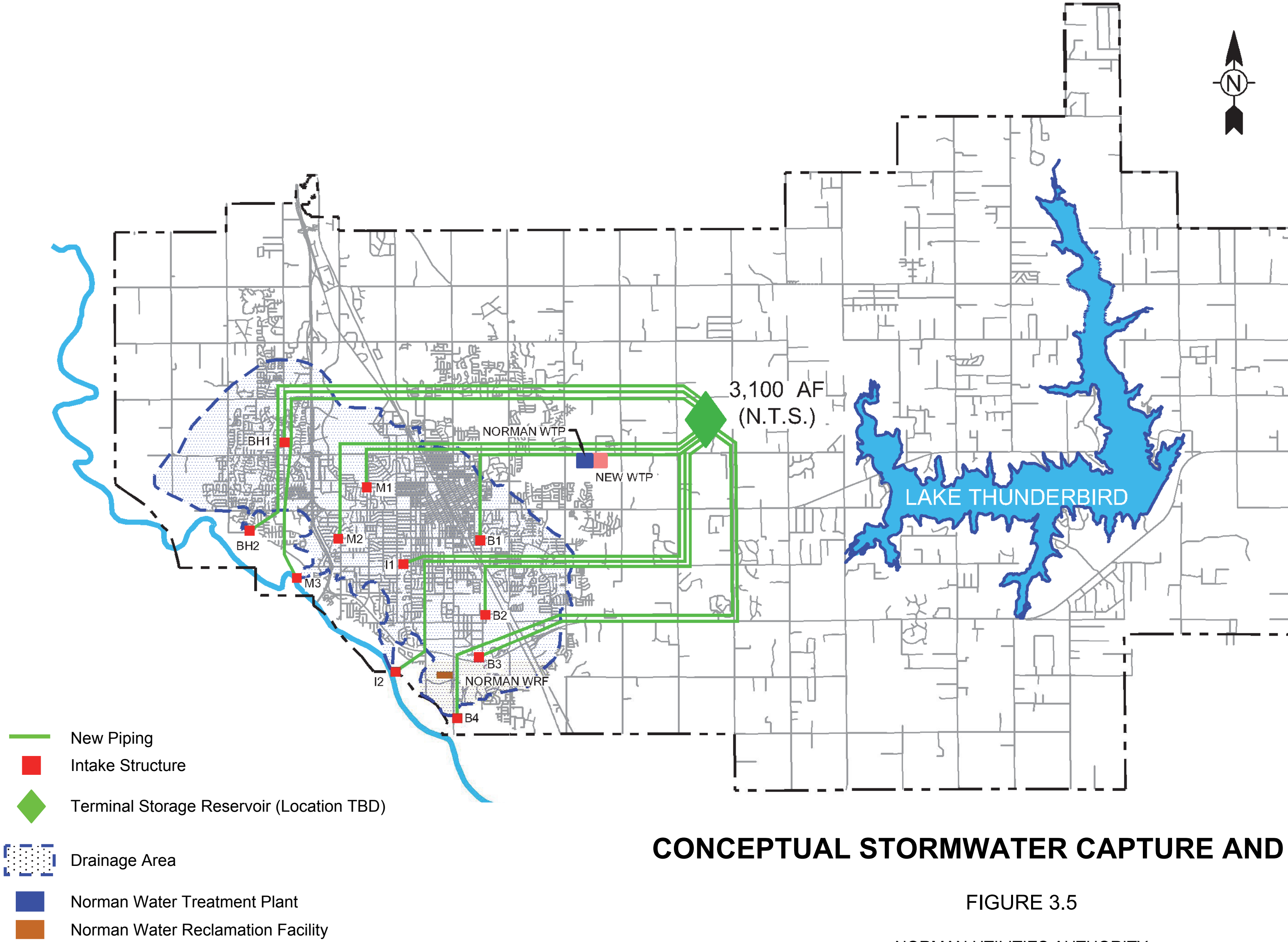
Collection and transmission infrastructure sizing was based on the annual stormwater runoff available in each basin and a maximum hourly diversion based on a precipitation rate of 1.5 inch per hour. Precipitation rates above this would not be captured by the system for beneficial reuse. As rainfall frequently comes in large quantities over a short period of time, collection and conveyance infrastructure is quite large, with pipeline diameters ranging from 108 inches to 132 inches in diameter and an average intake structure size of 300 mgd. Because stormwater is an intermittent water source, terminal storage is required to make this supply option reliable. Without storage, this source would only be available for short periods of time at very high flow rates, and alternate sources would be needed to supplement times between storm events.

It was important to find a balance between available supply and infrastructure costs, considering the infrastructure needed to capture, convey, and store the available runoff. Firm yield was determined by optimizing the unit costs for this supply without allowing the stormwater yield to drop below 20 percent of Norman’s projected 2060 water demand. This resulted in a firm yield of 5.8 mgd and a terminal storage reservoir with 3,100 AF of storage, based on stormwater diversions of 1,800 AF per month. More information on this source is available in Appendix I. Terminal storage siting was not analyzed as part of the SWSP, but conveyance infrastructure costing analyses assumed that it would be located within Norman city limits.

It is difficult to anticipate exact water treatment requirements for stormwater collection because the stormwater can collect a variety of contaminants through overland flow, particularly in urban environments. For the 2060 SWSP, it was estimated that the treatment requirements for this water supply option would be a blend of conventional treatment and reverse osmosis treatment to meet potable standards. Non-potable use of this supply was not evaluated, in light of water quality variability that cannot be controlled or predicted and a lack of significant non-potable demand in winter months, which would in turn under-utilize the available resource.

3.2.4.2 Challenges Associated with Stormwater Capture and Reuse

Similar to both IPR and NPR, this supply source would reduce the amount of water that flows to the Canadian River. An assessment of potential impacts on downstream water users’ supplies, in direct consultation with OWRB, would be required prior to implementing this option. Any future instream flow program requirements, if adopted in Oklahoma, could also affect the implementation of this supply option.



CONCEPTUAL STORMWATER CAPTURE AND REUSE

FIGURE 3.5

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

3.2.4.3 Opinion of Capital Cost

Capital costs were calculated, using assumptions described in Chapter 2, for transmission piping, pumping, terminal storage, and treatment associated with the capture, transport, and treatment of stormwater.

3.2.4.4 Summary of Supply Option

Table 3.11 summarizes information on the Stormwater Capture and Reuse option.

Table 3.11 New Local Water Supply Source – Stormwater Capture and Reuse

Existing Yield Available to Norman	AFY	N/A
	mgd	N/A
Proposed Firm Yield Available to Norman(1)	AFY	6,500
	mgd	5.8
Percent of proposed firm yield in projected 2060 demands(2)	Percent	20
Raw Water Transmission Distance	Miles	96
Water Treatment Process		Blend of conventional and reverse osmosis (at new WTP)
Known Long-term Reliability Issues		Reliability is function of terminal storage and variability in local precipitation
Known Implementation Issues		Requires significant study of feasibility. Significant land needed in developed areas for transmission and terminal storage.
Opinion of Capital Costs	2012 $	$1,220,000,000
Unit Capital Cost of Source(3)	$/AFY	$190,000

Notes:
(1) Size constrained based on size and cost of infrastructure required. Additional yield is possible with increased sizing of infrastructure.
(2) Proposed firm yield divided by Norman's projected 2060 demands (29.1 mgd).
(3) Unit capital cost is capital cost associated with source divided by proposed firm yield. Rehabilitation/replacement costs were not assessed in initial source screening.
(4) Summed and converted values may vary slightly due to rounding.

3.2.5 Canadian River Diversion

The Canadian River runs along the southwest border of Norman, and a significant portion of this water remains unpermitted and available for use as a water supply source.

3.2.5.1 Description of Supply Source

Developing the Canadian River as a source of water supply for Norman would require obtaining permits from the OWRB; construction of a diversion and intake system; permitting, land acquisition, and construction of a new terminal storage reservoir; construction of a new WTP or an expansion of the existing Vernon Campbell WTP; and construction of conveyance infrastructure from the intake system to the terminal storage reservoir and from the terminal storage reservoir to the WTP.

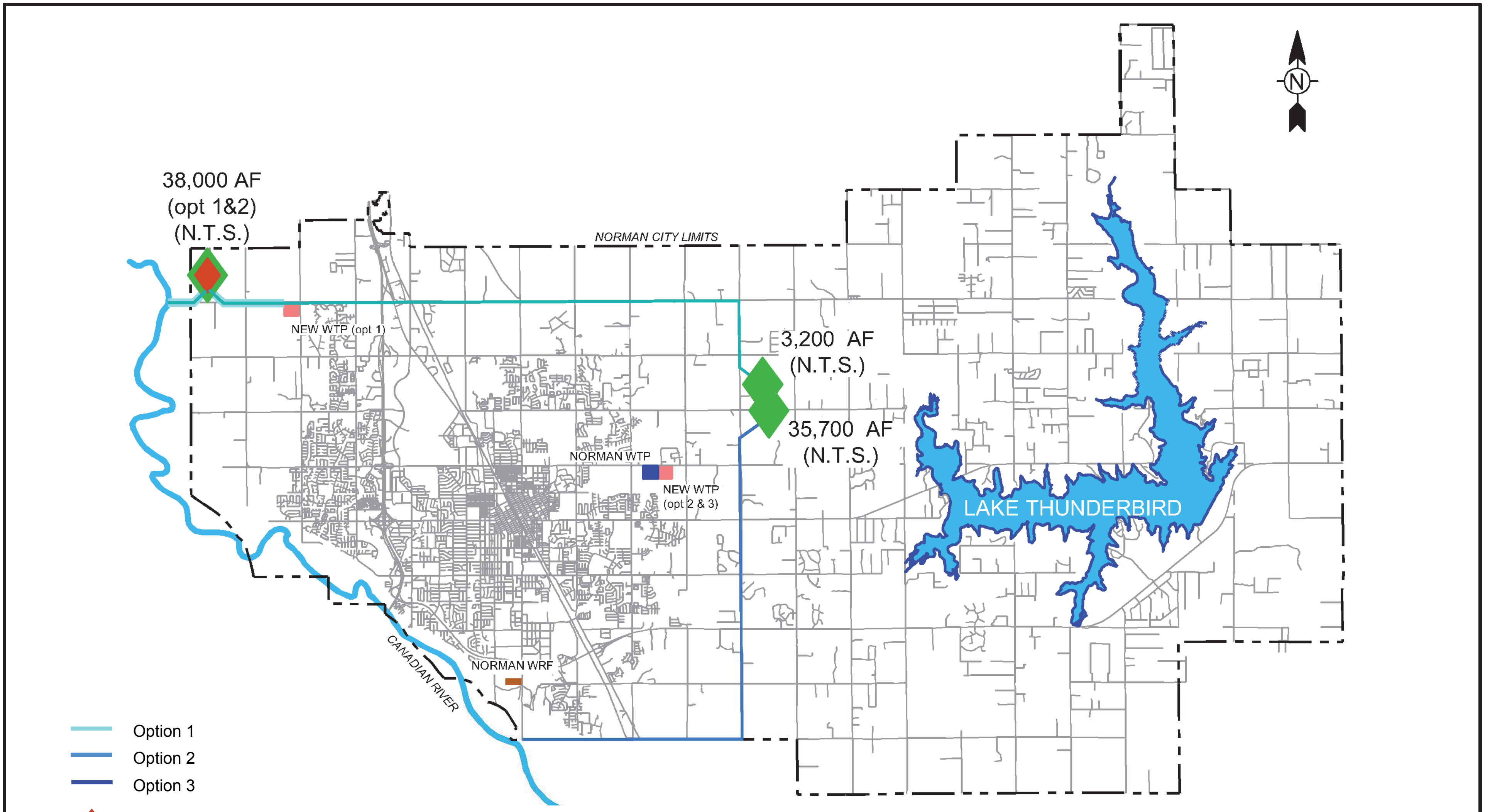
Diversion infrastructure and terminal storage sizing was based on monthly mean flow rates from the Canadian River at Bridgeport USGS Streamflow Gage ID# 07228500, 1970-2011 (USGS, 2011). Water supply diversions were assumed to be taken only when the flow rate in the Canadian River exceeded 100 cubic feet per second (CFS, equal to 155 mgd). Similar to Stormwater Capture and Reuse, a balance between size and cost of infrastructure and firm yield must be reached.

As with the stormwater capture supply option, the variability of flows in the river results in a need for terminal storage of diverted supplies in order to make the source consistently available to NUA's customers. Again, terminal storage siting was not analyzed as part of the SWSP, but conveyance infrastructure costing analyses assumed that it would be located within Norman city limits.

Three Canadian River diversion options initially were evaluated and are shown in Figure 3.6:

- Option 1 involves a 6.0-mgd diversion (maximum diversion of 2,000 acre-feet per month or AFM) from the Canadian River, a 38,000 AF terminal storage near the diversion point, and a new WTP all located on the northwest side of Norman.
- Option 2 involves a 6.0-mgd diversion (maximum diversion of 2,000 AFM) from the Canadian River and an intermediate 34,800 AF storage reservoir on the northwest side of Norman and a 3,200 AF terminal storage reservoir and expansion of the existing Norman WTP (both on east side of the city).
- Option 3 has a 6.0-mgd diversion (maximum diversion of 1,830 AFM) from the Canadian River on the southeast side of Norman and a 35,700 AF terminal storage reservoir and expansion of the existing Norman WTP. Because this diversion point is downstream of the discharge from the Norman WRF (which is very reliable), this option allows for the same firm yield with slightly smaller infrastructure.

Of the three options considered for Canadian River diversions, Option 1 has the shortest raw water transmission distance and allows the treated water to enter the distribution system at a strategic location on the northwest side. This point of entry into the distribution system would help meet demand and pressure requirements in northwest Norman.



CANADIAN RIVER DIVERSION OPTIONS

FIGURE 3.6

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

carollo — TETRA TECH

Option 3 was determined to be less feasible and cost-effective than IPR via augmentation of Lake Thunderbird with WRF effluent, and was thus not considered further. Issues affecting its feasibility, relative to Lake Thunderbird augmentation, include: the need for significant diversion infrastructure from the river; the salinity of both the WRF effluent and Canadian River supplies which when blended would likely require advanced treatment (e.g., reverse osmosis) for potable use, which would not be needed with augmented Lake Thunderbird supplies; and the need for terminal storage to buffer supply availability against seasonal demands, which is already constructed and available for the Lake Thunderbird augmentation IPR option.

Option 1 was selected as the basis of evaluation for this supply source. More information on all three Canadian River diversion options is available in Appendix J. The anticipated treatment required for the Canadian River diversions is a blend of conventional water treatment plus reverse osmosis to reduce the high concentrations of total dissolved solids in the river to below the EPA's secondary MCL of 500 mg/L.

The feasibility of using a series of low-head dams near Norman on the Canadian River as a water supply source was also considered. An evaluation of river flows and storage yields indicated that use of low-head dams would provide very limited firm yield (less than 0.5 mgd) and would require a large terminal storage reservoir to improve the firm yield. Achieving a similar yield with this option would be more expensive than other Canadian River sources and it was therefore not considered further.

3.2.5.2 <u>Challenges Associated with Canadian River Diversion</u>

A water rights permit must be obtained through the OWRB to withdraw water from the Canadian River. The OCWP Central Watershed Planning Region Report (OWRB, 2012) indicates that this reach of the Canadian River, in OCWP Basin 58, does have availability for additional permits. Additional challenges include water quality and supply variability issues, as described earlier in this section.

3.2.5.3 <u>Opinion of Capital Cost</u>

Capital costs were calculated, using assumptions described in Chapter 2, for transmission piping, pumping, terminal storage, and treatment associated with the diversion, transport, storage, and treatment of Canadian River water.

3.2.5.4 <u>Summary of Supply Option</u>

Table 3.12 summarizes information on the Canadian River Diversion option.

Table 3.12 New Local Water Supply Source – Canadian River Diversion (Option 1)		
Existing Yield Available to Norman	AFY	N/A
	mgd	N/A
Proposed Firm Yield Available to Norman[1]	AFY	6,700
	mgd	6.0
Percent of proposed firm yield in projected 2060 demands[2]	Percent	21
Raw Water Transmission Distance	Miles	1
Water Treatment Process		Blend of conventional and reverse osmosis (at new WTP)
Known Long-term Reliability Issues		OCWP Basin 58 (where diversion would be located) is shown to have some shortages in OCWP 2060 projections. Reliability for proposed project is a function of terminal storage and precipitation patterns.
Known Implementation Issues		Requires significant study of feasibility. Significant land needed for terminal storage.
Opinion of Capital Costs	2012 $	$264,000,000
Unit Capital Cost of Source[3]	$/AFY	$39,000

Notes:

(1) Yield constrained based on size and cost of infrastructure required. Slight increase in yield is possible if diversion is located downstream of Norman WRF.

(2) Proposed firm yield divided by Norman's projected 2060 demands (29.1 mgd).

(3) Unit capital cost is capital cost associated with source divided by proposed firm yield. Rehabilitation/replacement costs were not assessed in initial source screening.

(4) Summed and converted values may vary slightly due to rounding.

3.2.6 Lake Thunderbird Spillage

Lake Thunderbird's primary purpose is for municipal and industrial water supply with secondary uses for flood control, recreation and fish and wildlife propagation. Under the flood control intended use, water must be released from Lake Thunderbird in order to maintain the designated flood pool elevations. The Lake Thunderbird Spillage water supply option considers collecting this water for use.

3.2.6.1 Description of Supply Source

Historical records of monthly releases from Lake Thunderbird were reviewed to determine how much water could potentially be captured. The quantity of water released from Lake

Thunderbird is inconsistent and can be infrequent. Historical data show that it is common for there to be no releases from Lake Thunderbird for consecutive years (as seen in water years of 2011 and 2012). However, when water is released, it is released in large quantities over a short period of time. Due to the infrequent nature of this supply source, terminal storage is required in order to develop a firm yield that can be relied upon.

Similar to the Stormwater Capture and Canadian River Diversion options, a balance between size and cost of infrastructure and firm yield was sought. For purposes of preliminary screening, the firm yield was set to a minimum of 5.8 mgd, equal to 20 percent of Norman's projected 2060 demands.

Historically, the U.S. Army Corps of Engineers (USACE) calls for releases from the lake in order to evacuate the flood pool as quickly as practical. Permitting of the flood pool is uncertain (OWRB and federal agencies in Oklahoma have not previously issued permits for withdrawal of flood pool supplies). Should it be permitted, it is likely that the withdrawal of water from the flood pool would need to occur at the same high rate that water would typically be released (i.e., the flood pool cannot be used to store water). Releases from the flood pool downstream could be conducted in conjunction with diversions directly from the flood pool for water supply, provided the combined total met USACE's goals for timely evacuation of the flood pool storage volume.

Two options for capturing spillage initially were evaluated:

- Option 1 involves collecting water from the flood pool in Lake Thunderbird before it is released.
- Option 2 would collect water just downstream of Lake Thunderbird (after it has been released from the flood pool).

Both options require permits from OWRB for surface water diversions, and both would require substantial infrastructure to collect the large volumes of water quickly. Option 1 would require less conveyance infrastructure and was thus selected for analysis. The Capture Lake Thunderbird Spillage project is illustrated in Figure 3.7.

Sizing of infrastructure (intake, pumping, transmission pipelines), was based on an average monthly releases occurring over half the days in a month, resulting in spillage capture infrastructure sized to handle a peak flow of approximately 100 mgd. A terminal storage reservoir of 75,000 AF would be required to meet the desired yield. The large amount of terminal storage is driven by the highly infrequent and variable availability of water in the flood pool. With consecutive years of no spillage supply availability, terminal storage would need to hold enough water to supply an annual and peak-season demand reliably. To provide a sense of the magnitude of the required terminal storage reservoir, Lake Thunderbird has normal pool storage of just over 100,000 AF. The existing Norman WTP (conventional with softening) would be expanded by approximately 11 mgd to treat the water captured.

3.2.6.2 Challenges Associated with Lake Thunderbird Spillage

Regulatory impacts are fairly minimal for this water supply. Approval would be required through the OWRB and the Bureau of Reclamation, both of whom appear open to the concept (OWRB, 2012). Their primary concern would be any downstream water users that may be impacted by less water in the river as a result of this water supply option.

3.2.6.3 Opinion of Capital Cost

Capital costs were calculated, using assumptions described in Chapter 2, for collection, conveyance, terminal storage, and treatment associated with using water from the Lake Thunderbird flood pool.

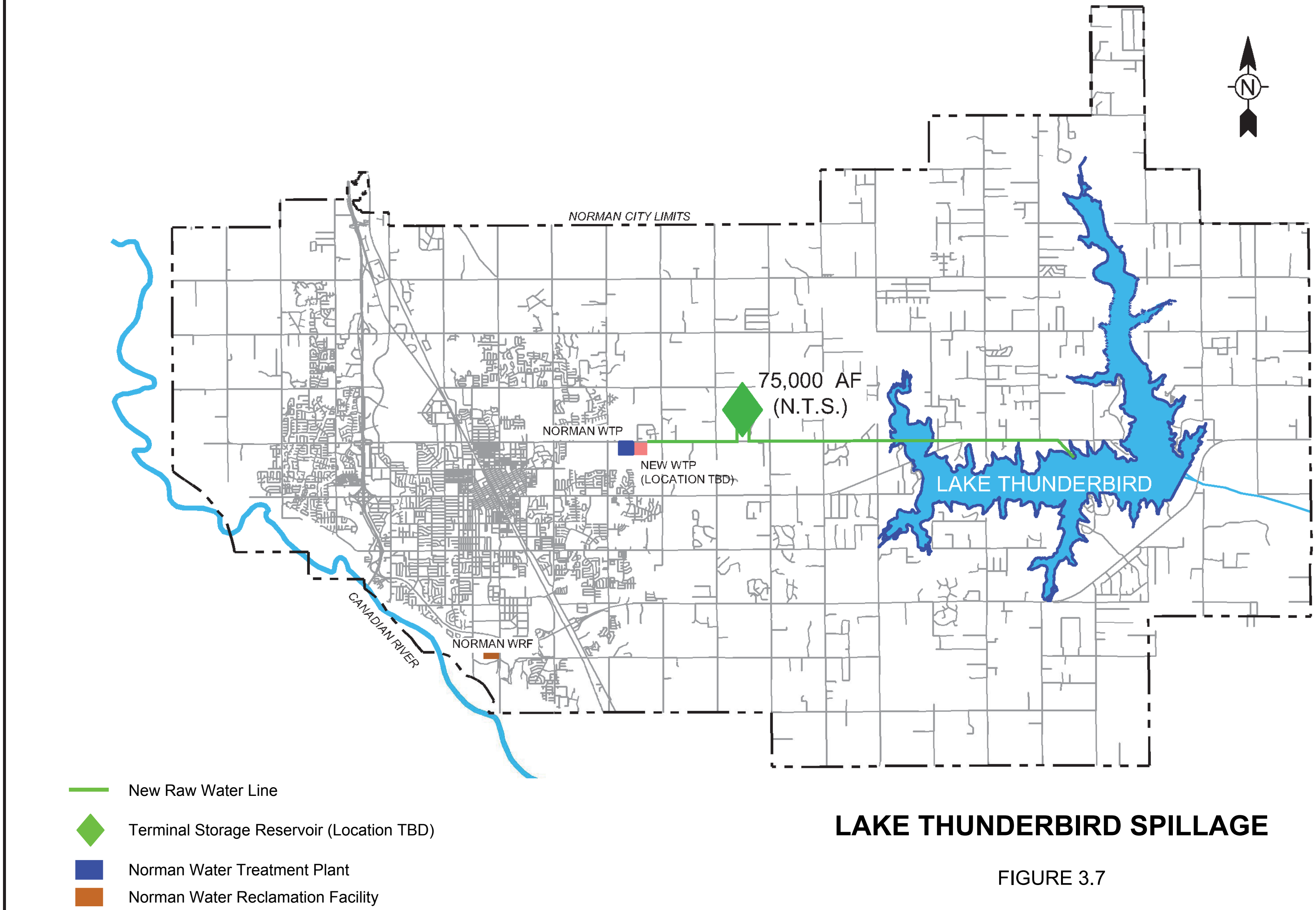
3.2.6.4 Summary of Supply Option

Table 3.13 summarizes information on the option to capture Lake Thunderbird Spillage.

Table 3.13 New Local Water Supply Source – Lake Thunderbird Spillage

Existing Yield Available to Norman	AFY	N/A
	mgd	N/A
Proposed Firm Yield Available to Norman[(1)]	AFY	6,500
	mgd	5.8
Percent of proposed firm yield in projected 2060 demands[(2)]	Percent	20
Raw Water Transmission Distance	Miles	7
Water Treatment Process		Conventional with softening
Known Long-term Reliability Issues		Reliability is a function of terminal storage.
Known Implementation Issues		Source has not been studied or permitted. OWRB will have to confirm than no downstream water rights holders will be impacted. Concurrence and approval from BOR and USACE would be needed. Significant land acquisition required for terminal storage.
Opinion of Capital Costs	2012 $	$510,000,000
Unit Capital Cost of Source[(3)]	$/AFY	$79,000

Notes:
(1) Yield constrained based on size and cost of infrastructure required.
(2) Proposed firm yield divided by Norman's projected 2060 demands (29.1 mgd).
(3) Unit capital cost is capital cost associated with source divided by proposed firm yield. Rehabilitation/replacement costs were not assessed in initial source screening.
(4) Summed and converted values may vary slightly due to rounding.



LAKE THUNDERBIRD SPILLAGE

FIGURE 3.7

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

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3.2.7 Groundwater Recharge (IPR)

Another option for reusing water from the Norman WRF is groundwater recharge. This water supply option involves injecting highly treated water from the Norman WRF into the Garber-Wellington Aquifer for storage and future recovery.

3.2.7.1 Description of Supply Source

In the absence of a detailed hydrogeological study and precedence for groundwater recharge in Oklahoma, several assumptions were made to develop this water supply project, as summarized below:

- Recharge will occur through injection wells. Given that Garber-Wellington Aquifer levels are approximately 650 feet below the ground surface and that the types of soils prevalent in the area are not conducive to rapid percolation, surface recharge is not preferred.
- Based on aquifer recharge injection well projects in other states, the average injection rate was assumed to be approximately 100 gallons per minute (gpm), or approximately 60 percent of the average withdrawal rate from existing Garber-Wellington Aquifer wells of 170 gpm.
- Water from the Norman WRF will require reverse osmosis and ultra-violet (UV) disinfection prior to injection into the Garber-Wellington Aquifer, in order to meet undefined but anticipated stringent water quality requirements.
- Upon withdrawal, reclaimed water will require wellhead chlorination prior to going into the potable distribution system. It is unknown whether arsenic and/or chromium-6 treatment will be required for reclaimed water. For purposes of preliminary screening, costs for arsenic and chromium-6 treatment were not included.

In lieu of physical demonstrations, modeling, or permitting precedent, it was conservatively assumed that 60 percent of water recharged could be physically and legally recovered. The Groundwater Recharge supply has a firm yield of 10.2 mgd, based on treating and injecting 17 mgd reclaimed water from the Norman WRF. It was assumed that water from the WRF designated for recharge would need to be recharged into the aquifer for blending and natural attenuation before it could be used as potable water. Therefore, a separate non-potable distribution piping network is required to convey water from the WRF to a network of dedicated injection wells.

Approximately 120 new injection wells and 28 new withdrawal wells are needed to achieve this firm yield. Injection wells, similar to withdrawal wells, must be spread out across the city to avoid interference between wells. The conceptual design for this water supply is illustrated in Figure 3.8.

3.2.7.2 Challenges Associated with Groundwater Recharge

Oklahoma does not have any regulations or applications of groundwater recharge using water from a WRF. It is anticipated that if such recharge were to be approved, ODEQ would require extremely stringent water quality and reliability standards for treatment and monitoring. From a physical water supply and permitting perspective, advanced modeling may be required to demonstrate the degree to which injected water could be recovered by withdrawal wells. Implementation of groundwater recharge will require significant study to confirm recovery rates and recharge's impact on constituent mobilization as well as significant regulatory negotiation.

3.2.7.3 Opinion of Capital Cost

Capital costs were calculated, using assumptions described in Chapter 2, for collection, conveyance, treatment, distribution to and injection wells, and withdrawal prior to entering the potable distribution system associated with groundwater recharge.

3.2.7.4 Summary of Supply Option

Table 3.14 summarizes information on the Groundwater Recharge supply source.

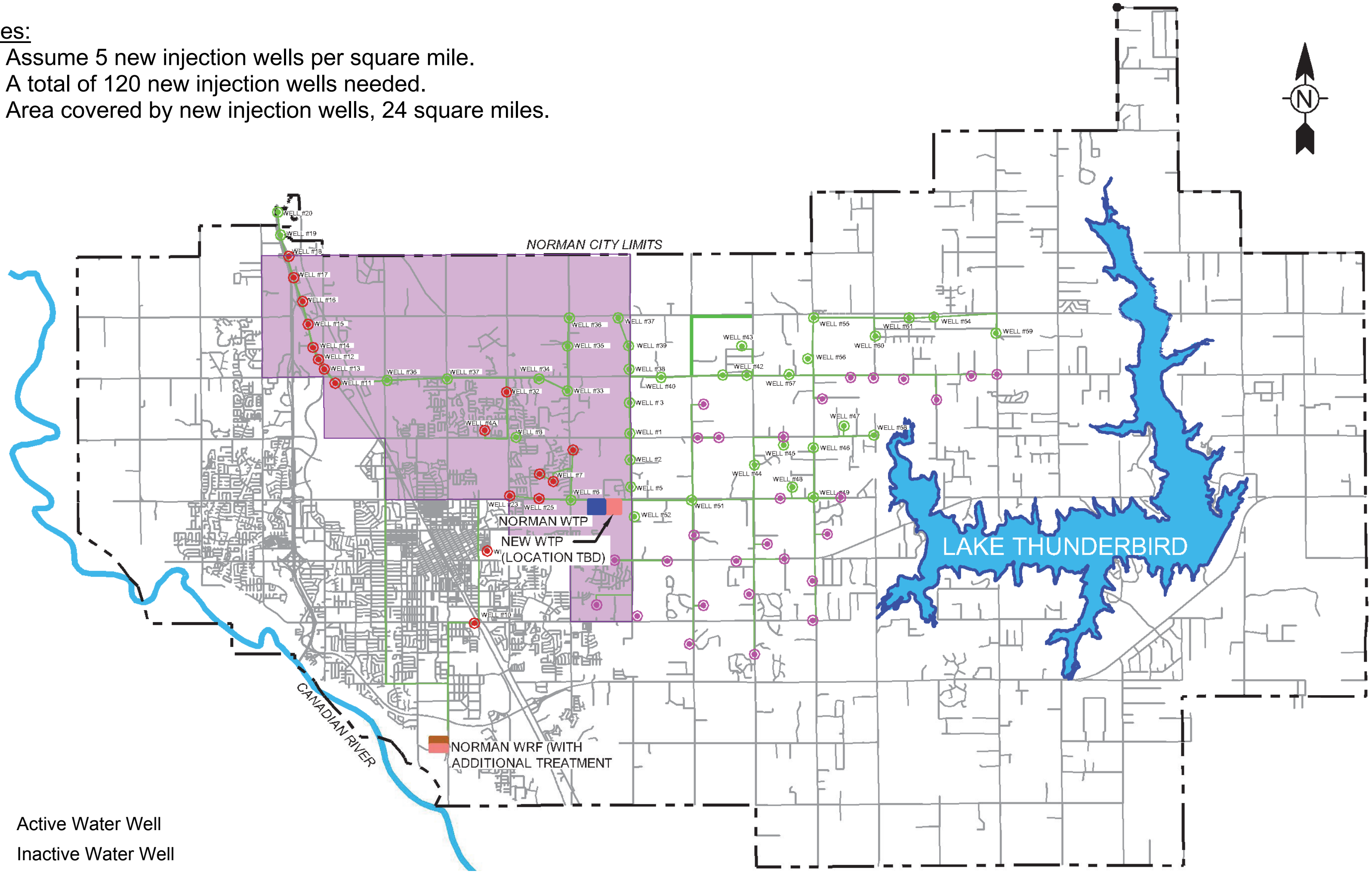
Table 3.14 New Local Water Supply Source – Groundwater Recharge

Existing Yield Available to Norman	AFY	N/A
	mgd	N/A
Proposed Firm Yield Available to Norman(1)	AFY	11,400
	mgd	10.2
Percent of proposed firm yield in projected 2060 demands(2)	Percent	35
Raw Water Transmission Distance(5)	Miles	89
Water Treatment Process(6)		Single pass reverse osmosis with UV disinfection
Known Long-term Reliability Issues		WRF effluent is highly reliable
Known Implementation Issues		Lack of permitting precedent or regulations for water quality and quantity. Subsequent study is needed to confirm recharge rates. Significant number of new well sites are required, with associated land acquisition needs.
Opinion of Capital Costs	2012 $	$364,000,000
Unit Capital Cost of Source(3)	$/AFY	$32,000

Notes:
(1) Yield constrained based on size and cost of infrastructure required.
(2) Proposed firm yield divided by Norman's projected 2060 demands (29.1 mgd).
(3) Unit capital cost is capital cost associated with source divided by proposed firm yield. Rehabilitation/replacement costs were not assessed in initial source screening.
(4) Summed and converted values may vary slightly due to rounding.
(5) Transmission distance includes pipelines out to injection wells and pipelines from new withdrawal wells.
(6) Treatment listed is required prior to groundwater injection. Chlorine disinfection is assumed upon groundwater withdrawal.

Notes:

- Assume 5 new injection wells per square mile.
- A total of 120 new injection wells needed.
- Area covered by new injection wells, 24 square miles.



- Active Water Well
- Inactive Water Well
- New Water Well
- New Raw Water Line
- Injection Water Well Area (assumes 5 injection wells per square mile)
- Norman Water Treatment Plant
- Norman Water Reclamation Facility

CONCEPTUAL GROUNDWATER RECHARGE

FIGURE 3.8

NORMAN UTILITIES AUTHORITY

2060 STRATEGIC WATER SUPPLY PLAN

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3.3 NEW REGIONAL SOURCES

This section discusses potential new regional supplies to meet Norman's future needs.

3.3.1 Co-owner with Oklahoma City for Southeast Oklahoma Treated Water

In this supply option, Norman would partner with Oklahoma City (as co-owners in infrastructure and supply) for a new regional raw water supply and subsequent treatment.

3.3.1.1 Description of Supply Source

This water supply option is generally based on Theme D1 from the Regional Raw Water Supply Study (OCWUT, 2009) and is illustrated in Figure 3.9. Oklahoma City, Norman, and several other water suppliers participated in this regional study, however it is unknown which, if any, study participants will ultimately take part in the capital project. Raw water would be diverted from one of several Southeast Oklahoma surface water diversion points considered in the study, then conveyed to one of Oklahoma City's existing supply sources (Lake Atoka and/or McGee Creek Reservoir). A transmission system parallel to the existing Atoka pipeline would bring water to Oklahoma City's Lake Stanley Draper for regional treatment at an expanded Draper WTP (one of Oklahoma City's existing WTPs), then conveyed to Norman through an interconnection between Oklahoma City and Norman's potable water distribution systems.

This project is expected to be implemented by Oklahoma City in phases, with the Atoka parallel pipeline being constructed and operated for several years before a new line from a diversion point in the Kiamichi River basin is needed to augment supplies, Norman's pro-rata costs for both project phases were included in 2060 SWSP analyses of this supply option. SWSP analyses of this option assumed that Norman would participate as a co-owner in the supply infrastructure, where Norman would provide its pro-rata share of capital costs and operating costs rather than purchasing water from Oklahoma City on a wholesale basis.

Norman's costs for participation were adjusted to reflect an increase in Norman's portion of supply relative to that assumed in the 2009 study. No new terminal storage reservoir is required, as Lake Stanley Draper will serve as terminal storage.

3.3.1.2 Challenges Associated with Co-owner with Oklahoma City for Southeast Oklahoma Treated Water

This water supply option is not without uncertainties, as water rights are currently under dispute between Oklahoma City, the State of Oklahoma, and Native American Tribes. Moreover, permitting for a project of this magnitude (independent of water rights issues) can be difficult and require lengthy analyses.

Since the 2009 study, however, Oklahoma City has continued to pursue planning and preliminary engineering for the Atoka parallel pipeline and Kiamichi basin diversion. The parallel conveyance system is currently in preliminary design. Those efforts, coupled with revisions to participation levels by metro area communities, may result in changes to the pipeline and booster pump station sizing and costing from what was presented in the 2009 study.

3.3.1.3 Opinion of Capital Cost

Capital costs for the project were adjusted from the 2009 study to reflect 2012 dollars and an pro-rata increase in Norman's portion of the project's supply. Other costs were based on unit costs described in Chapter 2.

3.3.1.4 Summary of Supply Option

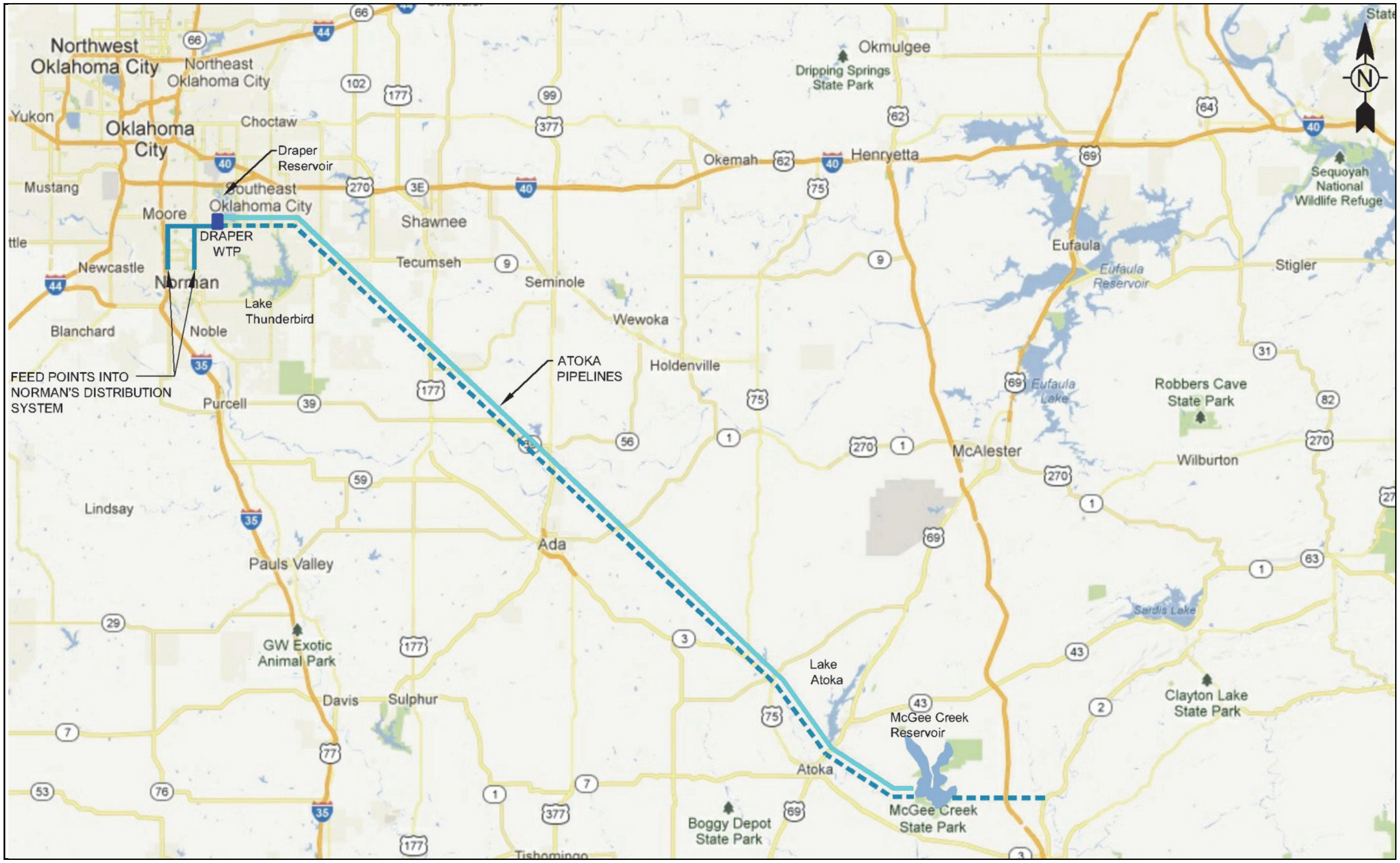
Table 3.15 summarizes information on the Co-owner with Oklahoma City for Treated Water supply source.

Table 3.15 New Regional Water Supply Source – Co-owner with Oklahoma City for Southeast Oklahoma Treated Water

Existing Yield Available to Norman	AFY	N/A
	mgd	N/A
Proposed Firm Yield Available to Norman(1)	AFY	32,600
	mgd	29.1
Percent of proposed firm yield in projected 2060 demands(2)	Percent	100
Raw Water Transmission Distance	Miles	133
Water Treatment Process		Conventional
Known Long-term Reliability Issues		Source reservoirs are constructed. From 2012 Update to OCWP, source basin is not shown to have any shortages through 2060.
Known Implementation Issues		There are known water rights issues that must be resolved. The source project is actively being pursued by Oklahoma City.
Opinion of Capital Costs	2012 $	$407,000,000
Unit Capital Cost of Source(3)	$/AFY	$12,000

Notes:

(1) Pending negotiations with Oklahoma City, yield could be any amount. For source evaluation, a yield equal to Norman's full projected 2060 demand was used.
(2) Proposed firm yield divided by Norman's projected 2060 demands (29.1 mgd).
(3) Unit capital cost is capital cost associated with source divided by proposed firm yield. Rehabilitation/replacement costs were not assessed in initial source screening.
(4) Summed and converted values may vary slightly due to rounding.



New Treated Water Line

Existing Treated Water Line

Existing Shared Water Line

Draper Water Treatment Plant

CONCEPTUAL CO-OWNER WITH OKLAHOMA CITY FOR SOUTHEAST OKLAHOMA TREATED WATER

FIGURE 3.9

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

carollo — TETRA TECH

3.3.2 Co-owner with Oklahoma City for Southeast Oklahoma Raw Water

In this supply option, Norman would partner with Oklahoma City (as co-owners in infrastructure and supply) for a new regional raw water supply. In contrast to the previous supply option, treatment remains wholly Norman's responsibility. Norman would receive untreated (raw) water from a joint project with Oklahoma City, then treat Norman's portion of the water at a new or expanded Norman WTP.

3.3.2.1 Description of Supply Source

This water supply option is generally based on Theme D3 from the Regional Raw Water Supply Study (OCWUT, 2009) and is illustrated in Figure 3.10. Oklahoma City, Norman, and several other water suppliers participated in this regional study; however, it is unknown which, if any, study participants will ultimately take part in the capital project. Raw water would be diverted from one of several Southeast Oklahoma surface water diversion points considered in the study, then conveyed to one of Oklahoma City's existing supply sources (Lake Atoka and/or McGee Creek Reservoir). A transmission system parallel to the existing Atoka pipeline would bring water to Central Oklahoma for subsequent treatment by individual participants. Norman's costs for participation were adjusted to reflect an increase in Norman's portion of supply relative to the 2009 study. Additionally, a 15-mile, 36-inch pipeline is dedicated for bringing water from the Atoka pipeline to Norman is included.

This project is expected to be implemented by Oklahoma City in phases, with the Atoka parallel pipeline being constructed and operated for several years before a new line from a diversion point in the Kiamichi River basin is needed to augment supplies, Norman's pro-rata costs for both project phases were included in 2060 SWSP analyses of this supply option. SWSP analyses of this option assumed that Norman would participate as a co-owner in the supply infrastructure, where Norman would provide its pro-rata share of capital costs and operating costs rather than purchasing water from Oklahoma City on a wholesale basis.

Because raw water would be delivered directly to Norman, a new terminal storage reservoir would be required to buffer steady raw water deliveries against variable treated water demands. The terminal storage reservoir would be placed into service when Norman's peak day needs from this supply source exceed the 2060 average day pipeline capacity purchased by the City. The 6,100-AF terminal storage reservoir will provide enough storage capacity to meet 2060 peak day demands. As with other supply options, terminal storage siting was not analyzed as part of the SWSP, but conveyance infrastructure costing analyses assumed that it would be located within Norman city limits.

For the 2060 SWSP, it is assumed that the existing Vernon Campbell WTP would be expanded to treat raw water from Southeast Oklahoma under this supply option.

3.3.2.2 Challenges Associated with Co-owner with Oklahoma City for Southeast Oklahoma Raw Water

This water supply option is not without uncertainties, as water rights are currently under dispute between Oklahoma City, the State of Oklahoma, and Native American Tribes. Moreover, permitting for a project of this magnitude (independent of water rights issues) can be difficult and require lengthy analyses.

Since the 2009 study, however, Oklahoma City has continued to pursue planning and preliminary engineering for the Atoka parallel pipeline and Kiamichi basin diversion. The parallel conveyance system is currently in preliminary design. Those efforts, coupled with revisions to participation levels by metro area communities, may result in changes to the pipeline and booster pump station sizing and costing from what was presented in the 2009 study.

3.3.2.3 Opinion of Capital Cost

Capital costs for the project were adjusted from the 2009 study to reflect 2012 dollars and a pro-rata increase in Norman's portion of the project's supply. Other costs were based on unit costs described in Chapter 2.

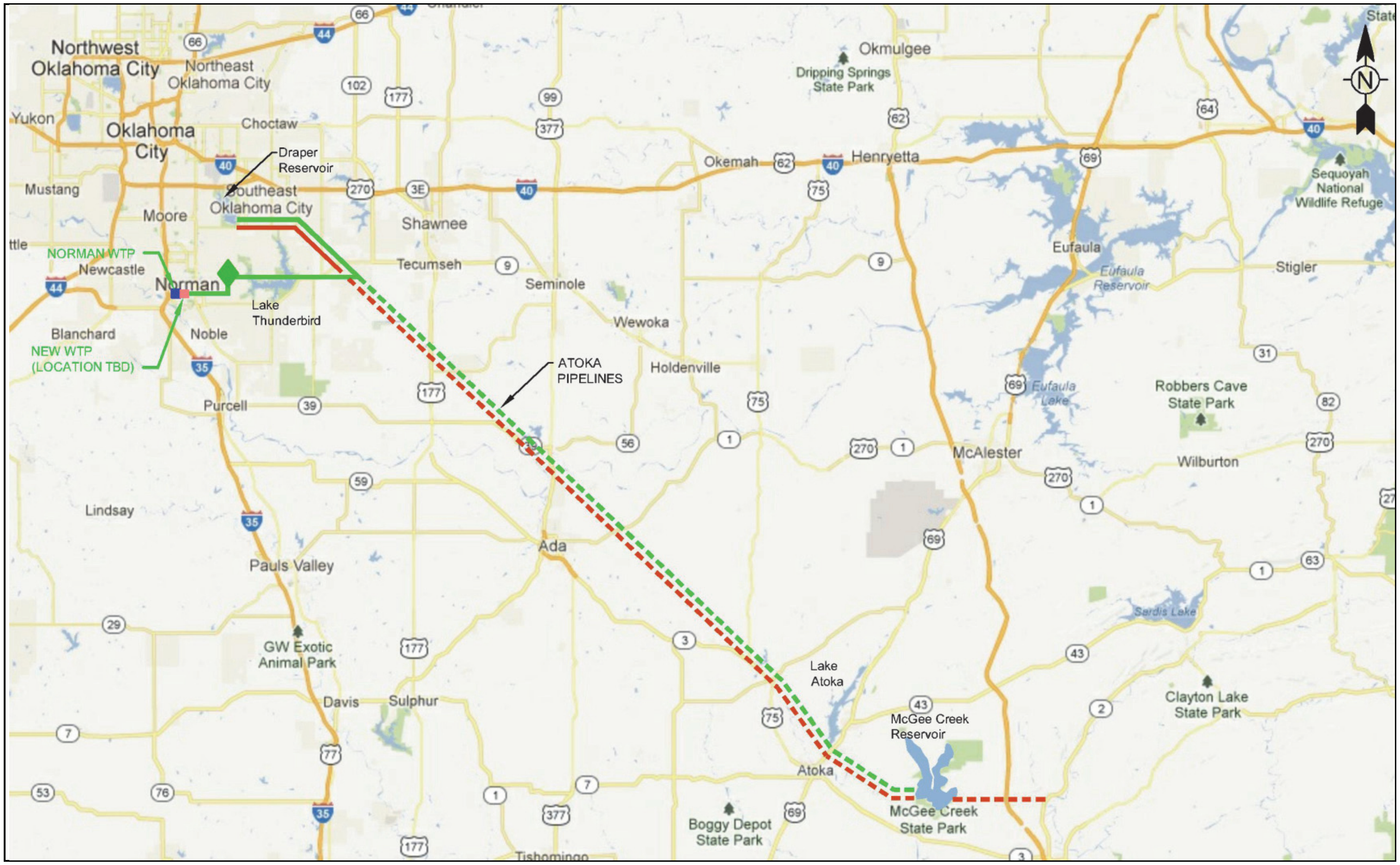
3.3.2.4 Summary of Supply Option

Table 3.14 summarizes information on the Co-owner with Oklahoma City for Raw Water supply source.

Table 3.16 New Regional Water Supply Source – Co-owner with Oklahoma City for Southeast Oklahoma Raw Water

Existing Yield Available to Norman	AFY	N/A
	mgd	N/A
Proposed Firm Yield Available to Norman(1)	AFY	32,600
	mgd	29.1
Percent of proposed firm yield in projected 2060 demands(2)	Percent	100
Raw Water Transmission Distance	Miles	129
Water Treatment Process		Conventional
Known Long-term Reliability Issues		Source reservoirs are constructed. From 2012 Update to OCWP, source basin is not shown to have any shortages through 2060.
Known Implementation Issues		There are known water rights issues that must be resolved. The source project is actively being pursued by Oklahoma City. Land acquisition needed for new terminal storage reservoir
Opinion of Capital Costs	2012 $	$440,000,000
Unit Capital Cost of Source(3)	$/AFY	$14,000

Notes:
(1) Pending negotiations with Oklahoma City, yield could be any amount. For source evaluation, a yield equal to Norman's full projected 2060 demand was used.
(2) Proposed firm yield divided by Norman's projected 2060 demands (29.1 mgd).
(3) Unit capital cost is capital cost associated with source divided by proposed firm yield. Rehabilitation/replacement costs were not assessed in initial source screening.
(4) Summed and converted values may vary slightly due to rounding.



New Raw Water Line

New Shared Water Line

Existing Raw Water Line

Existing Shared Water Line

Terminal Storage Reservoir 6,100 AF (Location TBD)

Norman Water Treatment Plant

CONCEPTUAL CO-OWNER WITH OKLAHOMA CITY FOR SOUTHEAST OKLAHOMA RAW WATER

FIGURE 3.10

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

3.3.3 Scissortail Reservoir

Scissortail Reservoir is a proposed water supply reservoir on Sandy Creek in Pontotoc County near the City of Ada. A feasibility study for Scissortail Reservoir was initiated in 1984 by the BOR. As part of the 2012 Update of the OCWP, a supplemental report evaluated the viability of major reservoirs. Scissortail Reservoir was included and categorized as a Category 4 reservoir, meaning that it is has the highest potential likelihood of development (OWRB, 2010). The Scissortail Reservoir was most recently evaluated in detail by the City of Ada (Ada, 2009).

3.3.3.1 <u>Description of Supply Source</u>

The proposed Scissortail Reservoir is located approximately three miles west of the City of Ada and approximately 60 miles southeast of Norman. Scissortail Reservoir would have a maximum surface area of 7,027 acres with a storage size of 177,524 acre-feet (Ada, 2009). Scissortail Reservoir has a firm yield of 32,000 AFY (28.55 mgd annual average) (Ada, 2009). This source option is illustrated in Figure 3.11.

The 2060 SWSP assumed that Norman would partner with Ada for development of Scissortail Reservoir, meaning that costs for reservoir development will be shared proportionally between the two cities. Assuming a moderate average demand of 8.7 mgd for the City of Ada (Ada, 2009), the remaining approximately 19.9 mgd annual average yield would available to Norman.

Raw water transmission infrastructure and treatment was assumed to be developed and operated for Norman's benefit only. Raw water pipeline and pump stations are sized to transport supply at the annual average rate. A terminal storage reservoir with approximately 4,200 AF of storage is needed to buffer the constant supply against peak demands. Conventional treatment with softening was assumed based on anticipated water quality.

3.3.3.2 <u>Challenges Associated with Scissortail Reservoir</u>

There are several regulatory hurdles to overcome whenever constructing a new reservoir. Approval may be required from several agencies, such as the OWRB, ODEQ, BOR, and USACE. This is often a lengthy process. Inundation of existing land and/or developments can also be a challenge. These and other challenges associated with development of the proposed reservoir are noted in the 2009 study of the reservoir (Ada, 2009).

3.3.3.3 <u>Opinion of Capital Cost</u>

Capital costs for reservoir development were adjusted from the 2009 study to reflect 2012 dollars, consistent unit pricing, and Norman's pro-rata portion of supply. Other costs were developed as described in Chapter 2.

3.3.3.4 <u>Summary of Supply Option</u>

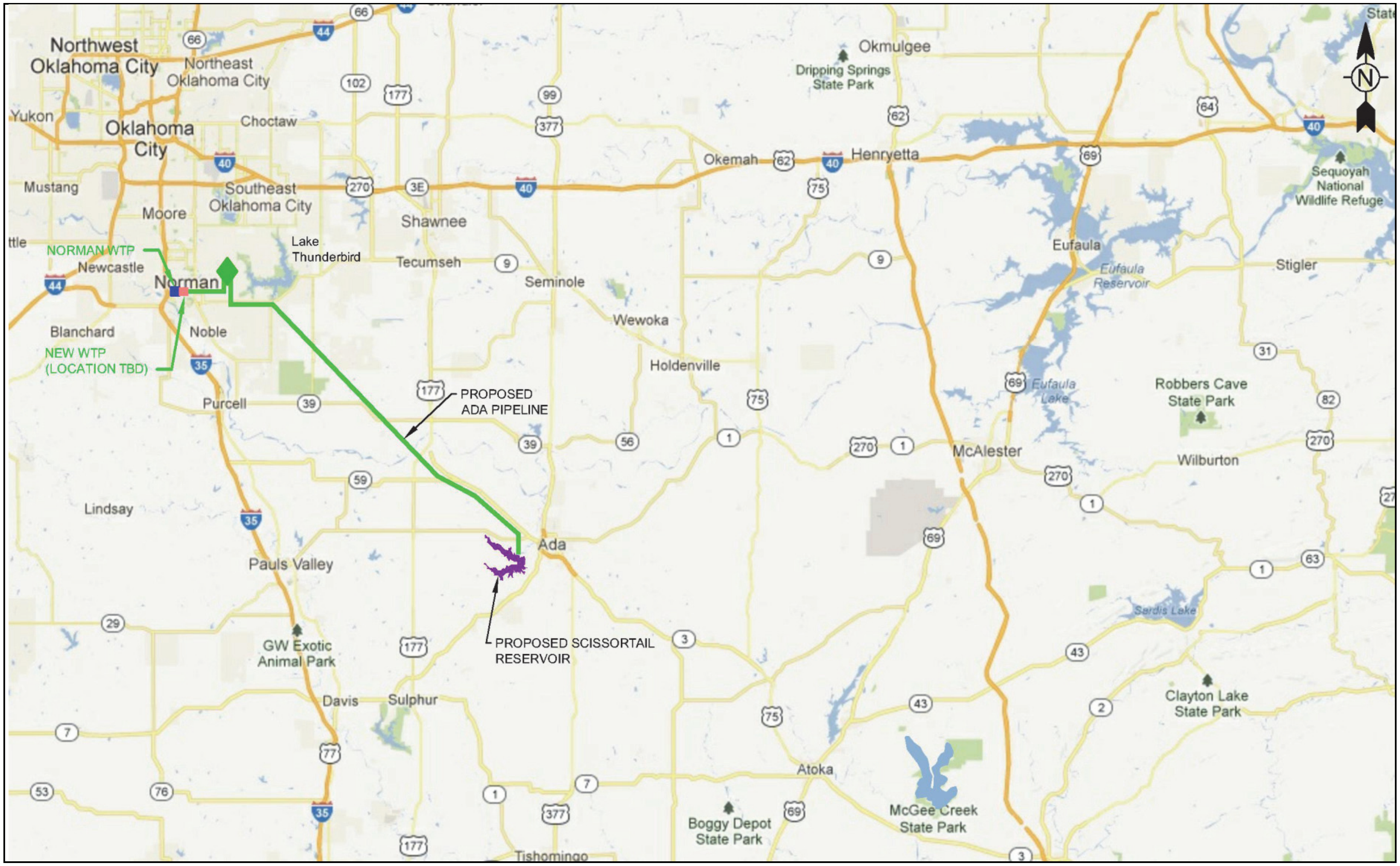
Table 3.17 summarizes information on the Scissortail Reservoir supply option.

Table 3.17 New Regional Water Supply Source – Scissortail Reservoir		
Existing Yield Available to Norman	AFY	N/A
	mgd	N/A
Proposed Firm Yield Available to Norman(1)	AFY	22,300
	mgd	19.9
Percent of proposed firm yield in projected 2060 demands(2)	Percent	68
Raw Water Transmission Distance	Miles	60
Water Treatment Process		Conventional with softening
Known Long-term Reliability Issues		From 2012 Update to OCWP, source basin is shown to have significant shortages by 2060. This reservoir is not built, but previous studies show a reliable yield for its location.
Known Implementation Issues		This was identified as a viable reservoir site, however permitting new reservoir construction will be challenging. Planning studies have been completed and Ada is interested in collaborating.
Opinion of Capital Costs	2012 $	$408,000,000
Unit Capital Cost of Source(3)	$/AFY	$18,000

Notes:
(1) Represents firm yield of Scissortail minus a moderate demand estimate for Ada of 8.7 mgd. Demand estimates for Ada vary between 6.7 mgd to 11.9 mgd.
(2) Proposed firm yield divided by Norman's projected 2060 demands (29.1 mgd).
(3) Unit capital cost is capital cost associated with source divided by proposed firm yield. Rehabilitation/replacement costs were not assessed in initial source screening.
(4) Summed and converted values may vary slightly due to rounding.

3.3.4 Parker Reservoir

Parker Reservoir is a proposed water supply reservoir on Muddy Boggy River in Coal and Hughes Counties. An initial feasibility study for Parker Reservoir was conducted, but further funding for the reservoir was halted in 1985 (NewsOK, 1985). As part of the 2012 Update of the OCWP, a supplemental report evaluated the viability of major reservoirs. Parker Reservoir was included and categorized as a Category 4 reservoir, meaning that it is has the highest potential likelihood of development (OWRB, 2010).



New Raw Water Line

Terminal Storage Reservoir 4,200 AF (Location TBD)

Norman Water Treatment Plant

CONCEPTUAL SCISSORTAIL RESERVOIR

FIGURE 3.11

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

carollo — TETRA TECH

3.3.4.1 Description of Supply Source

The proposed Parker Reservoir is located approximately 15 miles east of the City of Ada and approximately 75 miles southeast of Norman. Parker Reservoir is anticipated to have a maximum surface area of 9,240 acres with a storage of 220,240 acre-feet (OWRB, 2010). Parker Reservoir has a firm yield of 45,900 AFY (OWRB, 2010). This source option is illustrated in Figure 3.12.

For source screening, the 2060 SWSP assumed that Norman would develop Parker Reservoir, meaning that all capital costs for development of the source would be paid for by Norman. Several entities have expressed interest in possible participation in a reservoir at this site, but no entity has expressed definitive participation in the project. Since Parker Reservoir's firm yield exceeds NUA's projected 2060 demands (29.1 mgd annual average), Norman may be able to sell or collaborate with others to reduce source costs. Possible cost benefits of partnering on this project were not included in the 2060 SWSP evaluation.

Raw water transmission infrastructure was sized to meet Norman's projected 2060 annual average demand (29.1 mgd). A terminal storage reservoir with approximately 5,900 AF of storage is needed to buffer the constant supply against peak demands. Conventional treatment with softening was assumed based on anticipated water quality.

3.3.4.2 Challenges Associated with Parker Reservoir

Similar to Scissortail Reservoir, there are several regulatory hurdles to overcome whenever constructing a new reservoir. Approval may be required from several agencies, such as the OWRB, ODEQ, BOR, and USACE. This is often a lengthy process. Inundation of existing land and/or developments can also be a challenge. These and other challenges associated with development of the proposed reservoir are noted in previous studies of the reservoir.

3.3.4.3 Opinion of Capital Cost

Capital costs were developed as described in Chapter 2.

3.3.4.4 Summary of Supply Option

Table 3.18 summarizes information on Parker Reservoir.

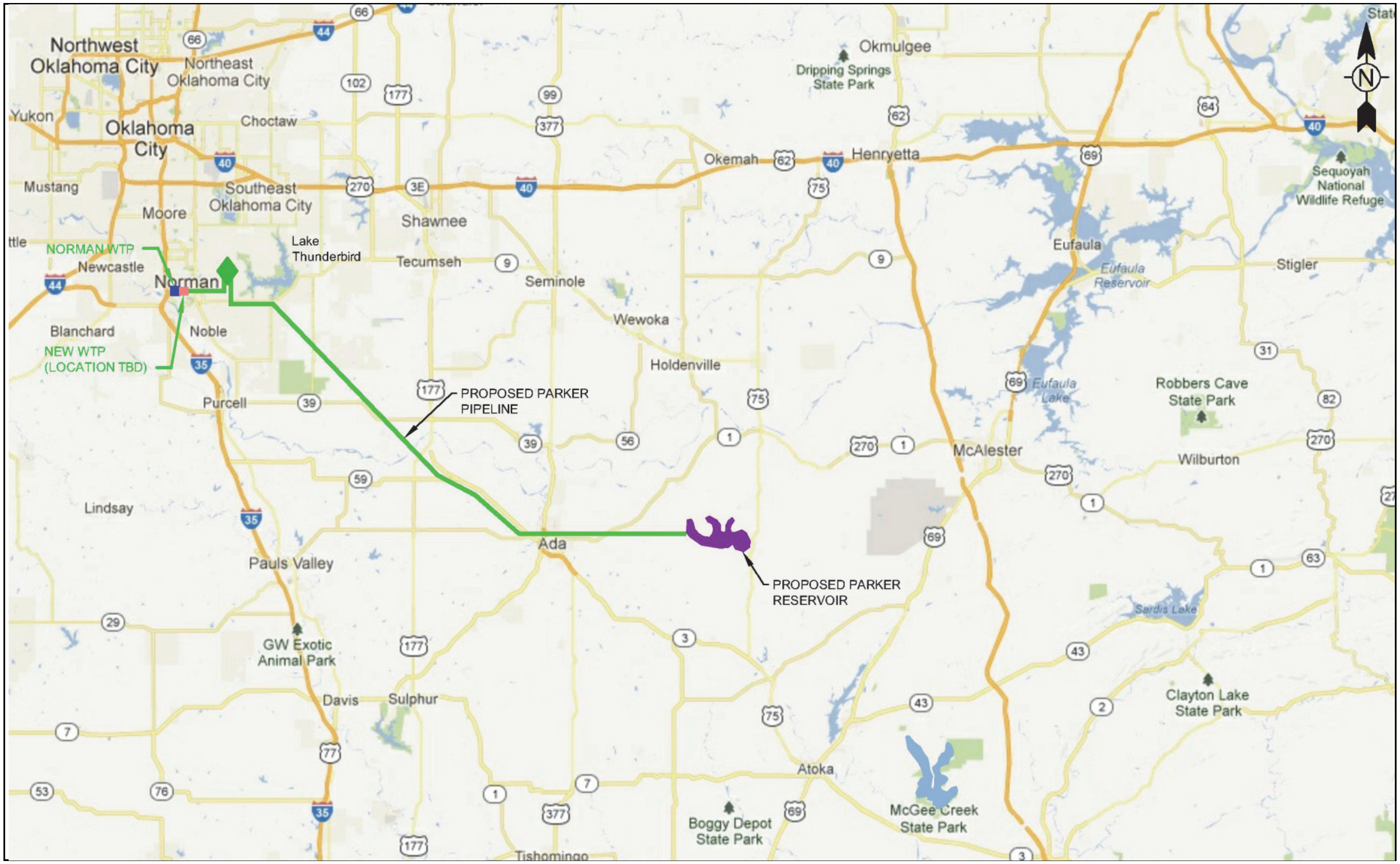
Table 3.18 New Regional Water Supply Source – Parker Reservoir		
Existing Yield Available to Norman	AFY	N/A
	mgd	N/A
Proposed Firm Yield Available to Norman(1)	AFY	32,600
	mgd	29.1
Percent of proposed firm yield in projected 2060 demands(2)	Percent	100
Raw Water Transmission Distance	Miles	75
Water Treatment Process		Conventional with softening
Known Long-term Reliability Issues		From 2012 Update to OCWP, source basin is not shown to have any shortages through 2060. This reservoir is not built, but previous studies show a reliable yield for its location.
Known Implementation Issues		This was identified as a viable reservoir site, however permitting new reservoir construction will be challenging. Detailed planning studies have not been completed.
Opinion of Capital Costs(4)	2012 $	$629,000,000
Unit Capital Cost of Source(3)	$/AFY	$19,000

Notes:

(1) Firm yield for Parker Reservoir is estimated at 45,900 AF (or 41 mgd annual average). The yield available to Norman represents the projected 2060 demand for NUA.
(2) Proposed firm yield divided by Norman's projected 2060 demands (29.1 mgd).
(3) Unit capital cost is capital cost associated with source divided by proposed firm yield. Rehabilitation/replacement costs were not assessed in initial source screening.
(4) Capital cost represents construction of Parker Reservoir (at its full firm yield) with other infrastructure sized to handle Norman's projected 2060 water demands.
(5) Summed and converted values may vary slightly due to rounding.

3.3.5 Kaw Lake

This section describes the supply option of using raw water from the existing Kaw Lake to meet Norman's long-term water needs. Kaw Lake is located approximately 125 miles north of Norman, 10 miles east of Ponca City, and 50 miles north of Stillwater. Construction was completed in 1976, and Kaw Lake currently serves as Stillwater's primary water source. Kaw Lake is a federally owned reservoir and is operated and maintained by USACE.



New Raw Water Line

Terminal Storage Reservoir 5,900 AF (Location TBD)

Norman Water Treatment Plant

CONCEPTUAL PARKER RESERVOIR

FIGURE 3.12

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

carollo — TETRA TECH

3.3.5.1 Description of Supply Source

Kaw Lake has a total surface area of 17,040 acres and total storage volume of 428,600 AF. The firm yield of the lake is 187,040 AFY (167 mgd annual average). Currently, 141,403 AFY is permitted. There are pending permits for approximately 64,050 AFY; however, discussions with OWRB staff conducted as part of SWSP development indicate that some of these pending permits are no longer relevant. For this study, it was assumed that Kaw Lake could provide 32,551 AFY (29.1 mgd annual average) to Norman.

This water supply option assumes that the pipeline from Kaw Lake to Stillwater would be shared by Stillwater and Norman, as shown in Figure 3.13. From Kaw Lake to Stillwater, the pipeline is estimated to be a 46-mile long, 54-inch diameter line. The costs for this line would be shared between Stillwater and Norman proportionally to their respective anticipated demands. For this study, Stillwater's peak use of the pipeline is assumed to be 27 mgd.

From Stillwater to Norman, an 83-mile long, 36-inch diameter pipeline would have a conveyance capacity of 29.1 mgd. Norman would assume all costs for this portion of pipeline.

The pipeline would end at a new 6,100 AF terminal storage reservoir in Norman, to buffer constant deliveries against variable demands. Again, terminal storage siting was not analyzed as part of the SWSP, but conveyance infrastructure costing analyses assumed that it would be located within Norman city limits. Water would then be piped to a new WTP utilizing conventional treatment with softening, based on available water quality data from Kaw Lake.

3.3.5.2 Challenges Associated with Co-owner with Oklahoma City for Treated Water

Availability of water from Kaw Lake is subject to permit approval by OWRB.

3.3.5.3 Opinion of Capital Cost

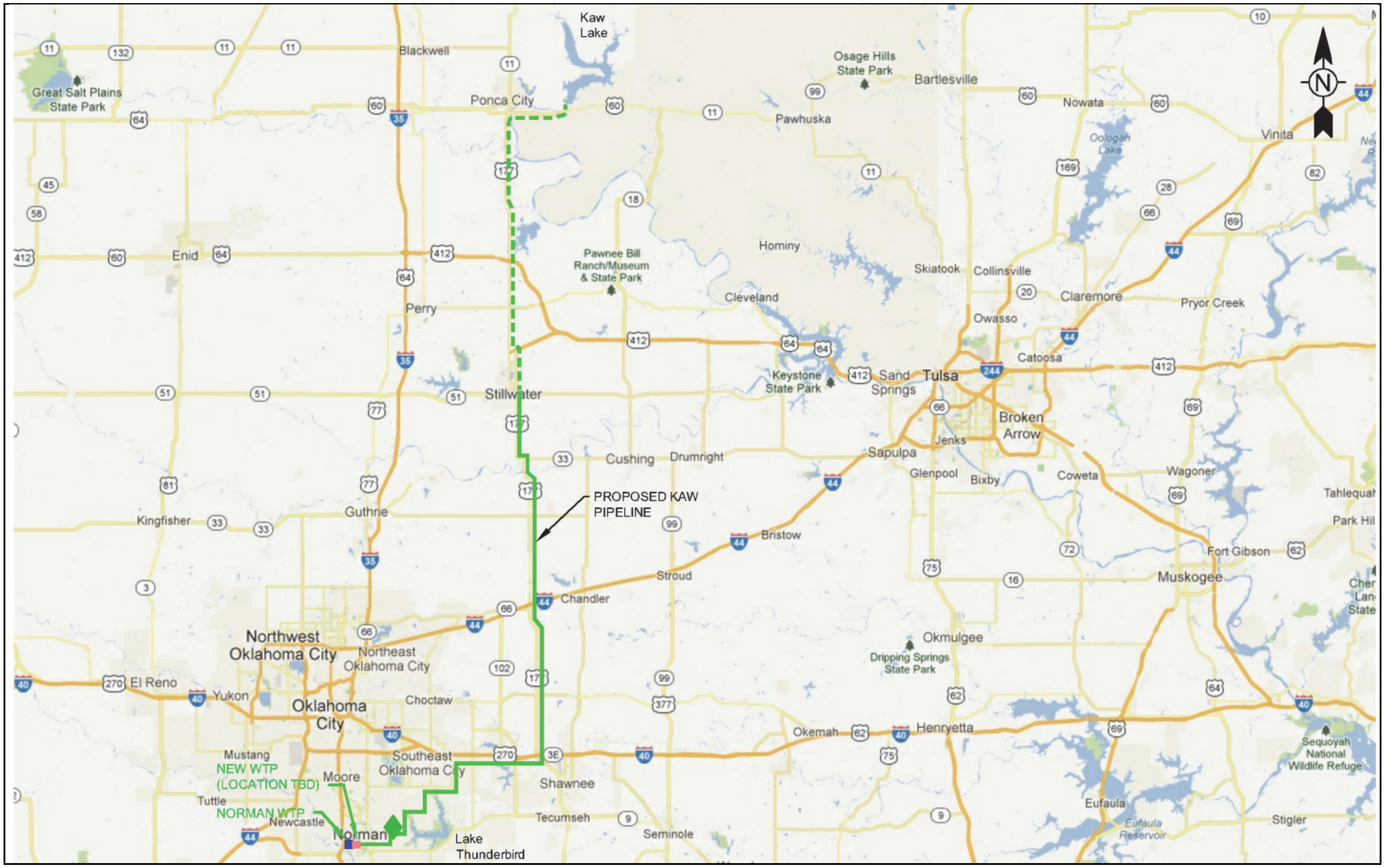
Capital costs were developed as described in Chapter 2. This study assumes that costs for the pipeline from Kaw Lake to Stillwater would be shared based on pro-rata usage by Norman and Stillwater, and that the costs for the pipeline south of Stillwater and other necessary infrastructure would be Norman's sole responsibility.

3.3.5.4 Summary of Supply Option

Table 3.19 summarizes information on Kaw Lake.

Table 3.19 New Regional Water Supply Source – Kaw Lake		
Existing Yield Available to Norman	AFY	N/A
	mgd	N/A
Proposed Firm Yield Available to Norman(1)	AFY	32,600
	mgd	29.1
Percent of proposed firm yield in projected 2060 demands(2)	Percent	100
Raw Water Transmission Distance	Miles	129
Water Treatment Process		Conventional with softening
Known Long-term Reliability Issues		Source reservoir is constructed. From the 2012 Update to the OCWP, the source basin is not shown to have any shortages.
Known Implementation Issues		Resolution of pending water right applications for Kaw Lake supplies is required. Existing reservoir but conveyance will require significant study and institutional cooperation between project participants.
Opinion of Capital Costs	2012 $	$606,000,000
Unit Capital Cost of Source(4)	$/AFY	$19,000

Notes:
(1) The yield available to Norman represents the projected 2060 demand for NUA.
(2) Proposed firm yield divided by Norman's projected 2060 demands (29.1 mgd).
(3) Unit capital cost is capital cost associated with source divided by proposed firm yield. Rehabilitation/replacement costs were not assessed in initial source screening.
(4) Summed and converted values may vary slightly due to rounding.



New Raw Water Line

New Shared Water Line

Terminal Storage Reservoir 6,100 AF (Location TBD)

Norman Water Treatment Plant

CONCEPTUAL KAW LAKE

FIGURE 3.13

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

carollo — TETRA TECH

3.4 INITIAL SOURCE SCREENING

Individual sources were compared and assessed for their viability to meet Norman's long-term needs, in light of four screening criteria selected in consultation with City staff and AHC members. Existing water supply sources and additional conservation were excluded from preliminary screening, as these were automatically considered when developing supply portfolios (Chapter 4). Table 3.20, Table 3.21, Table 3.22, and Table 3.23 provide information for each new local and regional supply source relative to the screening criteria.

The screening criteria were applied to provide a relative comparison of the source options to one another. They include the following:

- Supply Availability (Table 3.20): This criterion considers the question, "Can this source (by itself) meet at least 20 percent of Norman's 2060 demand?" This criterion, while not a strict pass/fail test, is intended to prevent having multiple small water supply sources that would be operationally inefficient and would not reflect the "economy of scale" or the decreased water infrastructure and delivery unit costs associated with a larger project.
- Reliability (Table 3.21): This criterion considers the question, "What is the long-term reliability of the source?" This criterion reflects the need for a secure water supply to meet Norman's long-term water demands, and to consider whether Norman will be able to rely on its firm availability throughout the planning period (year 2060) and beyond.
- Certainty and Timeliness (Table 3.22): This criterion considers the question, "What is the current implementation status of the source? Are there any known implementation issues?" This criterion is used to identify sources that have not been significantly studied or are likely to have permitting or acceptability issues that may delay or prevent implementation. This criterion is used to assess the ability to implement selected long-term source(s) with certainty by the time they are needed.
- Cost-Effectiveness (Table 3.23): This criterion considers the question, "What is the capital cost per acre-foot of firm yield of supply?" This criterion is used to compare the capital cost of each supply source. The unit cost was obtained by dividing conceptual-level project capital costs ($) by the firm yield (AFY). Normalizing costs to a unit basis ($/AFY) provides an objective comparison between the sources with different supply yields. While source screening was conducted using capital costs, portfolio evaluations also considered annual operation and maintenance costs.

Table 3.24 summarizes preliminary screening and identifies the supply sources that were recommended as being most viable for Norman, and thus suitable for portfolio development.

Table 3.20 Preliminary Screening Criteria – Supply Availability

Source Name	Firm Yield as Percent of 2060 Demand	Notes
Lake Thunderbird Spillage	20%	Constrained to 6 mgd firm yield based on size and cost of infrastructure required; additional yield possible with upsized infrastructure.
Lake Thunderbird Augmentation (IPR)	52%	Assumes 15 mgd of water reclaimed from the Norman WRF is available for recovery at lake by 2060.
Groundwater Recharge (IPR)	35%	Assumes 17 mgd WRF effluent and 60 percent recapture rate (10.2 mgd) by 2060.
Canadian River Diversion Option 1[(1)]	21%	Constrained to 6 mgd firm yield based on size and cost of infrastructure required; additional yield possible with upsized infrastructure.
Non-potable Reuse	5%	Sized based on list of potential customers for first phase of reuse project plus excess pipeline capacity for future customers.
Stormwater Capture and Reuse	20%	Constrained to 6 mgd firm yield based on size and cost of infrastructure required; additional yield possible with upsized infrastructure.
Co-Owner with Oklahoma City for Southeast Oklahoma Treated Water	100%	29.1 mgd available to Norman from regional project.
Co-Owner with Oklahoma City for Southeast Oklahoma Raw Water	100%	29.1 mgd available to Norman from regional project.
Scissortail Reservoir	68%	Assumes full amount of Scissortail firm yield available (28.6 mgd) minus 8.7 mgd allocated to Ada.
Parker Reservoir	100%	Firm yield of Parker Reservoir exceeds Norman's 2060 demand; partnership opportunities may exist.
Kaw Lake	100%[(2)]	Resolution of several pending permit applications could affect availability to Norman. Existing permits are for about 140,000 AFY out of the total yield of 187,040 AFY.

Notes:

(1) Three options were evaluated for diversion of the Canadian River. Option 1 represents the best of the three options reviewed from both a cost perspective and water transmission/distribution perspective. It contains a new terminal reservoir and WTP on the west side of Norman. Diversions downstream of Norman could increase yield slightly, but would require an Eastside terminal storage reservoir and distribution system improvements, or significant transmission piping to the Westside terminal storage reservoir.

(2) Assumes that none of the pending permit applications will be granted. Should all pending permit applications be approved, there would be no available supply for Norman.

Table 3.21 Preliminary Screening Criteria – Reliability		
Source Name	**Reliability Score[1]**	**Notes**
Lake Thunderbird Spillage	2	Reliability is a function of terminal storage and infrequency of spills.
Lake Thunderbird Augmentation (IPR)	4	WRF effluent is highly reliable.
Groundwater Recharge (IPR)	4	WRF effluent is highly reliable.
Canadian River Diversion Option 1	1	From the 2012 Update to OCWP, this source basin is shown to have some shortages by 2060. Reliability is a function of terminal storage. Minor increases in yield could be achieved if diversion point was moved to be downstream of Norman.
Non-potable Reuse	4	WRF effluent is highly reliable.
Stormwater Capture and Reuse	2	Reliability is a function of terminal storage and variability in local precipitation.
Co-Owner with Oklahoma City for Southeast Oklahoma Treated Water	5	Source reservoirs are constructed. From the 2012 Update to OCWP, this source basin is not shown to have any shortages through 2060.
Co-Owner with Oklahoma City for Southeast Oklahoma Raw Water	5	Source reservoirs are constructed. From the 2012 Update to OCWP, this source basin is not shown to have any shortages through 2060.
Scissortail Reservoir	3	From the 2012 Update to OCWP, this source basin is shown to have significant shortages by 2060. No historical operation data available (this reservoir is not built yet) for this reservoir, but previous studies show a reliable yield for this location.
Parker Reservoir	4	From the 2012 Update to OCWP, this source basin is not shown to have any shortages through 2060. No historical operation data available (this reservoir is not built yet).
Kaw Lake	5	Source reservoir is constructed. From the 2012 Update to OCWP, this source basin is not shown to have any shortages through 2060.

Notes:

(1) Relative ranking where 1 represents the least reliable source and 5 represents the most reliable source.

Table 3.22 Preliminary Screening Criteria – Certainty and Timeliness		
Source Name	**Certainty and Timeliness Score(1)**	**Notes**
Lake Thunderbird Spillage	1	Source has not been studied or permitted. OWRB will have to confirm than no downstream water rights holders will be impacted. Concurrence and approval from COMCD, OWRB, BOR, and USACE would be needed. Significant land acquisition required for terminal storage.
Lake Thunderbird Augmentation (IPR)	2	Lack of IPR rules in Oklahoma, and designation of Lake Thunderbird as a SWS brings uncertainty in discharge water quality requirements. An agreement with COMCD and other member cities for discharges and additional storage and diversions may be necessary. Costs for increased use of the lake's capacity have not been established. Public outreach will be necessary to secure public acceptance.
Groundwater Recharge (IPR)	1	Lack of permitting precedent or regulations for water quality and quantity. Subsequent study is needed to confirm recharge rates. Significant number of new well sites are required, with associated land acquisition needs.
Canadian River Diversion Option 1	2	Requires significant study of feasibility. Significant land acquisition needed for terminal storage.
Non-potable Reuse	5	ODEQ rules are in place for non-potable reuse. Significant ability to control implementation locally. Potential requirements for continued discharges from WRF to Canadian River.
Stormwater Capture and Reuse	2	Requires significant study of feasibility. Significant land acquisition needed in developed areas for transmission and terminal storage.
Co-Owner with Oklahoma City for Southeast Oklahoma Treated Water	4	There are known water rights issues that must be resolved. The source project is actively being pursued by Oklahoma City.
Co-Owner with Oklahoma City for Southeast Oklahoma Raw Water	4	There are known water rights issues that must be resolved. The source project is actively being pursued by Oklahoma City.

Table 3.22 Preliminary Screening Criteria – Certainty and Timeliness

Source Name	Certainty and Timeliness Score[1]	Notes
Scissortail Reservoir	3	This was identified as a viable reservoir site, however permitting new reservoir construction will be challenging. Planning studies have been completed and Ada is interested in collaborating.
Parker Reservoir	3	This was identified as a viable reservoir site, however permitting new reservoir construction will be challenging. Detailed planning studies have not been completed.
Kaw Lake	4	Resolution of pending water right applications for Kaw Lake supplies is required. Existing reservoir but conveyance will require significant study and institutional cooperation between project participants.

Notes:

(1) Relative ranking where 1 represents the most significant implementation issues and 5 represents the least significant implementation issues.

Table 3.23 Preliminary Screening Criteria – Cost-Effectiveness		
Source Name	**Capital Unit Cost ($1000/AFY)**	**Notes on Criteria Rating**
Lake Thunderbird Spillage	$79	Costs impacted by large size of terminal storage reservoir necessary to get firm yield and the necessity to capture after it spills.
Lake Thunderbird Augmentation (IPR)	$8.2	
Groundwater Recharge (IPR)	$32	Cost impacted by level of treatment anticipated.
Canadian River Diversion Option 1	$39	Costs impacted by large size of terminal storage reservoir necessary to get firm yield.
Non-potable Reuse	$22	Costs impacted by transmission infrastructure necessary to get supply to customers when and where needed.
Stormwater Capture and Reuse	$190	Costs impacted by large size of terminal storage reservoir necessary to get firm yield.
Co-Owner with Oklahoma City for Southeast Oklahoma Treated Water	$12	
Co-Owner with Oklahoma City for Southeast Oklahoma Raw Water	$14	Includes costs for terminal storage reservoir.
Scissortail Reservoir	$18	Assumes participation with Ada.
Parker Reservoir	$19	
Kaw Lake[(1)]	$19	Assumes participation with Stillwater.

Notes:
(1) Kaw Lake capital unit cost does not include any debt service or other costs that may be incurred, but may be updated as information becomes available.

Table 3.24 Preliminary Screening Criteria – Summary

Source Name	Retained for Use in Portfolio Analyses?	Explanatory Notes
Lake Thunderbird	Yes	Existing local source
Garber-Wellington Aquifer Wells	Yes	Existing local source
Conservation	Yes	Existing local source
Lake Thunderbird Spillage	No	Very high unit cost, large uncertainty related to implementation, and uncertainty of long-term reliability remove this source from further evaluation.
Lake Thunderbird Augmentation (IPR)	Yes	Low unit cost, uncertainty for implementation, however community benefits and efficiency justify further evaluation.
Groundwater Recharge (IPR)	No	High unit cost and significant uncertainty for implementation remove this source from further evaluation; Lake Thunderbird Augmentation option for IPR is more implementable and significantly more cost-effective.
Canadian River Diversion Option 1	No	High unit cost and significant uncertainty for implementation remove this source from further evaluation.
Non-potable Reuse	Yes	Even with high unit cost, this source has community benefits and efficiency that justify further evaluation.
Stormwater Capture and Reuse	No	Very high unit cost, uncertainty related to implementation, and uncertainty of long-term reliability remove this source from further evaluation.
Co-Owner with Oklahoma City for Southeast Oklahoma Treated Water	Yes	Low unit cost, detailed studies completed, and project proponents moving forward toward implementation.
Co-Owner with Oklahoma City for Southeast Oklahoma Raw Water	Yes	Low unit cost, detailed studies completed, and project proponents moving forward toward implementation.
New Out of Basin Reservoir	Yes	Scissortail and Parker scored similarly against screening criteria, and were thus combined into “New Out of Basin Reservoir” source for purposes of portfolio evaluations
Kaw Lake	Yes	Existing reservoir, low unit costs, and opportunities for regional partnerships for implementation

Chapter 4

WATER SUPPLY PORTFOLIOS

Using the results of the individual supply source screening, several water supply portfolios were developed. Each portfolio uses one or more of the viable supply sources identified via the source screening to meet the entire 2060 projected demand for the NUA service area reliably. These portfolios were analyzed, compared, and refined using detailed evaluation criteria. This chapter describes the portfolio evaluation criteria, development and evaluation of portfolios, and the results of portfolio analysis.

4.1 OBJECTIVES DEVELOPMENT AND WEIGHTING

Evaluation criteria, sometimes referred to as “objectives” for water supply, were used as the basis for evaluating and comparing a range of water supply portfolios. The evaluation process is described briefly below.

- Objectives, sub-objectives, and performance measures were defined to provide a common basis for detailed evaluation and comparison of supply portfolios.
- The primary objectives were comparatively weighted using a ”paired comparison” methodology.
- Portfolios were first scored separately for each objective, independent of the objectives’ relative weight, then ranked using the individual objectives’ weights developed in the preceding step.

The objectives, sub-objectives, and performance measures shown in Table 4.1 represent the factors that were used to evaluate and compare supply portfolios.

In nearly all decision-making processes, the objectives are not all equally important. Some objectives may be more relevant for a given stakeholder than others. As an example, for a given individual, environmental stewardship may be more important than timely implementation. Moreover, these relative weightings vary from person to person, reflecting each individual’s values. Thus, weighting objectives is necessary to reflect better the range of values and preferences present in the decision-making process.

For the SWSP, the relative weights of the primary objectives were determined through a process known as “paired comparison.” This method is based on the fact that when presented with a series of objectives, a decision as to the relative importance of those objectives against each other is made more simply when the objectives are compared separately in pairs. The results of the comparison of each pair of objectives are later aggregated to determine the overall importance of every objective. Results from the paired comparison exercise are available in Appendix R.

Table 4.1 Portfolio Evaluation Criteria

Objective	Sub-objective	Performance Measure
Affordability *"What will it cost to reliably provide treated water?"*	✓ Minimize capital cost	✓ Unit capital cost including diversion, transmission, and treatment ($/AFY of firm yield using 2012 non-escalated dollars)
	✓ Minimize life-cycle cost	✓ 2060 O&M ($M/Yr)
Long-Term Supply Reliability *"Will we be able to reliably meet our demand?"*	✓ Minimize supply shortages	✓ Weighted average of 2060 shortages (frequency) in basins of origin (per 2012 OCWP Watershed Planning Regional Reports)
		✓ Supply diversity in terms of number of sources and types of sources (qualitative score)
		✓ Percent of supply portfolio coming from Garber-Wellington Aquifer
	✓ Infrastructure reliability	✓ Raw water transmission distance (mi)
		✓ Transmission complexity, considering length of pipeline and number/complexity of pumping operations (qualitative score)
		✓ Treatment complexity (qualitative score)
		✓ Degree of redundancy, e.g., parallel pipelines (qualitative score)
Phasing Potential *"Can we defer capital and increase the supply over time?"*	✓ Defer capital costs	✓ Ability to phase implementation and construction (qualitative score)
	✓ Provide for future needs	✓ Ability to access additional supplies beyond projected 2060 demands (qualitative score)
Timely Implementation and Certainty *"Are we certain we can bring the supply online by the time it is needed?"*	✓ Reduce institutional complexity and increase local control	✓ Number of agency/utility partners (facility owners and/or project co-participants) (qualitative score)
		✓ Percent of supply sourced in Norman
		✓ Public/political acceptability (qualitative score)
		✓ Vulnerability to potential future changes in water rights allocations and water quality standards (qualitative score)
	✓ Timely implementation	✓ Project development status in 2012 for new supplies in portfolio (qualitative score)
		✓ Amount and ease of environmental permitting, water rights acquisition, and land acquisition (qualitative score)

Table 4.1 Portfolio Evaluation Criteria		
Objective	**Sub-objective**	**Performance Measure**
Efficient Use of Water Resources *"Are we making the best use of the available resources?"*	✓ Maximize water use efficiency	✓ Percent of total demand met by non-potable reuse in 2060
		✓ Percent of total demand met by indirect reuse (supply augmentation) in 2060
	✓ Increase conservation	✓ Percent reduction from baseline demand due to additional conservation measures and programs
Environmental Stewardship *"Are we preserving our environmental resources?"*	✓ Minimize energy consumption	✓ Pumping head per unit supply (ft/1000 AFY)
	✓ Minimize temporary construction impacts and environmental mitigation needs	✓ Amount of land disturbed during construction (ac)
	✓ Minimize permanent ecosystem impacts	✓ Environmental impacts (qualitative score)
	✓ Increase use of renewable resources	✓ Renewable supply score for portfolio (qualitative score)
Treated Water Quality Aesthetics *"Will our customers be satisfied with the quality of the water we deliver?"*	✓ Achieve secondary MCLs	✓ Blended average conductivity (µg/L)
	✓ Minimize taste and odor potential	✓ Percent of supply originating from surface water sources
Community Values (Recreation, Aesthetics, and Property Rights) *"Will our community gain value from this alternative, while protecting property rights?"*	✓ Impact on non-water supply benefits	✓ Perceived impacts to recreation and aesthetics (qualitative score)
	✓ Protection of property rights	✓ Potential impact to property rights (qualitative score)

Members of NUA staff, trustees and chairman, and members of the SWSP Ad Hoc Committee were invited to complete the paired comparison exercise. This exercise and the portfolio evaluation process is intended to show the range of values present in the community and to seek out two or more portfolios that robustly meet the range of values expressed by community members.

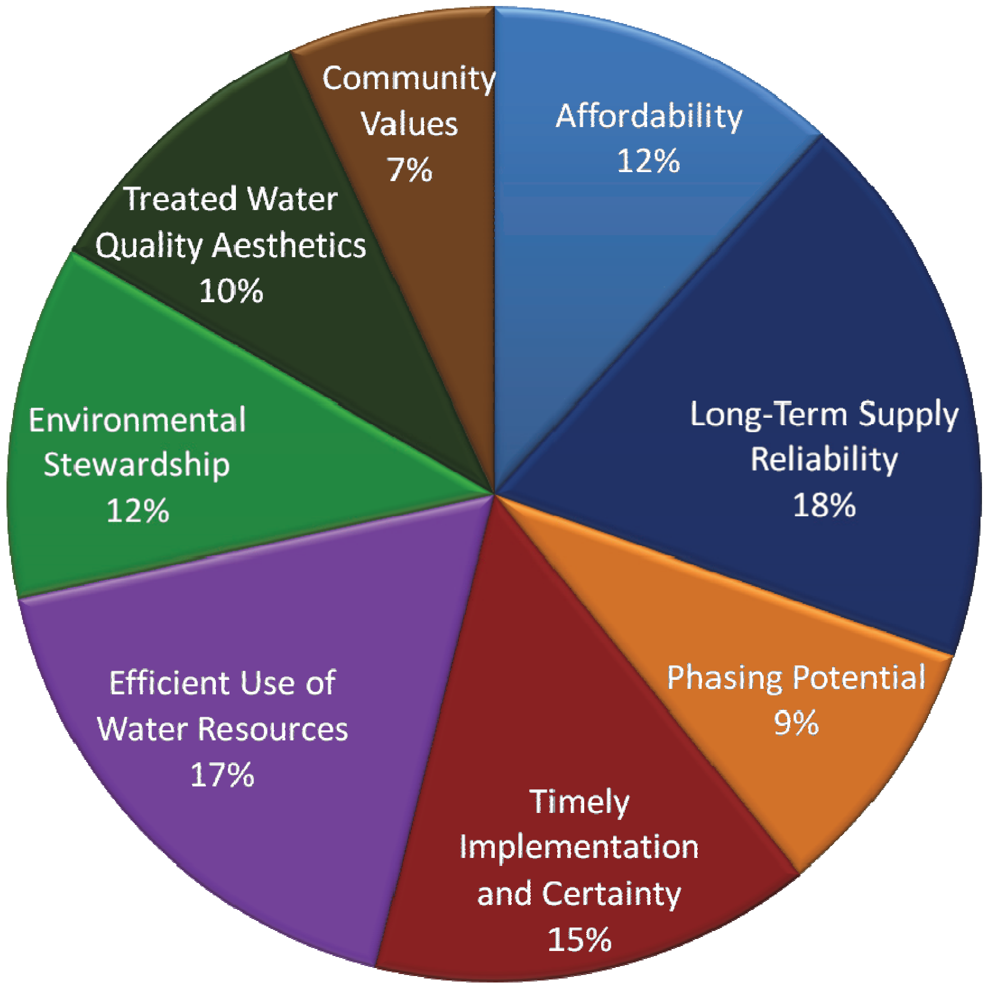
In the paired comparison exercise, all possible pairs of primary objectives are identified. Each participant chooses which objective from each pair is more important to him or her. The results are summed to get a relative percentage weight of importance for each objective. Higher percent weightings indicate a higher importance. Figure 4.1 summarizes the major objectives and their relative importance, or weight, averaged for those who participated in the weighting exercise. This weighting profile was used as the primary basis for comparing and ranking portfolios. However, discussions at AHC meetings and in interim analyses assessed the sensitivity to changes in the objective weightings, to understand the impact – if any – on the relative ranking in response to changes in objective weighting profiles. The final recommended portfolios were found to be generally insensitive to minor modifications in weighting profiles. This suggests that the recommended portfolios are diverse and offer multiple benefits, balancing the tradeoffs between economic costs and non-monetary benefits.

4.2 WATER SUPPLY PORTFOLIOS

Initially, six portfolios were developed that looked at extremes in long-range water supply for Norman. For example, Portfolio 5 looked at meeting all of Norman's 2060 water demand using a new out-of-basin reservoir. An additional eight portfolios, referred to as "hybrid portfolios" because they took elements of the initial six portfolios and recombined them into new portfolios, were developed over the course of SWSP analyses.

The hybrid portfolios were assembled with the intent of combining the strongest regional and local sources in order to determine the most robust long-range water supply options to meet NUA's long-term water needs. Assumptions regarding individual supply sources detailed in Chapters 2 and 3 of this report were carried forth for the portfolio analyses. Individual supplies were combined into the portfolios, adjusting the individual sources' sizing (annual average or peak day yields) so that each portfolio would meet the projected 2060 demands. Capital and operational costs were adjusted to reflect the source supply amounts utilized in the portfolio. Table 4.2 summarizes the amount of water provided by each source, on an average annual amount, in each of the 14 portfolios. All portfolios provide an annual average total supply of 29.1 mgd and a peak day supply of 55.3 mgd, matching the 2060 higher-end demand projections. To the degree that lower demands are observed (e.g., less conversion of domestic wells to NUA water service), implementation of new supply projects or expansions can be delayed or deferred.

Detailed portfolio evaluation workbooks are provided in Appendix B.



WEIGHTING FOR PORTFOLIO EVALUATION CRITERIA

FIGURE 4.1

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

Table 4.2 Portfolio Summary

Portfolio ID	2060 Supply by Source (mgd)												
		Lake Thunderbird	Active Garber-Wellington Wells (with treatment)	Inactive Garber-Wellington Wells (with treatment)	New Garber-Wellington Wells (with treatment)	Additional Conservation	Non-potable Reuse	Lake Thunderbird Augmentation (IPR)	Treated Water from Oklahoma City (wholesale)	Treated Water from Oklahoma City (co-owner)	Raw Water from Oklahoma City (co-owner)	New Out of Basin Reservoir (Parker or Scissortail)	Kaw Lake
P1	Annual Average	6.1	6.0	2.1		1.0	0.8	12.4					
	Peak	17	9.0	2.7		1.5	4.6	20.5					
P2	Annual Average	6.1	6.0	2.1		1.0	0.8		13.1				
	Peak	17	9.0	2..7		1.5	4.6		20.5				
P3	Annual Average									29.1			
	Peak									55.3			
P4	Annual Average										29.1		
	Peak										55.3		

Table 4.2 Portfolio Summary

Portfolio ID	2060 Supply by Source (mgd)												
		Lake Thunderbird	Active Garber-Wellington Wells (with treatment)	Inactive Garber-Wellington Wells (with treatment)	New Garber-Wellington Wells (with treatment)	Additional Conservation	Non-potable Reuse	Lake Thunderbird Augmentation (IPR)	Treated Water from Oklahoma City (wholesale)	Treated Water from Oklahoma City (co-owner)	Raw Water from Oklahoma City (co-owner)	New Out of Basin Reservoir (Parker or Scissortail)	Kaw Lake
P5	Annual Average											29.1	
	Peak											55.3	
P6	Annual Average												29.1
	Peak												55.3
P7	Annual Average	6.1				1.0	0.8			21.2			
	Peak	17				1.5	4.6			32.2			
P8	Annual Average	6.1				1.0		17.0	5.0				
	Peak	17				1.5		29.3	7.5				

Table 4.2 Portfolio Summary

Portfolio ID		2060 Supply by Source (mgd)											
		Lake Thunderbird	Active Garber-Wellington Wells (with treatment)	Inactive Garber-Wellington Wells (with treatment)	New Garber-Wellington Wells (with treatment)	Additional Conservation	Non-potable Reuse	Lake Thunderbird Augmentation (IPR)	Treated Water from Oklahoma City (wholesale)	Treated Water from Oklahoma City (co-owner)	Raw Water from Oklahoma City (co-owner)	New Out of Basin Reservoir (Parker or Scissortail)	Kaw Lake
P9	Annual Average	6.1	6.0	2.1	13.1	1.0	0.8						
	Peak	17	9.0	2.7	20.5	1.5	4.6						
P10	Annual Average	6.1	6.0	2.1		1.0	0.8					13.1	
	Peak	17	9.0	2.7		1.5	4.6					20.5	
P11	Annual Average	6.1	6.0	2.1		1.0	0.8			13.1			
	Peak	17	9.0	2.7		1.5	4.6			20.5			
P12	Annual Average	6.1				1.0						22.0	
	Peak	17				1.5						36.8	

Table 4.2 Portfolio Summary

Portfolio ID		2060 Supply by Source (mgd)											
		Lake Thunderbird	Active Garber-Wellington Wells (with treatment)	Inactive Garber-Wellington Wells (with treatment)	New Garber-Wellington Wells (with treatment)	Additional Conservation	Non-potable Reuse	Lake Thunderbird Augmentation (IPR)	Treated Water from Oklahoma City (wholesale)	Treated Water from Oklahoma City (co-owner)	Raw Water from Oklahoma City (co-owner)	New Out of Basin Reservoir (Parker or Scissortail)	Kaw Lake
P13	Annual Average	6.1	6.0	2.1		1.0	0.8				13.1		
	Peak	17	9.0	2.7		1.5	4.6				20.5		
P14	Annual Average	6.1	6.0	2.1	2.0	1.0	0.8	11.1					
	Peak	17	9.0	2.7	3.0	1.5	4.6	17.5					

4.2.1 Portfolio 1

Portfolio 1 is a diverse portfolio that maximizes use of local sources like Lake Thunderbird, groundwater wells, and use of reclaimed water. The available supply from Lake Thunderbird is based on Norman's allocation of the firm yield of the reservoir. It is assumed that all of the groundwater wells (active and inactive) will be piped together and receive centralized treatment for chromium-6 and arsenic. Reclaimed water will be used for augmenting Lake Thunderbird (with treatment to address anticipated regulations for IPR plus non-regulated contaminants like EDCs and pharmaceutically-active compounds) and for non-potable purposes like irrigation (with treatment needed to comply with ODEQ NPR regulations). Conservation programs will be expanded to provide additional water savings beyond Norman's existing programs.

Table 4.3 summarizes key attributes and a comparison of Portfolio 1 to other portfolios for some of the key evaluation criteria. The complete set of scores for this portfolio relative to all objectives and performance measures, as used in the evaluation and ranking process, is provided in Appendix B. This portfolio offers a locally diverse supply portfolio combining surface, groundwater, and reclaimed water supplies within or close to the city. Because supplies are local, there is less energy required for bringing raw water to treatment/distribution facilities. However, this portfolio requires three unique treatment processes: continued potable water treatment for Lake Thunderbird, new potable treatment for groundwater supplies, and new treatment for reclaimed water tailored to requirements for Lake Thunderbird augmentation and for NPR. While NPR is allowed and regulated by ODEQ, there are no current regulations allowing for IPR or precedent for discharging to a SWS (Lake Thunderbird augmentation). In the 2060 SWSP, IPR treatment was assumed to not only meet anticipated regulations but also address non-regulated contaminants like EDCs. However, even with this conservative planning approach, the lack of current regulations leaves this portfolio with uncertainties regarding timely implementation and costs.

Table 4.3 Portfolio 1 – Maximize Local Sources[1]

Affordability[2]	Unit Capital Cost ($M/AFY)	$7,672
	2060 O&M Cost ($/yr)	$21.3
	Capital Cost ($M)	$250
Long-Term Supply Reliability	Diversity of Supply Sources	Most Diverse
	Complexity of Transmission System	Least Complex
	Complexity of Treatment	More Complex
	Percent of Supply from Garber-Wellington Aquifer	29%
Phasing Potential	Ability to Phase Projects	Best Opportunity
	Ability to Meet Demands Beyond 2060	Good Opportunity

Table 4.3 Portfolio 1 – Maximize Local Sources[1]		
Timely Implementation and Certainty	Percent of Local Supply	100%
	Vulnerability to potential future changes in water rights allocations and water quality standards	More Vulnerable
	Project development status in 2012	Lack of existing regulations and/or no detailed studies[3]
Efficient Use of Water Resources	Percent of supply utilizing reclaimed wastewater (both NPR and IPR)	49%
Environmental Stewardship	Energy required for operation	Lower energy
	Permanent Environmental Impacts	Average impact
Treated Water Quality Aesthetics	Achieve secondary MCLs	Average likelihood
	Minimize taste and odor potential	Average potential
Community Values	Impact on property rights	Average impact

Notes:

(1) Representative evaluation of portfolio. Not all evaluation criteria are included in this table, but are available in Appendix B. Analysis is based on comparison between portfolios (for example, is Portfolio 1 more likely, less likely, or about the same as Portfolio 2 to have permanent environmental impacts).

(2) All costs are in 2012 dollars (ENR 5416).

(3) Represents the current regulatory uncertainty of Lake Thunderbird Augmentation and chromium-6 MCL.

4.2.2 Portfolio 2

Portfolio 2 is a diverse portfolio that minimizes capital investment through purchasing treated water from Oklahoma City on a wholesale basis. Similar to Portfolio 1, the available supply from Lake Thunderbird is based on Norman's allocation of the firm yield of the reservoir, it is assumed that all of the groundwater wells will be piped together and receive centralized treatment, and reclaimed water will be used for non-potable purposes like irrigation. Conservation programs will expand to offer some additional water savings. The remainder of 2060 demand will be met by purchasing treated water from Oklahoma City utilizing the terms of Oklahoma City's Take or Pay wholesale rate structure. This has a lower rate than the City's current Demand Service contract with Oklahoma City but requires a more consistent usage of water. Norman will likely need to use water from Oklahoma City to meet base demands and meet peak demands using other supply sources, which is the opposite of current practice of using water from Oklahoma City to meet seasonal peak demands only.

Table 4.4 summarizes key attributes and a comparison of Portfolio 2 to other portfolios for some of the key evaluation criteria. The complete set of scores for this portfolio relative to all objectives and performance measures, as used in the evaluation and ranking process, is provided in Appendix B. This portfolio offers a diverse supply portfolio combining surface, groundwater, and small amounts of reclaimed water supplies. All but purchasing water from Oklahoma City are considered local sources. This portfolio has less complicated treatment than Portfolio 1 in that it requires continued water treatment for Lake Thunderbird, new treatment for groundwater supplies, and new treatment for reclaimed water (though this treatment will be less complex and smaller quantities than that proposed for Lake Thunderbird augmentation). Portfolio 2 requires purchasing a significant amount of water from Oklahoma City to meet Norman's 2060 demands. While this source has minimal capital costs for Norman directly, the seller, Oklahoma City, is able to charge a water rate that allows them to cover their costs of supply, meaning that the rate includes their capital and operational costs for acquiring, transporting, treating, and distributing water to their customers. Over time, the cumulative annual costs become significant and would eventually exceed the cumulative capital and annual costs of other higher-capital portfolios.

Table 4.4 Portfolio 2 – Minimize Capital Cost(1)

Affordability(2)	Unit Capital Cost ($M/AFY)	$4,367
	2060 O&M Cost ($/yr)	$53.0
	Capital Cost ($M)	$140
Long-Term Supply Reliability	Diversity of Supply Sources	Good Diversity
	Complexity of Transmission System	Average Complexity
	Complexity of Treatment	Average Complexity
	Percent of Supply from Garber-Wellington Aquifer	29%
Phasing Potential	Ability to Phase Projects	Best Opportunity
	Ability to Meet Demands Beyond 2060	Average Opportunity
Timely Implementation and Certainty	Percent of Local Supply	53%
	Vulnerability to potential future changes in water rights allocations and water quality standards	Average Vulnerability
	Project development status in 2012	Detailed study completed and implementation initiated by project sponsor(3)
Efficient Use of Water Resources	Percent of supply utilizing reclaimed wastewater (both NPR and IPR)	3%
Environmental Stewardship	Energy required for operation	Higher energy
	Permanent Environmental Impacts	Fewer impacts
Treated Water Quality Aesthetics	Achieve secondary MCLs	Average likelihood
	Minimize taste and odor potential	Average potential
Community Values	Impact on property rights	Average impact

Notes:
(1) Representative evaluation of portfolio. Not all evaluation criteria are included in this table, but are available in Appendix B. Analysis is based on comparison between portfolios (for example, is Portfolio 1 more likely, less likely, or about the same as Portfolio 2 to have permanent environmental impacts).
(2) All costs are in 2012 dollars (ENR 5416).
(3) Reflects understanding of purchasing water from Oklahoma City as wholesale customer.

4.2.3 Portfolios 3, 4, 5, and 6

Portfolios 3, 4, 5, and 6 are single source portfolios, meaning that Norman would meet its entire 2060 demand using a single supply source. These portfolios were evaluated primarily to determine which regional source best meets Norman's detailed supply objectives, described in Table 4.1. Portfolios 3 and 4 evaluate being a co-owner with Oklahoma City for water supply infrastructure as part of Oklahoma City's plans to expand its southeast

Oklahoma supplies. Portfolio 3 includes treatment of those supplies at Oklahoma City's Draper WTP, while Portfolio 4 would deliver raw water to Norman for treatment at a NUA facility. Portfolio 5 assesses obtaining water from a new out-of-basin reservoir (either Scissortail or Parker). Portfolio 6 evaluates conveying raw water from Kaw Lake to Norman for treatment and distribution, in partnership with Stillwater.

While these portfolios have a variety of supply sources, there are some similarities between them. None of these four portfolios has diverse supplies. All supplies are located a considerable distance from Norman, and thus have higher transmission costs (both in capital and operational costs).

There also are some significant differences between these portfolios. Treatment complexity varies based on water quality of supply, with anticipated raw water quality being better in Portfolios 3 and 4 and poorer in Portfolios 5 and 6. Portfolio 5 requires constructing a new source reservoir, which is a timely, complicated, and expensive process. However, it would likely offer the ability to meet Norman's demands beyond 2060. Alternatively, extra water could be sold (either wholesale or as co-owner) to other entities. Portfolios 3 and 4 rely on collaborating with Oklahoma City in a regional supply project. Oklahoma City is pursuing bringing water from Southeast Oklahoma to Central Oklahoma for treatment and distribution. There are known permitting and water rights issues that must be resolved in order to develop this water supply. Portfolio 6 utilizes an existing reservoir, but the conveyance distance is considerable and will require significant study before implementation. The unknowns for each of Portfolios 3, 4, 5, and 6 factor into the key attributes listed in Table 4.5, Table 4.6, Table 4.7, and Table 4.8. The complete set of scores for each of these portfolios relative to all objectives and performance measures, as used in the evaluation and ranking process, is provided in Appendix B.

Table 4.5 Portfolio 3 – Regional Option with Oklahoma City Treated Water(1)

Affordability(2)	Unit Capital Cost ($M/AFY)	$12,494
	2060 O&M Cost ($/yr)	$23.6
	Capital Cost ($M)	$410
Long-Term Supply Reliability	Diversity of Supply Sources	Poor diversity
	Complexity of Transmission System	More Complex
	Complexity of Treatment	Least Complex
	Percent of Supply from Garber-Wellington Aquifer	0%
Phasing Potential	Ability to Phase Projects	Average Opportunity
	Ability to Meet Demands Beyond 2060	Average Opportunity

Table 4.5 Portfolio 3 – Regional Option with Oklahoma City Treated Water(1)		
Timely Implementation and Certainty	Percent of Local Supply	0%
	Vulnerability to potential future changes in water rights allocations and water quality standards	Least Vulnerable
	Project development status in 2012	Some studies conducted and permitting process established(3)
Efficient Use of Water Resources	Percent of supply utilizing reclaimed wastewater (both NPR and IPR)	0%
Environmental Stewardship	Energy required for operation	Average energy
	Permanent Environmental Impacts	Average impact
Treated Water Quality Aesthetics	Achieve secondary MCLs	High likelihood
	Minimize taste and odor potential	Higher potential
Community Values	Impact on property rights	Fewer impacts

Notes:

(1) Representative evaluation of portfolio. Not all evaluation criteria are included in this table, but are available in Appendix B. Analysis is based on comparison between portfolios (for example, is Portfolio 1 more likely, less likely, or about the same as Portfolio 2 to have permanent environmental impacts).

(2) All costs are in 2012 dollars (ENR 5416).

(3) Reflects status of bringing water from Southeast Oklahoma. There are uncertainties associated with water rights, however the process and treatment required is well understood.

Table 4.6 Portfolio 4 – Regional Option with Oklahoma City Raw Water(1)		
Affordability(2)	Unit Capital Cost ($M/AFY)	$13,538
	2060 O&M Cost ($/yr)	$23.8
	Capital Cost ($M)	$440
Long-Term Supply Reliability	Diversity of Supply Sources	Poor diversity
	Complexity of Transmission System	More Complex
	Complexity of Treatment	Average Complexity
	Percent of Supply from Garber-Wellington Aquifer	0%
Phasing Potential	Ability to Phase Projects	Poor phasing potential
	Ability to Meet Demands Beyond 2060	Average Opportunity
Timely Implementation and Certainty	Percent of Local Supply	0%
	Vulnerability to potential future changes in water rights allocations and water quality standards	Average Vulnerable
	Project development status in 2012	Some studies conducted and permitting process established(3)

Table 4.6 Portfolio 4 – Regional Option with Oklahoma City Raw Water[1]		
Efficient Use of Water Resources	Percent of supply utilizing reclaimed wastewater (both NPR and IPR)	0%
Environmental Stewardship	Energy required for operation	Average energy
	Permanent Environmental Impacts	Average impact
Treated Water Quality Aesthetics	Achieve secondary MCLs	Highly Likely
	Minimize taste and odor potential	Higher potential
Community Values	Impact on property rights	More impact[4]

Notes:

(1) Representative evaluation of portfolio. Not all evaluation criteria are included in this table, but are available in Appendix B. Analysis is based on comparison between portfolios (for example, is Portfolio 1 more likely, less likely, or about the same as Portfolio 2 to have permanent environmental impacts).

(2) All costs are in 2012 dollars (ENR 5416).

(3) Reflects status of bringing water from Southeast Oklahoma. There are uncertainties associated with water rights, however the process and treatment required is well understood.

(4) Reflects impacts to Norman resulting from building or expanding WTP versus using regional treatment facility proposed under Portfolio 3.

Table 4.7 Portfolio 5 – Regional Option with New Reservoir[1]		
Affordability[2]	Unit Capital Cost ($M/AFY)	$18,952
	2060 O&M Cost ($/yr)	$25.5
	Capital Cost ($M)	$620
Long-Term Supply Reliability	Diversity of Supply Sources	Poor Diversity
	Complexity of Transmission System	More Complex
	Complexity of Treatment	Average Complexity
	Percent of Supply from Garber-Wellington Aquifer	0%
Phasing Potential	Ability to Phase Projects	Poor phasing potential
	Ability to Meet Demands Beyond 2060	Good Opportunity
Timely Implementation and Certainty	Percent of Local Supply	0%
	Vulnerability to potential future changes in water rights allocations and water quality standards	Average vulnerability
	Project development status in 2012	Some studies conducted, needs new reservoir[3]
Efficient Use of Water Resources	Percent of supply utilizing reclaimed wastewater (both NPR and IPR)	0%

Table 4.7 Portfolio 5 – Regional Option with New Reservoir[1]		
Environmental Stewardship	Energy required for operation	Average energy
	Permanent Environmental Impacts	More impact
Treated Water Quality Aesthetics	Achieve secondary MCLs	Average likelihood
	Minimize taste and odor potential	Higher potential
Community Values	Impact on property rights	More impact

Notes:
(1) Representative evaluation of portfolio. Not all evaluation criteria are included in this table, but are available in Appendix B. Analysis is based on comparison between portfolios (for example, is Portfolio 1 more likely, less likely, or about the same as Portfolio 2 to have permanent environmental impacts).
(2) All costs are in 2012 dollars (ENR 5416).
(3) Reflects difficulty associated with developing new reservoir. Both Scissortail and Parker Reservoir sites have been evaluated but further study is necessary.

Table 4.8 Portfolio 6 – Regional Option with Kaw Lake[1]		
Affordability[2]	Unit Capital Cost ($M/AFY)	$19,155
	2060 O&M Cost ($/yr)	$25.7
	Capital Cost ($M)	$620
Long-Term Supply Reliability	Diversity of Supply Sources	Poor diversity
	Complexity of Transmission System	More complex
	Complexity of Treatment	Average complexity
	Percent of Supply from Garber-Wellington Aquifer	0%
Phasing Potential	Ability to Phase Projects	Poor phasing potential
	Ability to Meet Demands Beyond 2060	Poor opportunity
Timely Implementation and Certainty	Percent of Local Supply	0%
	Vulnerability to potential future changes in water rights allocations and water quality standards	Average vulnerability
	Project development status in 2012	Some studies conducted and permitting process established[3]
Efficient Use of Water Resources	Percent of supply utilizing reclaimed wastewater (both NPR and IPR)	0%
Environmental Stewardship	Energy required for operation	Lower energy
	Permanent Environmental Impacts	Average impact
Treated Water Quality Aesthetics	Achieve secondary MCLs	Possibly unlikely
	Minimize taste and odor potential	Higher potential
Community Values	Impact on property rights	More impact

Notes:
(1) Representative evaluation of portfolio. Not all evaluation criteria are included in this table, but are available in Appendix B. Analysis is based on comparison between portfolios (for example, is Portfolio 1 more likely, less likely, or about the same as Portfolio 2 to have permanent environmental impacts).
(2) All costs are in 2012 dollars (ENR 5416).
(3) Reflects status of routing study between Kaw Lake and Norman.

4.2.4 Portfolio 7

Portfolio 7 is a variation of Portfolio 3. Portfolio 7 evaluates continued use of Lake Thunderbird, adds non-potable reuse, and expands conservation. The remainder of the 2060 supply needs is met through partnering with Oklahoma City for treated water.

Table 4.9 summarizes key attributes and a comparison of Portfolio 7 to other portfolios for some of the key evaluation criteria. The complete set of scores for this portfolio relative to all objectives and performance measures, as used in the evaluation and ranking process, is provided in Appendix B. This portfolio offers a more diverse supply portfolio than Portfolio 7, by combining multiple surface water sources along with a small amount of reclaimed water supplies. It draws upon a combination of local and regional sources. Because of the regional project that would need to be constructed at one time in order to gain benefit, phasing ability (to increase supplies incrementally as demands grow over time) is limited. Known permitting and water rights issues associated with bringing water from Southeast Oklahoma are similar to those described under Portfolios 3 and 4. Treatment complexity is moderate in comparison to other portfolios, consisting of continued water treatment for Lake Thunderbird, new (shared) treatment for Southeast Oklahoma water, and new treatment for reclaimed water.

This portfolio offers several advantages over Portfolio 3. It continues to use existing source (Lake Thunderbird) recognizing that NUA has already made capital investments in this development, transmission, and treatment of this source water. However, it does not continue use of the groundwater wells. It implements a NPR project as in recognition of the high value placed on the efficient use of water resources by the community.

Table 4.9 Portfolio 7 – Hybrid Portfolio with Oklahoma City Treated Water(1)

Affordability(2)	Unit Capital Cost ($M/AFY)	$9,712
	2060 O&M Cost ($/yr)	$21.7
	Capital Cost ($M)	$320
Long-Term Supply Reliability	Diversity of Supply Sources	Average diversity
	Complexity of Transmission System	Average complexity
	Complexity of Treatment	Average complexity
	Percent of Supply from Garber-Wellington Aquifer	0%
Phasing Potential	Ability to Phase Projects	Poor phasing potential
	Ability to Meet Demands Beyond 2060	Average opportunity
Timely Implementation and Certainty	Percent of Local Supply	25%
	Vulnerability to potential future changes in water rights allocations and water quality standards	Average vulnerability
	Project development status in 2012	Some studies conducted and permitting process established(3)

Table 4.9	Portfolio 7 – Hybrid Portfolio with Oklahoma City Treated Water(1)	
Efficient Use of Water Resources	Percent of supply utilizing reclaimed wastewater (both NPR and IPR)	3%
Environmental Stewardship	Energy required for operation	Higher energy
	Permanent Environmental Impacts	Average impact
Treated Water Quality Aesthetics	Achieve secondary MCLs	Highly likely
	Minimize taste and odor potential	Higher potential
Community Values	Impact on property rights	Average impact

Notes:

(1) Representative evaluation of portfolio. Not all evaluation criteria are included in this table, but are available in Appendix B. Analysis is based on comparison between portfolios (for example, is Portfolio 1 more likely, less likely, or about the same as Portfolio 2 to have permanent environmental impacts).

(2) All costs are in 2012 dollars (ENR 5416).

(3) Reflects understanding of bringing water from Southeast Oklahoma and non-potable reuse.

4.2.5 Portfolio 8

Portfolio 8 is a variation on Portfolios 1 and 2. Portfolio 8 implements augmentation to Lake Thunderbird, expands conservation and continues using water from Lake Thunderbird. The remainder of the 2060 supply needs is met through purchasing treated water from Oklahoma City (as wholesale customer).

Table 4.10 summarizes key attributes and a comparison of Portfolio 8 to other portfolios for some of the key evaluation criteria. The complete set of scores for this portfolio relative to all objectives and performance measures, as used in the evaluation and ranking process, is provided in Appendix B. This portfolio offers moderate diversity, by combining multiple surface water sources and reclaimed water (at higher rates than Portfolios 1, 2, and 7). Treatment complexity is relatively high because of the advanced treatment required for the Lake Thunderbird augmentation project. Similar to the description in Portfolio 1, Portfolio 8 is contingent on future regulations on IPR. Similar to Portfolio 2, it is anticipated that Norman will utilize the Take or Pay lower wholesale contract rate that result in use of more consistent water from Oklahoma City and peaking off other sources.

This portfolio continues use of Lake Thunderbird and discontinues use of the existing Garber-Wellington Aquifer wells. Portfolio 8 implements a high level of reuse, in recognition of community values. This portfolio offers a more balanced approach to being a wholesale customer of Oklahoma City than Portfolio 2.

Table 4.10 Portfolio 8 – Hybrid Portfolio with Lake Thunderbird Augmentation[1]		
Affordability[2]	Unit Capital Cost ($M/AFY)	$5,527
	2060 O&M Cost ($/yr)	$33.8
	Capital Cost ($M)	$180
Long-Term Supply Reliability	Diversity of Supply Sources	Average diversity
	Complexity of Transmission System	Average complexity
	Complexity of Treatment	More Complex
	Percent of Supply from Garber-Wellington Aquifer	0%
Phasing Potential	Ability to Phase Projects	Good Opportunity
	Ability to Meet Demands Beyond 2060	Average Opportunity
Timely Implementation and Certainty	Percent of Local Supply	82%
	Vulnerability to potential future changes in water rights allocations and water quality standards	More Vulnerable
	Project development status in 2012	Lack of existing regulations and/or no detailed studies[3]
Efficient Use of Water Resources	Percent of supply utilizing reclaimed wastewater (both NPR and IPR)	60%
Environmental Stewardship	Energy required for operation	Higher energy
	Permanent Environmental Impacts	Average impact
Treated Water Quality Aesthetics	Achieve secondary MCLs	Average likelihood
	Minimize taste and odor potential	Higher potential
Community Values	Impact on property rights	Average impact

Notes:
(1) Representative evaluation of portfolio. Not all evaluation criteria are included in this table, but are available in Appendix B. Analysis is based on comparison between portfolios (for example, is Portfolio 1 more likely, less likely, or about the same as Portfolio 2 to have permanent environmental impacts).
(2) All costs are in 2012 dollars (ENR 5416).
(3) Represents the current regulatory uncertainty of Lake Thunderbird Augmentation.

4.2.6 Portfolio 9

Portfolio 9 is a variation on Portfolio 1. In Portfolio 9, Lake Thunderbird continues to be used and groundwater use is significantly expanded through drilling of new wells. Additionally, conservation is expanded and a NPR project is implemented.

Table 4.11 summarizes key attributes and a comparison of Portfolio 9 to other portfolios for some of the key evaluation criteria. The complete set of scores for this portfolio relative to all objectives and performance measures, as used in the evaluation and ranking process, is provided in Appendix B. This portfolio has a good diversity through its use of surface water, groundwater, and reuse. Treatment complexity is above average, as all of these sources require different treatment processes. Portfolio 9 offers the best opportunity for phasing as new wells can be drilled and connected to the transmission network for treatment as additional supply is needed. This portfolio offers a high degree of local control over the management of Norman's supplies.

A concern with Portfolio 9 is the changing water quality in the Garber-Wellington Aquifer and concerns over long-term viability of the aquifer if pumped heavily for an extended period. Norman has historically used the existing wells for short periods of time, allowing the wells to recover for several months between use. Over the last few years, in order to remain within Lake Thunderbird allocation and minimize purchasing treated water from Oklahoma City, Norman has used the wells more frequently. As the wells are used more heavily, some wells have seen declining water quality. If this trend continues, the well field capacity may be reduced. Additionally, NUA chose to take some wells offline when the Arsenic Groundwater Rule was implemented, rather than implement wellhead treatment at affected wells. Depending on the standard for chromium-6 in anticipated future regulations, most of NUA's existing wells will likely require treatment. There is also a possibility that other constituents that are not currently regulated could be subject to future regulation, and that standards for existing regulated contaminants could be tightened.

Another concern with Portfolio 9 is the quantity of water in the aquifer. As is described in Chapter 3, OWRB is currently studying the Garber-Wellington Aquifer. While the study is not complete, it is anticipated that the permanent EPS for the wellfield will be reduced from the temporary 2.0 AFY per acre of dedicated land that is used for permitting wells in the aquifer. Preliminary analyses indicate that permit availability will not limit Norman's ability to withdraw water (Norman can allocate more land if needed to increase permitted withdrawal amount). However, a groundwater permit does not guarantee the ability to withdraw water. As has been seen recently in declining water quality, NUA has also seen local water levels decline after more heavy usage. NUA will need to manage wells through spacing new wells so as not to influence surrounding wells, along with rotating well usage.

Table 4.11 Portfolio 9 – Hybrid Portfolio Maximizing Groundwater Use(1)

Affordability(2)	Unit Capital Cost ($M/AFY)	$9,985
	2060 O&M Cost ($/yr)	$24.3
	Capital Cost ($M)	$330
Long-Term Supply Reliability	Diversity of Supply Sources	Good diversity
	Complexity of Transmission System	Average complexity
	Complexity of Treatment	More Complex
	Percent of Supply from Garber-Wellington Aquifer	75%
Phasing Potential	Ability to Phase Projects	Best Opportunity
	Ability to Meet Demands Beyond 2060	Average Opportunity
Timely Implementation and Certainty	Percent of Local Supply	100%
	Vulnerability to potential future changes in water rights allocations and water quality standards	More Vulnerable
	Project development status in 2012	Permitting process uncertain(3)
Efficient Use of Water Resources	Percent of supply utilizing reclaimed wastewater (both NPR and IPR)	100%

Table 4.11 Portfolio 9 – Hybrid Portfolio Maximizing Groundwater Use[1]		
Environmental Stewardship	Energy required for operation	Lower energy
	Permanent Environmental Impacts	Average impact
Treated Water Quality Aesthetics	Achieve secondary MCLs	Average likelihood
	Minimize taste and odor potential	Lower potential
Community Values	Impact on property rights	Average impact

Notes:

(1) Representative evaluation of portfolio. Not all evaluation criteria are included in this table, but are available in Appendix B. Analysis is based on comparison between portfolios (for example, is Portfolio 1 more likely, less likely, or about the same as Portfolio 2 to have permanent environmental impacts).

(2) All costs are in 2012 dollars (ENR 5416).

(3) Represents the current regulatory uncertainty of chromium-6 MCL.

4.2.7 Portfolio 10

Portfolio 10 is a variation of Portfolio 5 and Portfolio 1. In Portfolio 10, Lake Thunderbird and existing groundwater wells (with treatment) continue to be used. Conservation is expanded and a non-potable reuse project is implemented. The balance of water supply needed to meet 2060 demands comes from a new Parker Reservoir.

Table 4.12 summarizes key attributes and a comparison of Portfolio 10 to other portfolios for some of the key evaluation criteria. The complete set of scores for this portfolio relative to all objectives and performance measures, as used in the evaluation and ranking process, is provided in Appendix B. This portfolio has a good diversity through its use of surface water, groundwater, and reuse. Treatment complexity is above average, as all of these sources require different treatment processes. Portfolio 10 offers water supply to meet needs beyond 2060. As described in Chapter 3, the capital cost for Parker Reservoir is based on meeting Norman's 2060 needs. Partnerships with other communities to share the reservoir's yield could reduce Norman's costs to develop this supply.

Portfolio 10 offers little opportunity for phasing, as the reservoir must be constructed at once. While Parker Reservoir has been studied, additional evaluation and detailed design and environmental assessment will need to be completed prior to implementation.

Table 4.12 Portfolio 10 – Hybrid Portfolio with Parker Reservoir[1]		
Affordability[2]	Unit Capital Cost ($M/AFY)	$14,996
	2060 O&M Cost ($/yr)	$24.7
	Capital Cost ($M)	$490
Long-Term Supply Reliability	Diversity of Supply Sources	Good diversity
	Complexity of Transmission System	More complex
	Complexity of Treatment	More complex
	Percent of Supply from Garber-Wellington Aquifer	30%
Phasing Potential	Ability to Phase Projects	Poor phasing opportunity
	Ability to Meet Demands Beyond 2060	Good Opportunity

Table 4.12 Portfolio 10 – Hybrid Portfolio with Parker Reservoir[1]		
Timely Implementation and Certainty	Percent of Local Supply	52%
	Vulnerability to potential future changes in water rights allocations and water quality standards	Average vulnerability
	Project development status in 2012	Some studies conducted, needs new reservoir[3]
Efficient Use of Water Resources	Percent of supply utilizing reclaimed wastewater (both NPR and IPR)	3%
Environmental Stewardship	Energy required for operation	Higher energy
	Permanent Environmental Impacts	More impact
Treated Water Quality Aesthetics	Achieve secondary MCLs	Average likelihood
	Minimize taste and odor potential	Average potential
Community Values	Impact on property rights	More impact

Notes:

(1) Representative evaluation of portfolio. Not all evaluation criteria are included in this table, but are available in Appendix B. Analysis is based on comparison between portfolios (for example, is Portfolio 1 more likely, less likely, or about the same as Portfolio 2 to have permanent environmental impacts).

(2) All costs are in 2012 dollars (ENR 5416).

(3) Represents the current regulatory uncertainty of chromium-6 MCL and need for new reservoir.

4.2.8 Portfolio 11

In Portfolio 11, Lake Thunderbird and existing groundwater wells (with treatment) continue to be used. Conservation is expanded and a NPR project is implemented. The balance of water supply needed to meet 2060 demands comes from partnering with Oklahoma City for treated water. Portfolio 11 differs from Portfolio 2 because Norman would be a co-owner in raw water supply, transmission, and treatment with Oklahoma City instead of a wholesale customer to Oklahoma City as in Portfolio 2.

Table 4.13 summarizes key attributes and a comparison of Portfolio 11 to other portfolios for some of the key evaluation criteria. The complete set of scores for this portfolio relative to all objectives and performance measures, as used in the evaluation and ranking process, is provided in Appendix B. This portfolio offers a diverse supply portfolio combining surface, groundwater, and small amounts of reclaimed water supplies. Treatment complexity is average in that it requires continued water treatment for Lake Thunderbird, new treatment for Southeast Oklahoma water, new treatment for groundwater supplies, and new treatment for reclaimed water (though this treatment will be less complex and smaller quantities than that proposed for Lake Thunderbird augmentation). Similar to Portfolio 3, phasing opportunities are limited.

Table 4.13 Portfolio 11 – Hybrid Portfolio with Oklahoma City for Treated Water[1]		
Affordability[2]	Unit Capital Cost ($M/AFY)	$9,266
	2060 O&M Cost ($/yr)	$27.5
	Capital Cost ($M)	$300
Long-Term Supply Reliability	Diversity of Supply Sources	Good diversity
	Complexity of Transmission System	Average complexity
	Complexity of Treatment	Average complexity
	Percent of Supply from Garber-Wellington Aquifer	29%
Phasing Potential	Ability to Phase Projects	Average phasing potential
	Ability to Meet Demands Beyond 2060	Average Opportunity
Timely Implementation and Certainty	Percent of Local Supply	53%
	Vulnerability to potential future changes in water rights allocations and water quality standards	Average vulnerability
	Project development status in 2012	Some studies conducted and permitting process established.[3]
Efficient Use of Water Resources	Percent of supply utilizing reclaimed wastewater (both NPR and IPR)	3%
Environmental Stewardship	Energy required for operation	Higher energy
	Permanent Environmental Impacts	Average impact
Treated Water Quality Aesthetics	Achieve secondary MCLs	Average likelihood
	Minimize taste and odor potential	Average potential
Community Values	Impact on property rights	Average impact

Notes:
(1) Representative evaluation of portfolio. Not all evaluation criteria are included in this table, but are available in Appendix B. Analysis is based on comparison between portfolios (for example, is Portfolio 1 more likely, less likely, or about the same as Portfolio 2 to have permanent environmental impacts).
(2) All costs are in 2012 dollars (ENR 5416).
(3) Represents the current regulatory uncertainty of chromium-6 MCL and status of bringing water from Southeast Oklahoma.

4.2.9 Portfolio 12

Portfolio 12 is similar Portfolio 10. In Portfolio 12, Lake Thunderbird continues to be used and conservation is expanded. A new Scissortail Reservoir provides the balance of water supply.

Table 4.14 summarizes key attributes and a comparison of Portfolio 12 to other portfolios for some of the key evaluation criteria. The complete set of scores for this portfolio relative to all objectives and performance measures, as used in the evaluation and ranking process, is provided in Appendix B. This portfolio is less diverse than Portfolio 10 because it lacks both groundwater and reuse. It has low phasing potential, similar to Portfolio 10, because a new reservoir must be constructed. There have been more recent studies completed for the Scissortail Reservoir site than for Parker Reservoir, but detailed planning and environmental studies are still needed. Similar to Portfolio 10, there is the ability to access water supply to meet Norman's water needs beyond 2060.

Table 4.14 Portfolio 12 – Hybrid Portfolio with Scissortail Reservoir[1]		
Affordability[2]	Unit Capital Cost ($M/AFY)	$13,209
	2060 O&M Cost ($/yr)	$22.4
	Capital Cost ($M)	$430
Long-Term Supply Reliability	Diversity of Supply Sources	Poor diversity
	Complexity of Transmission System	Average complexity
	Complexity of Treatment	Average complexity
	Percent of Supply from Garber-Wellington Aquifer	0%
Phasing Potential	Ability to Phase Projects	Poor phasing potential
	Ability to Meet Demands Beyond 2060	Good Opportunity
Timely Implementation and Certainty	Percent of Local Supply	22%
	Vulnerability to potential future changes in water rights allocations and water quality standards	Average vulnerability
	Project development status in 2012	Some studies conducted, needs new reservoir[3]
Efficient Use of Water Resources	Percent of supply utilizing reclaimed wastewater (both NPR and IPR)	0%
Environmental Stewardship	Energy required for operation	Average energy
	Permanent Environmental Impacts	More impact
Treated Water Quality Aesthetics	Achieve secondary MCLs	Average likelihood
	Minimize taste and odor potential	Higher potential
Community Values	Impact on property rights	More impact

Notes:
(1) Representative evaluation of portfolio. Not all evaluation criteria are included in this table, but are available in Appendix B. Analysis is based on comparison between portfolios (for example, is Portfolio 1 more likely, less likely, or about the same as Portfolio 2 to have permanent environmental impacts).
(2) All costs are in 2012 dollars (ENR 5416).
(3) Reflects difficulty associated with developing new reservoir.

4.2.10 Portfolio 13

Portfolio 13 is very similar to Portfolio 11, but differs in that Norman would collaborate with Oklahoma City for raw water supply and transmission, but treat the water at a NUA facility. In Portfolio 12, Lake Thunderbird and existing groundwater wells (with treatment) continue to be used. Conservation is expanded and a non-potable reuse project is implemented.

Table 4.15 summarizes key attributes and a comparison of Portfolio 13 to other portfolios for some of the key evaluation criteria. The complete set of scores for this portfolio relative to all objectives and performance measures, as used in the evaluation and ranking process, is provided in Appendix B. The benefits and drawbacks are similar to those listed under

Portfolio 11 with a few exceptions. Portfolio 13 offers more local control and has higher treatment complexity because Norman is responsible for treating the water.

Table 4.15 Portfolio 13 – Hybrid Portfolio with Oklahoma City for Raw Water[1]		
Affordability[2]	Unit Capital Cost ($M/AFY)	$10,337
	2060 O&M Cost ($/yr)	$22.8
	Capital Cost ($M)	$340
Long-Term Supply Reliability	Diversity of Supply Sources	Good diversity
	Complexity of Transmission System	Average complexity
	Complexity of Treatment	More Complex
	Percent of Supply from Garber-Wellington Aquifer	29%
Phasing Potential	Ability to Phase Projects	Average phasing potential
	Ability to Meet Demands Beyond 2060	Average opportunity
Timely Implementation and Certainty	Percent of Local Supply	53%
	Vulnerability to potential future changes in water rights allocations and water quality standards	Average vulnerability
	Project development status in 2012	Some studies conducted and permitting process established[3]
Efficient Use of Water Resources	Percent of supply utilizing reclaimed wastewater (both NPR and IPR)	3%
Environmental Stewardship	Energy required for operation	Higher energy
	Permanent Environmental Impacts	Average impact
Treated Water Quality Aesthetics	Achieve secondary MCLs	Average likelihood
	Minimize taste and odor potential	Average potential
Community Values	Impact on property rights	Average impact

Notes:
(1) Representative evaluation of portfolio. Not all evaluation criteria are included in this table, but are available in Appendix B. Analysis is based on comparison between portfolios (for example, is Portfolio 1 more likely, less likely, or about the same as Portfolio 2 to have permanent environmental impacts).
(2) All costs are in 2012 dollars (ENR 5416).
(3) Represents the current regulatory uncertainty of chromium-6 MCL and status of bringing water from Southeast Oklahoma.

4.2.11 Portfolio 14

Portfolio 14 is a variation of Portfolio 1. Portfolio 14 includes less water being sent to Lake Thunderbird for augmentation and recovery, and adds a few new groundwater wells. Portfolio 14 was added in response to input from AHC members suggesting that groundwater should continue to make up a similar proportion of Norman's 2060 supply as it does today.

Table 4.16 summarizes key attributes and a comparison of Portfolio 14 to other portfolios for some of the key evaluation criteria. The complete set of scores for this portfolio relative to all objectives and performance measures, as used in the evaluation and ranking process, is provided in Appendix B. The advantages and disadvantages are similar to Portfolio 1.

Table 4.16 Portfolio 14 – Hybrid Portfolio with New Wells and Lake Thunderbird Augmentation(1)		
Affordability(2)	Unit Capital Cost ($M/AFY)	$8,326
	2060 O&M Cost ($/yr)	$21.7
	Capital Cost ($M)	$270
Long-Term Supply Reliability	Diversity of Supply Sources	Most Diverse
	Complexity of Transmission System	Least Complex
	Complexity of Treatment	More Complex
	Percent of Supply from Garber-Wellington Aquifer	36%
Phasing Potential	Ability to Phase Projects	Best Opportunity
	Ability to Meet Demands Beyond 2060	Good Opportunity
Timely Implementation and Certainty	Percent of Local Supply	100%
	Vulnerability to potential future changes in water rights allocations and water quality standards	More Vulnerable
	Project development status in 2012	Lack of existing regulations and/or no detailed studies (3)
Efficient Use of Water Resources	Percent of supply utilizing reclaimed wastewater (both NPR and IPR)	42%
Environmental Stewardship	Energy required for operation	Lower energy
	Permanent Environmental Impacts	Average impact
Treated Water Quality Aesthetics	Achieve secondary MCLs	Average likelihood
	Minimize taste and odor potential	Average potential
Community Values	Impact on property rights	Average impact

Notes:
(1) Representative evaluation of portfolio. Not all evaluation criteria are included in this table, but are available in Appendix B. Analysis is based on comparison between portfolios (for example, is Portfolio 1 more likely, less likely, or about the same as Portfolio 2 to have permanent environmental impacts).
(2) All costs are in 2012 dollars (ENR 5416).
(3) Represents the current regulatory uncertainty of Lake Thunderbird Augmentation and chromium-6 MCL.

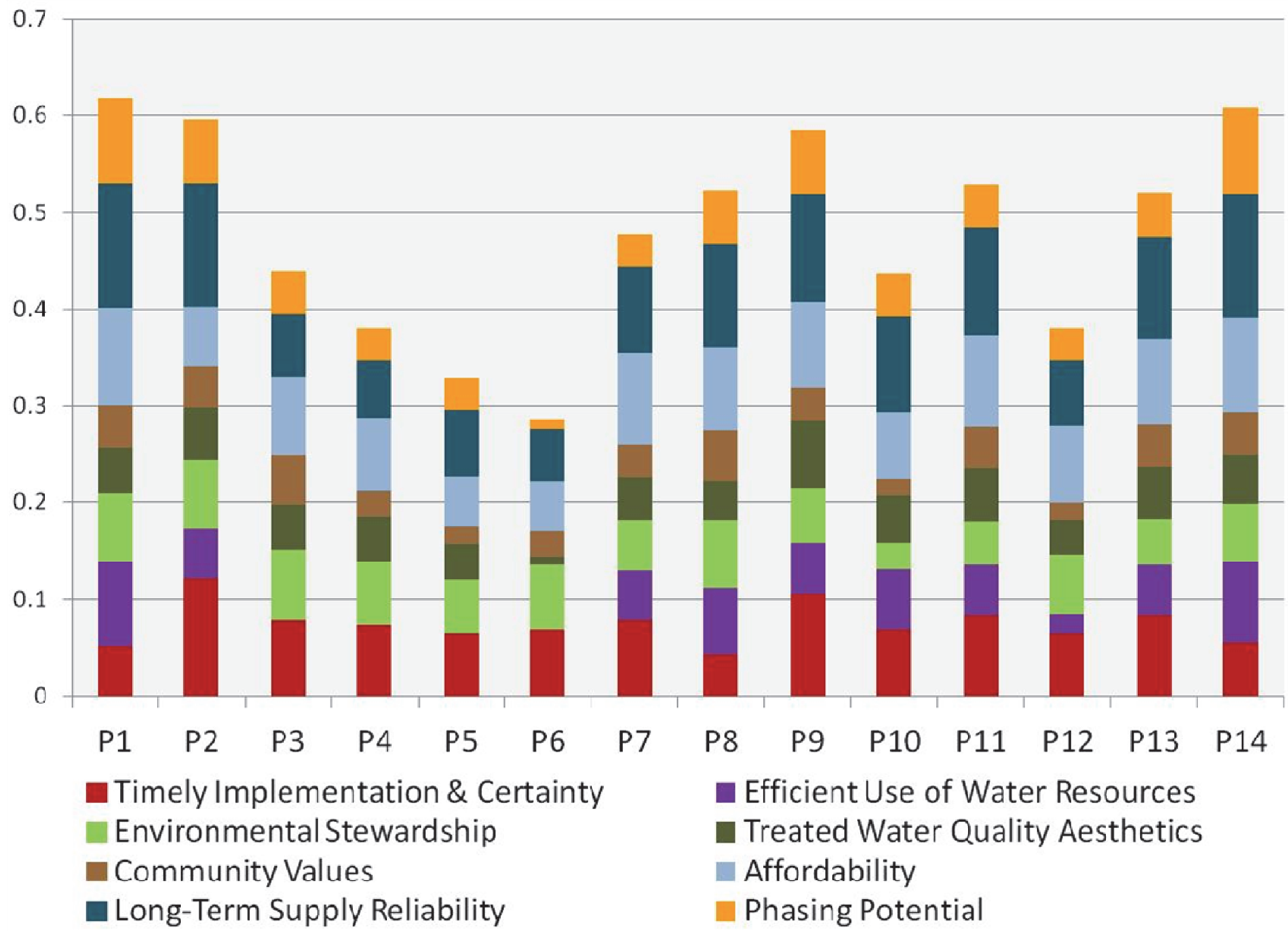
4.3 COMPARISON OF PORTFOLIOS

To compare the portfolios, raw scores were calculated or assigned for each objective and sub-objective, as listed in Section 4.1. The qualitative performance measures were rated on a scale of 1 to 5 and represent relative performance of a portfolio when compared to other portfolios. Quantitative measurements were calculated from data gathered for each portfolio. The raw score for each objective was then multiplied by the respective weighting to get a partial portfolio score. This process was repeated for each objective and for each portfolio utilizing commercially-available software designed for this purpose. Figure 4.2 illustrates the results of this analysis. A higher decision score indicates that the portfolio performed better against the most important objectives. Portfolios that meet a wide range of objectives well also were observed to score well in this analysis.

As expected, the single source portfolios, Portfolios 3, 4, 5, and 6, did not score well compared to other portfolios. These single source portfolios lack diversity, lack efficient water use (driven by conservation and use of treated water from the WRF), and lack local control and generally have longer transmission distances. All of these factors impact a wide variety of objectives negatively and result in lower scores. However, if these four portfolios are evaluated relative to each other, Portfolios 3 and 4, which focus on partnering with Oklahoma City for Southeast Oklahoma water, meet Norman’s long term needs better than Portfolio 5, which requires a new reservoir, and Portfolio 6, which uses Kaw Lake and has a longer transmission distance. Portfolios 5 and 6 have not been studied in as much detail as Southeast Oklahoma water supply options. Portfolios 3, 4, 5, and 6 were eliminated from further consideration.

Portfolios 10 and 12 have large new regional water supply components but also use local supplies to varying degrees. Portfolio 12 scores the lowest of these regional portfolios. It discontinues use of existing groundwater wells, lacks any reuse projects, and has significant risk associated with developing a new reservoir. Portfolio 10 includes continued use of already developed local water sources and new reclaimed water (improving its ability to meet Norman’s objectives over Portfolio 12) but still scores poorly because of the risk and expense associated with developing a new reservoir. Portfolios 10 and 12 were eliminated from further consideration.

Portfolios 2, 7, 11, and 13 involve partnering with Oklahoma City either through purchasing water as a wholesale customer or by becoming a co-owner in infrastructure for additional water supply. Portfolio 2 has low capital costs and scores well because of the diversity of supply sources. However, its annual operating costs are the highest of all of the portfolios. Additionally, Oklahoma City in recent discussions has indicated a preference that Norman participate in the Southeast Oklahoma supply project as a co-owner of the infrastructure (proportional to Norman’s use of the supply), rather than having Oklahoma City finance Norman’s debt for the infrastructure and recover those costs through its wholesale rates. Portfolios 7, 11, and 13 all utilize a co-owner approach for new Southeast Oklahoma water supply. The scores for Portfolios 11 and 13 are very similar. Portfolio 13 offers a little more local control because Norman would be responsible for treating raw water from Southeast Oklahoma. Portfolio 7 has the lowest overall score of this group. Portfolio 7 abandons groundwater wells (rather than treating the groundwater under anticipated regulatory requirements), lowering its score for long-term supply reliability and public acceptability. Portfolios 2, 7, and 11 were eliminated from further consideration. Portfolio 13 is among the three final recommended portfolios.



PORTFOLIO COMPARISON

FIGURE 4.2

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

carollo

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Portfolio 8 and 9 take opposite approaches to the use of groundwater. Portfolio 8 abandons all use of groundwater (including existing wells), while Portfolio 9 maximizes use of groundwater through drilling a large number of new wells. Feedback from the AHC and SWSP public meetings suggested that neither approach is practical or in Norman’s best interest. It is impractical to eliminate groundwater completely, as groundwater offers some degree of supply reliability through resistance to drought. However, as discussed in Chapter 3, there are concerns both about Garber-Wellington Aquifer quantity and quality, so it is impractical to rely to on groundwater as the vast majority of Norman’s supply. Portfolios 8 and 9 were eliminated from further consideration.

Portfolios 1 and 14 are fairly similar in terms of supply sources, as illustrated by their similar weighted decision scores. Both portfolios continue using existing sources, expand conservation, and have new reclaimed water projects, all of which are important to meeting Norman’s objectives. Portfolios 1 and 14 comprise the remaining two of the three recommended portfolios.

RECOMMENDED WATER SUPPLY PORTFOLIOS

5.1 PORTFOLIOS THAT BEST MEET NORMAN'S CRITERIA

The following three portfolios best meet the community's most important objectives for water supply, and were thus recommended for further consideration.

- **Maximize Local Sources (Portfolio 1):** This portfolio focuses on Lake Thunderbird augmentation using highly treated water from Norman's WRF with an annual average 2060 supply of 13.1 mgd. This approach is known as indirect potable reuse (IPR), as it reuses a portion of effluent from an advanced WRF process train to augment potable supplies through an environmental buffer. This would require that a portion of flow from the WRF be pumped to Dave Blue Creek, where it would then flow by gravity into Lake Thunderbird and blend with natural-tributary supplies in the lake. Stored water would be diverted from the lake via an expanded intake and transmission to an expanded water treatment plant (WTP). Uncertainties associated with this portfolio include anticipated regulatory requirements for hexavalent chromium (also referred to as chromium-6) and other potential regulatory changes in groundwater and requirements for discharges of water from the WRF into Lake Thunderbird, a state-designated SWS source. This portfolio is dependent on promulgation of rules for IPR by ODEQ and definition of SWS discharge requirements. Because flows to the WRF will grow as NUA's service area population grows, this portfolio has the potential to meet demands well beyond 2060.
- **Partnership with Oklahoma City for Raw Water (Portfolio 13):** Portfolio 13 makes up the balance of water supply needed by partnering with Oklahoma City as a co-owner of infrastructure to deliver raw water from Southeast Oklahoma. This would include paralleling the existing 100-mile Atoka pipeline system and eventually extending diversion infrastructure to the Kiamichi River basin (annual average 2060 supply of 13.1 mgd). Norman's Southeast Oklahoma water deliveries would be treated by NUA in Norman. Portfolio 13 is dependent on Oklahoma City proceeding with the parallel Atoka pipeline system and resolution of outstanding water rights disputes. This portfolio also offers the ability to meet Norman's needs beyond the 2060 planning horizon.
- **New Groundwater Wells and Lake Thunderbird Augmentation (Portfolio 14):** This portfolio is very similar to Portfolio 1 except that Lake Thunderbird Augmentation is reduced to 11.1 mgd annual average supply in 2060, and the remaining 2.0 mgd would be met by drilling new Garber-Wellington Aquifer wells. Timing, benefits, and uncertainties are similar to those listed for Portfolio 1. Portfolio 14 offers additional phasing opportunities relative to Portfolio 1, as new wells could be brought on individually as demand conditions warrant.

The individual supply components comprising these three portfolios are tabulated in Table 5.1. Each of the three recommended portfolios includes the following supplies for meeting 2060 demands:

- Lake Thunderbird (at an anticipated reduced annual allocation of 6.1 mgd based on firm yield of the reservoir).
- Existing wells with treatment (annual average 8.1 mgd), adding centralized treatment to existing active wells for chromium-6 when required by anticipated regulations, and providing the ability to bring currently inactive wells back online with treatment for arsenic.
- Additional conservation (annual average 1 mgd).
- Additional non-potable water reuse for irrigation and industrial uses (annual average 0.8 mgd and 4.6 mgd of peak summer demands).

Portfolios 1 and 14 have a strong focus on local supplies through continued use of Lake Thunderbird, groundwater wells (existing wells in Portfolio 1, and existing wells plus a 2-mgd expansion in Portfolio 14), expanded conservation, a new NPR project, and a new large IPR project through Lake Thunderbird augmentation (13.1 mgd in Portfolio 1 and 11.1 mgd in Portfolio 14). Portfolio 13 is similar to Portfolio 1, except that it replaces Lake Thunderbird augmentation with investing as a co-owner with Oklahoma City for raw water.

Throughout the 2060 SWSP process, meetings were held to gather feedback from Ad Hoc Committee members, NUA trustees and chairman, and the public. Public and NUA feedback indicated a strong preference for including new wells to maintain the existing groundwater supply proportion and allow additional supply development in the short-term. Since Portfolio 1 and Portfolio 14 are very similar except that Portfolio 14 includes new wells, Portfolio 1 was eliminated from further consideration.

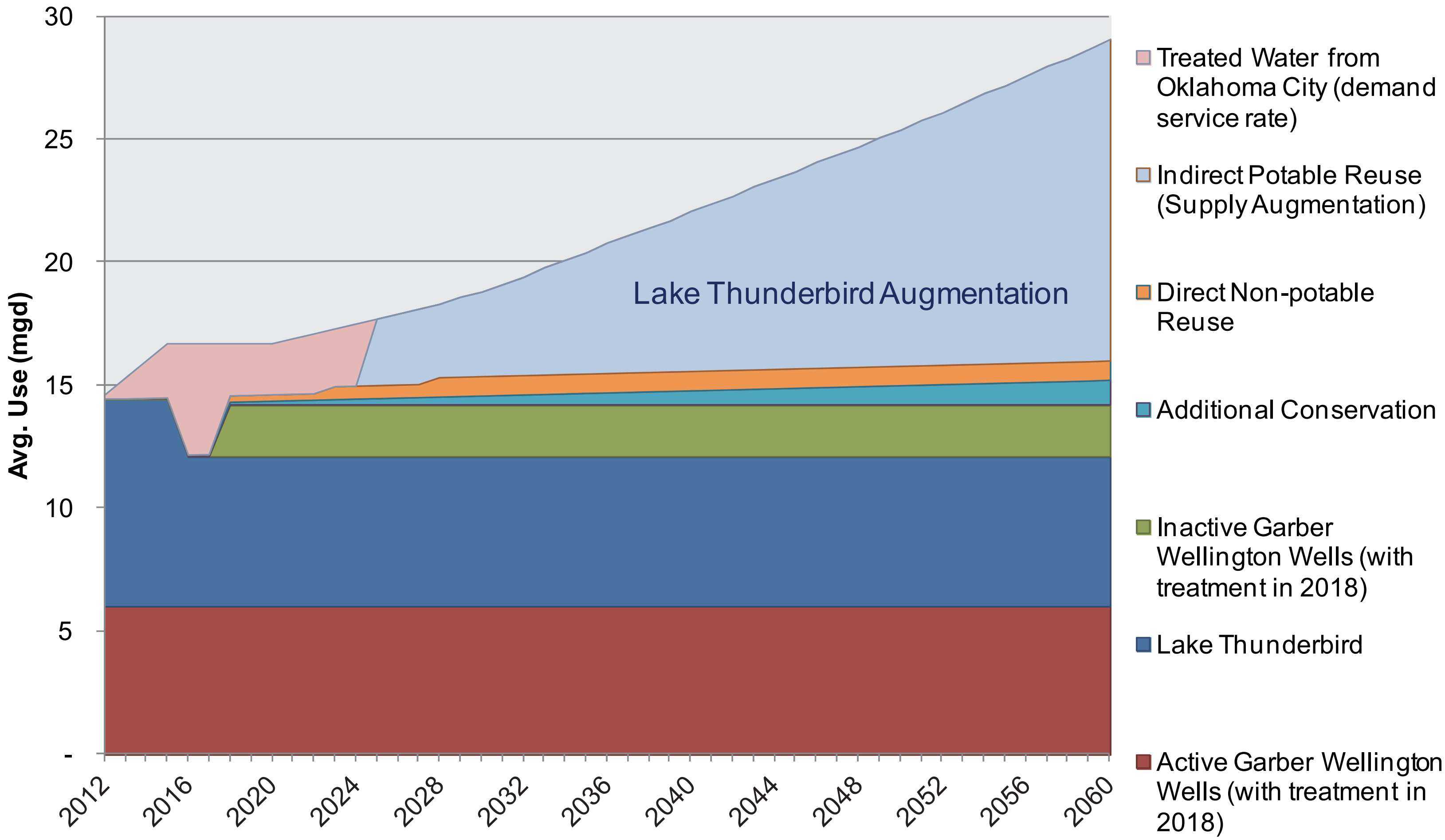
5.2 PHASED IMPLEMENTATION OF PORTFOLIOS 13 AND 14

In support of public, Ad Hoc Committee, and City Council dialogue, phased implementation was characterized for Portfolios 13 and 14. Figure 5.1 illustrates capacity phasing and Figure 5.2 illustrates capital costs for new infrastructure required for Portfolio 13. Figure 5.3 and Figure 5.4 illustrate phasing for Portfolio 14. Timing assumed for several elements is consistent between the two portfolios:

- The anticipated change in Lake Thunderbird allocation (assumed 2016, but triggered by allocation adjustment by COMCD);
- Centralized groundwater treatment and bringing inactive wells back online (assumed 2018, but triggered by promulgation of chromium-6 regulations);
- Expansion of conservation (gradually increasing from 2014 through 2060); and
- Implementation of the Phase 1 NPR system (2018; regulations are in place, but time needed for detailed design and construction to be completed).

Table 5.1 Recommended Portfolios

Portfolio	Water Supply Sources (Annual Average Supply in 2060, mgd)						Key Attributes
	Lake Thunderbird Allocation	Existing Groundwater Wells (with treatment)	New Groundwater Wells	Conservation and Non-potable Reuse	Lake Thunderbird Augmentation	Regional Supplies via Oklahoma City	
Maximize Local Sources (Portfolio 1)	6.1	8.1	–	1.8	13.1	–	• Discharge permitting uncertainties • Efficient use of water resources • Better phasing potential than Portfolio 13
Partnership with Oklahoma City for Raw Water (Portfolio 13)	6.1	8.1	–	1.8	–	13.1	• Local control over treatment • Contingent on Oklahoma City projects • Best option for meeting needs beyond 2060
New Groundwater Wells and Lake Thunderbird Augmentation (Portfolio 14)	6.1	8.1	2.0	1.8	11.1	–	• Discharge permitting uncertainties • Local control over sources • Efficient use of water resources • Best phasing potential

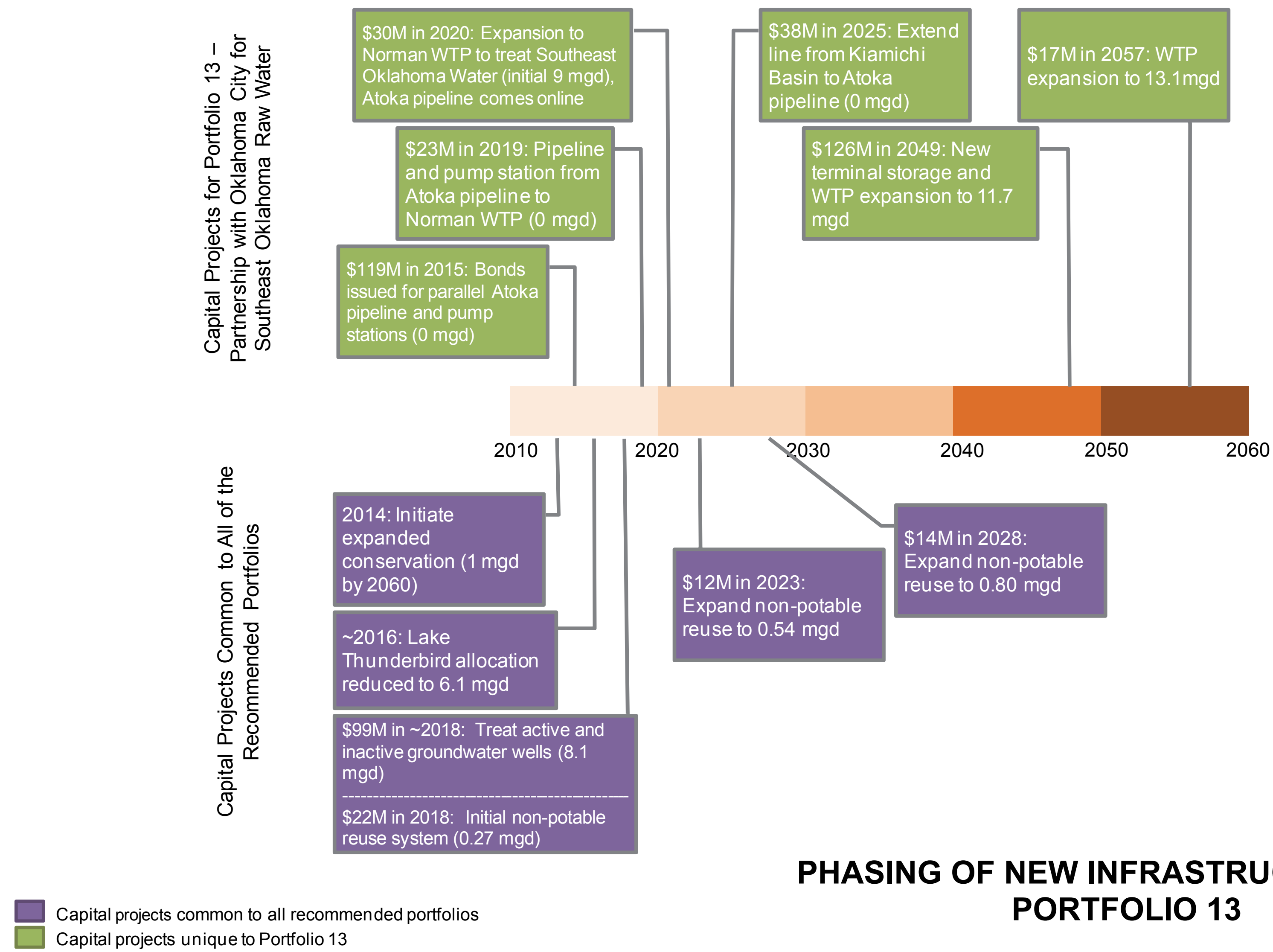


PHASED CAPACITY FOR PORTFOLIO 13

FIGURE 5.1

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

carollo



Note: All supplies are listed in annual average flow. Rehabilitation/replacement projects not shown. Capital expenditures shown in escalated (future) dollars.

PHASING OF NEW INFRASTRUCTURE FOR PORTFOLIO 13

FIGURE 5.2

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

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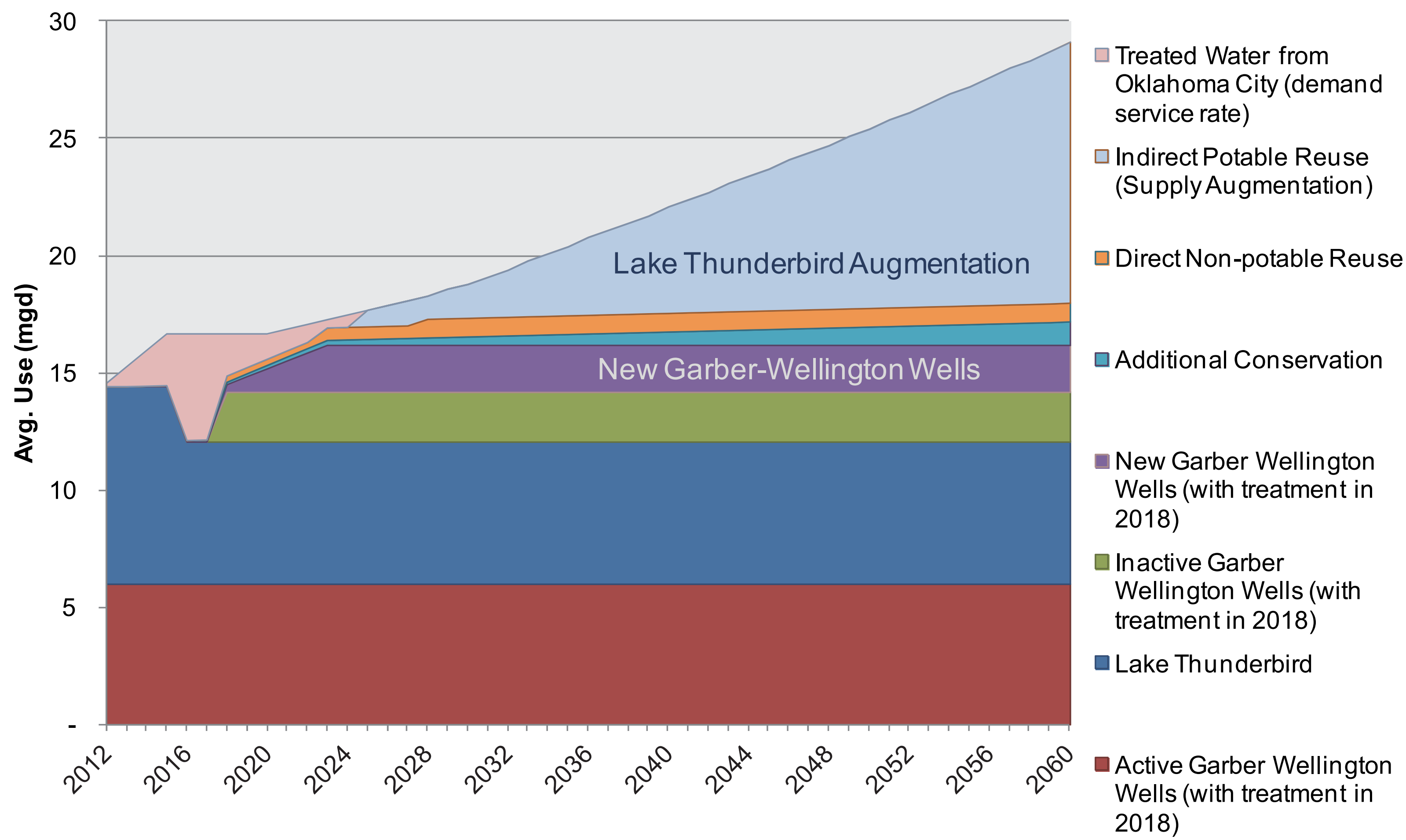
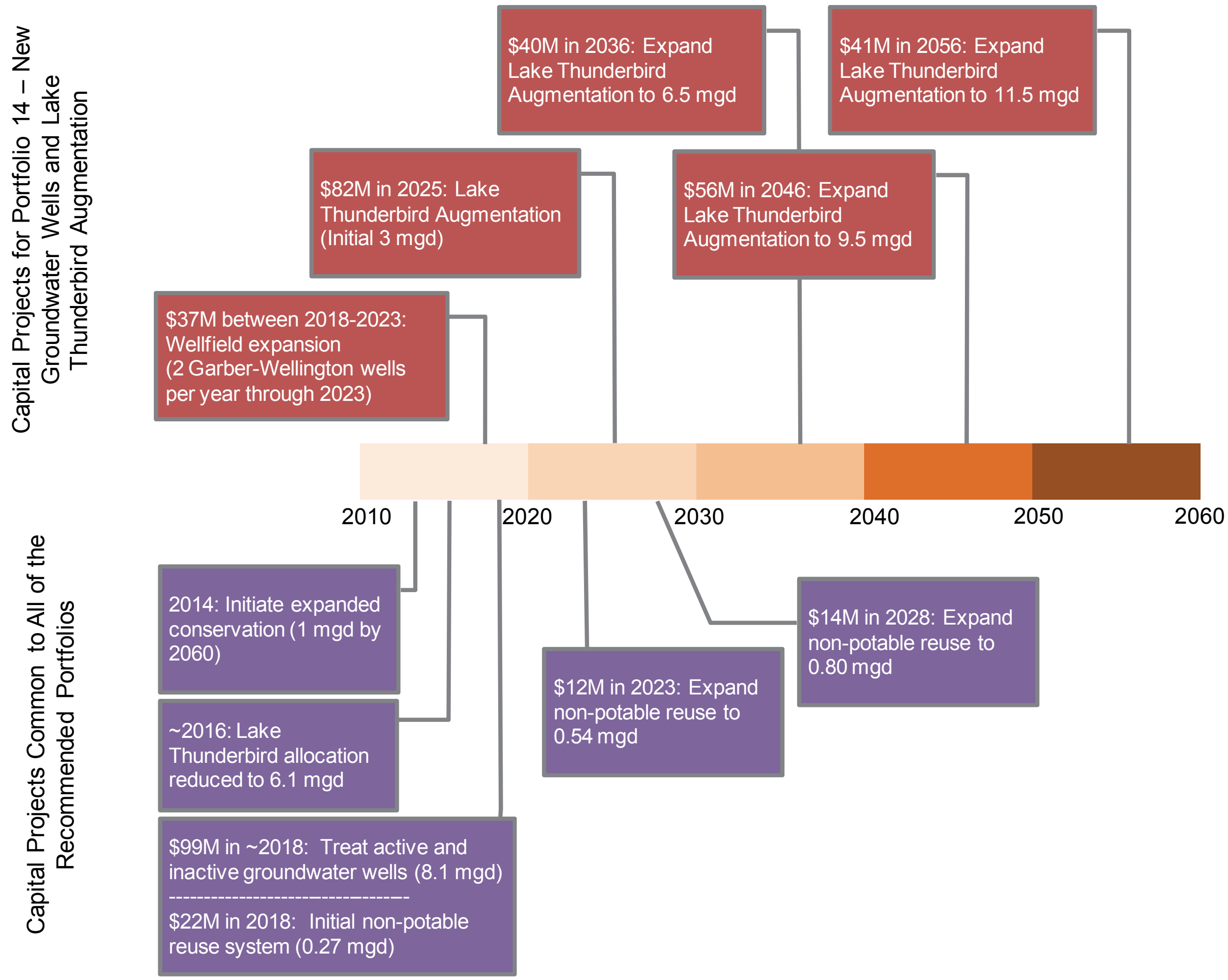


PHASED CAPACITY FOR PORTFOLIO 14

FIGURE 5.3

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN



Capital projects common to all recommended portfolios
Capital projects unique to Portfolio 14

Note: All supplies are listed in annual average flow. Rehabilitation/replacement projects not shown. Capital expenditures shown in escalated (future) dollars.

PHASING OF NEW INFRASTRUCTURE FOR PORTFOLIO 14

FIGURE 5.4

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

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Portfolio 14 assumes that Lake Thunderbird augmentation will be online in 2025. Until it is online, Norman will need to continue to purchase water from Oklahoma City to meet the deficit between available supply and demands. Lake Thunderbird augmentation could potentially be accelerated, depending on regulatory progress and improvements that may be required at the City's WRF for water to be discharged to Dave Blue Creek for augmentation purposes.

Portfolio 14 assumes that two new wells will be drilled each year beginning in 2018 (or when groundwater treatment is online) until a firm (average day) capacity of 2.0 mgd is added. Portfolio 13 assumes that the parallel Atoka pipeline and additional treatment capacity is in place by 2020. Later projects phase in terminal storage and treatment plant capacity expansions.

Dates have been assigned to all capital improvements based on assumptions related to probable timing of trigger events. However, if trigger events occur earlier or later than assumed, implementation of corresponding capital projects should be adjusted.

5.3 FINANCIAL CONSIDERATIONS

Along with phasing projects for new capacity, it is necessary to rehabilitate or replace infrastructure for both existing and new facilities as they approach the end of their useful life. Timing for these projects was based on the assumptions listed in Chapter 2 and discussions with NUA staff. Table 5.2 lists capital costs by category for Portfolios 13 and 14. The new infrastructure costs were used for portfolio evaluations; the rehabilitation/ replacement costs were developed only for the two recommended portfolios, in order to depict the long-term costs of meeting NUA's customers' water needs. Notably, significant costs will be incurred to simply maintain current production levels from NUA's existing sources – including rehabilitation/replacement costs and meeting anticipated regulations – independent of, and in addition to, costs needed to meet forecasted growth in demands.

Table 5.2 Comparison of Capital Costs for Recommended Portfolios				
	Capital Costs (2012 $)			
	Rehabilitation/ Replacement of Existing Infrastructure(1)	**New Infrastructure Improvements Required by Regulatory Changes(2)**	**New Infrastructure Required for Capacity Increases(3)**	**Rehabilitation/Replacement of New Infrastructure**
Partnership with Oklahoma City for Raw Water (Portfolio 13)	$89M	$70M	$269M	$54M
New Groundwater Wells and Lake Thunderbird Augmentation (Portfolio 14)	$89M	$70M	$193M	$63M

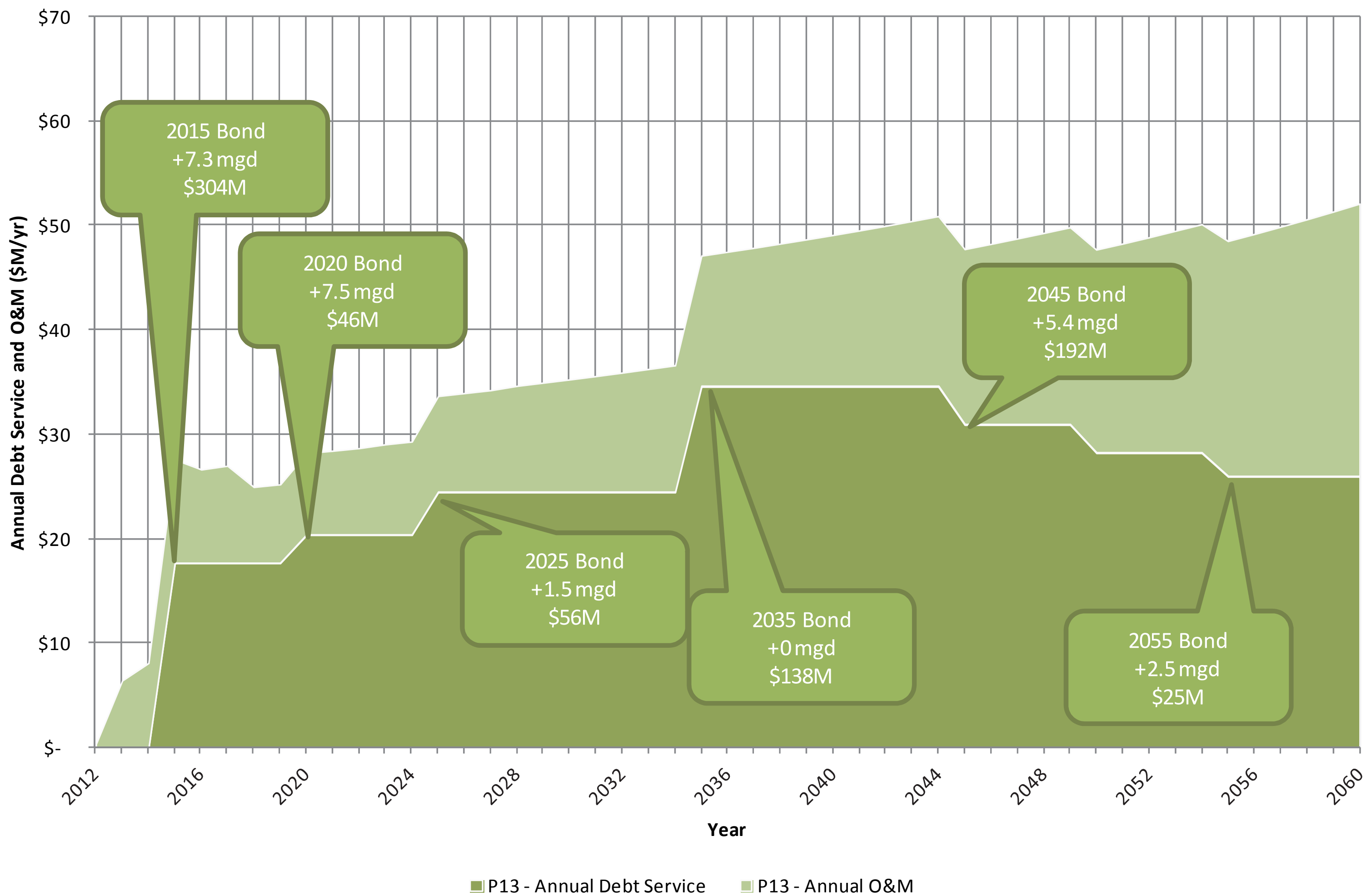
Notes:
(1) Existing infrastructure includes Vernon Campbell WTP, raw water piping, and treated water connection to Oklahoma City.
(2) Infrastructure required because of anticipated regulatory changes includes treatment for active Garber-Wellington Aquifer wells.
(3) Includes infrastructure associated with all new or expanded supply sources for the indicated portfolio.

Figure 5.5 and Figure 5.6 illustrate annual costs disaggregated into debt service payments for bonds and annual operating and maintenance costs. Bond issuance and debt service payments were based on assumptions described in Chapter 2. Table 5.3 and Table 5.4 summarize the capital projects covered by each bond. By 2060, regardless of which portfolio is selected, annual costs are estimated to be between $51 and $61 million as illustrated on Figure 5.7. Over time, the portfolios change places between highest and lowest annual costs. Cumulative costs – including all debt service and annual operating and maintenance costs for each year through 2060 – are comparable between the two portfolios.

5.4 RECOMMENDED PORTFOLIO

A final series of Ad Hoc Committee and public meetings was held in June 2014 (meeting materials are in Appendices AD and AE). Table 5.5 summarizes the feedback received during the final series of public, Ad Hoc Committee, and City Council study session meetings. Public meetings were held throughout the project, but these last meetings were held specifically to review the top two portfolios and determine which portfolio best meets Norman's long-term water supply objectives.

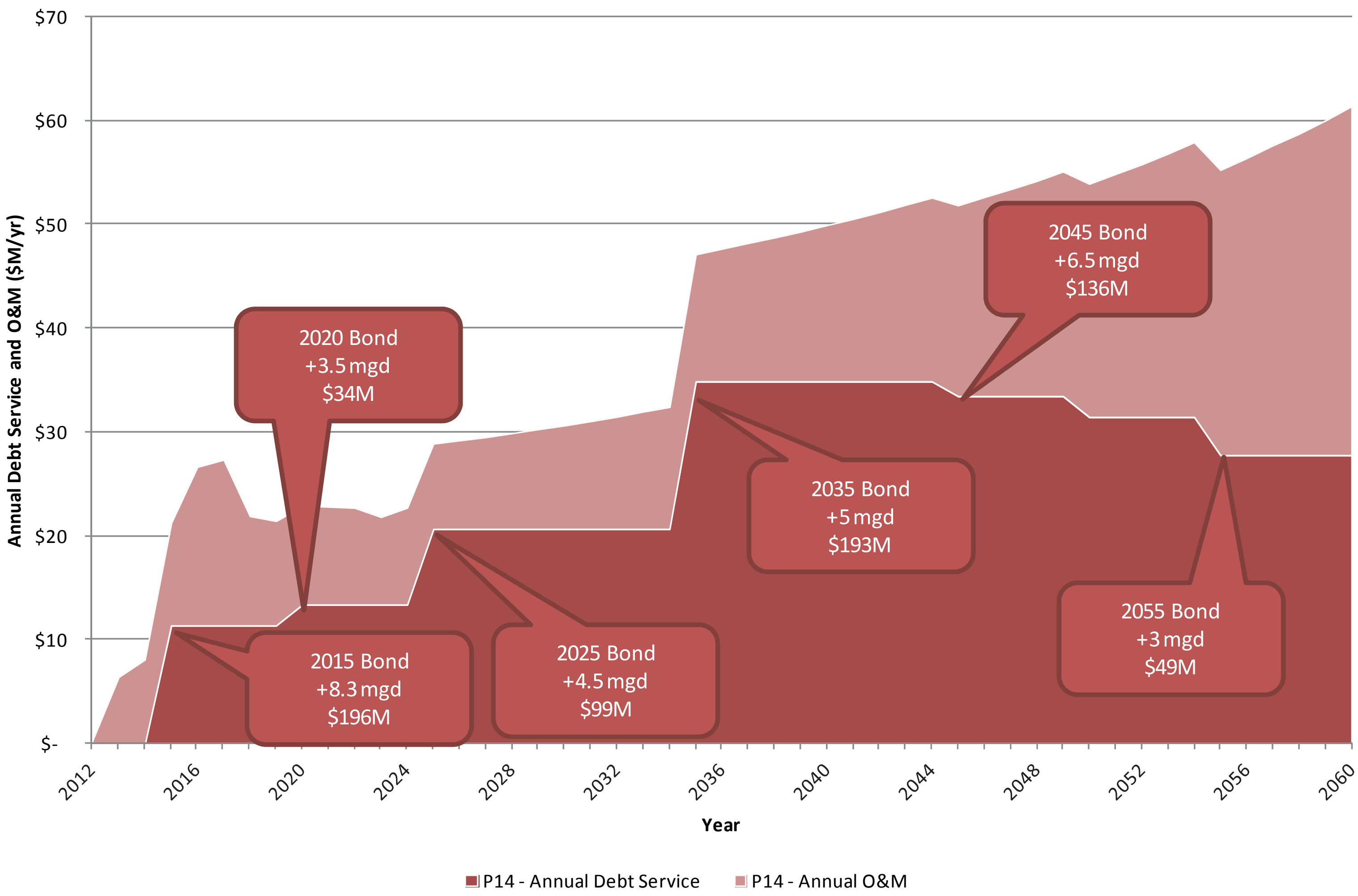
Input from these meetings indicated greater support for Portfolio 14, as it has lower capital costs, better phasing capability, more local control and management of supply sources, and makes effective use of effluent from the City's WRF. Generally, Portfolio 14 aligns more closely with the community's values. Consistent with public feedback, the NUA unanimously adopted Resolution R-1314-146 (Appendix AF) that designates Portfolio 14 for implementation as the City's 2060 Strategic Water Supply Plan.



ANNUAL COSTS FOR PORTFOLIO 13

FIGURE 5.5

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN



ANNUAL COSTS FOR PORTFOLIO 14

FIGURE 5.6

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN

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Table 5.3 Bond Issuance Portfolio 13		
Bond Issue Year[3]	**Amount ($M)[1]**	**Capital Projects[2]**
2015	$304	• Lake Thunderbird - Existing WTP disinfection improvements and clarifier rehabilitation • Garber-Wellington Wells – Treatment (active and inactive wells) • Oklahoma City Wholesale – Second connection • Oklahoma City Co-owner – Debt for Atoka transmission system, connection from Atoka pipeline to Norman • Non-potable Reuse – Treatment and initial phase of transmission network expansion
2020	$46.2	• Lake Thunderbird – Intake rehabilitation • Non-potable Reuse – Second phase of transmission network expansion • Oklahoma City Co-owner – Treatment (13.1 mgd)
2025	$55.7	• Non-potable Reuse – Final phase of transmission network expansion, storage tank rehabilitation • Oklahoma City Co-owner – Debt for Moyers (assumed diversion point) to Atoka transmission system
2035	$138	• Lake Thunderbird – Existing WTP rehabilitation • Garber-Wellington Wells – Treatment rehabilitation • Non-potable Reuse – Treatment and storage tank rehabilitation
2045	$192	• Lake Thunderbird – Intake rehabilitation • Non-potable Reuse – Treatment and storage tank rehab • Oklahoma City Co-owner – Terminal storage reservoir, Treatment rehabilitation and expansion to 18.5 mgd
2055	$24.9	• Non-potable Reuse – Storage tank rehabilitation • Oklahoma City Co-owner – Treatment expansion to 21 mgd

Notes:

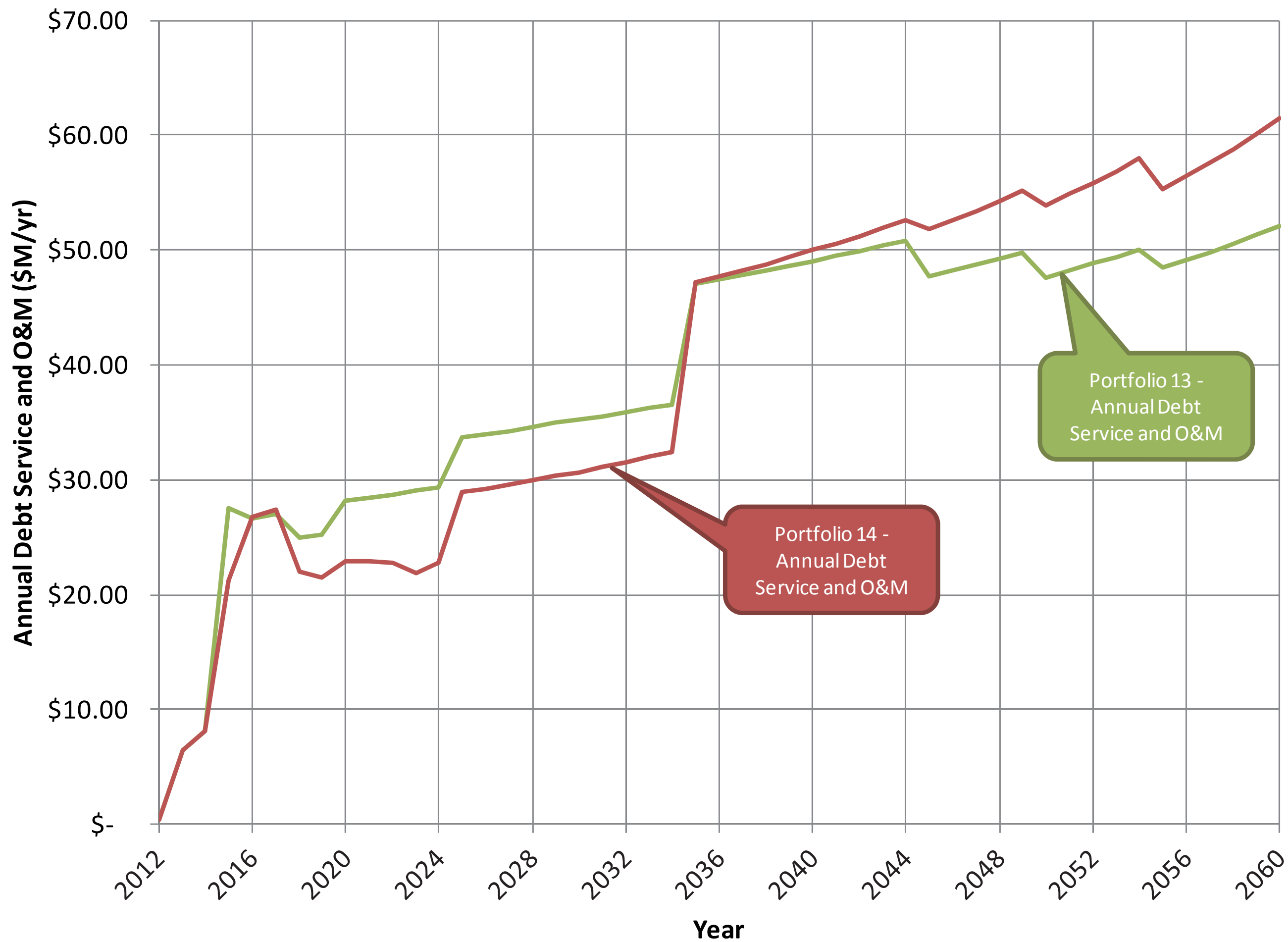
(1) Costs indicated have been escalated to indicated year of bond issuance.

(2) Capacities shown represent infrastructure sizing that is based on meeting peak day demands.

(3) Bonds typically cover five to ten years worth of projects. For example, the 2015 Bond will cover the existing WTP rehab (2015), treatment of active and inactive wells (2018), and first phase of non-potable reuse (2018), and components of Atoka project (2015, 2019).

Table 5.4 Bond Issuance Portfolio 14		
Bond Issue Year[3]	**Amount ($M)[1]**	**Capital Projects[2]**
2015	$196	• Lake Thunderbird – Existing WTP disinfection improvements and clarifier rehabilitation • Oklahoma City wholesale – Second connection • Garber-Wellington Wells – 1.0 mgd of new wells, piping network to connect all wells to treatment, and new centralized groundwater treatment facility • Non-potable Reuse – Treatment and initial phase of transmission network expansion
2020	$34.3	• Lake Thunderbird – Intake rehabilitation • Non-potable Reuse – Second phase of transmission network expansion • Garber-Wellington Wells – 2.0 mgd of additional new wells and piping to centralized treatment facility
2025	$99.3	• Non-potable Reuse – Final phase of transmission network expansion, storage tank rehabilitation • Lake Thunderbird Augmentation – 3.0 mgd WRF advanced treatment improvements, transmission to Dave Blue Creek, and 3.0 mgd additional diversion and WTP capacity for increased yield
2035	$193	• Lake Thunderbird – Existing WTP rehabilitation • Garber-Wellington Wells – Treatment rehabilitation • Non-potable Reuse – Treatment and storage tank rehabilitation • Lake Thunderbird Augmentation – Additional 3.5 mgd WRF advanced treatment improvements and additional 5.0 mgd diversion and WTP capacity for increased yield
2045	$136	• Lake Thunderbird – Intake rehabilitation • Non-potable Reuse – Treatment and storage tank rehabilitation • Lake Thunderbird Augmentation – Additional 3.0 mgd WRF advanced treatment improvements and additional 6.5 mgd diversion and WTP capacity for increased yield
2055	$49.4	• Non-potable Reuse – Storage tank rehabilitation • Lake Thunderbird Augmentation – Additional 2.0 mgd WRF advanced treatment improvements and additional 3.0 mgd diversion and WTP capacity for increased yield

Notes:
(1) Costs indicated have been escalated to indicate year of bond issuance.
(2) Capacities shown represent infrastructure sizing that is based on meeting peak day demands.
(3) Bonds typically cover five to ten years of capital project expenditures. For example, the 2015 Bond will cover the existing WTP rehabilitation (2015), new wells, piping and centralized treatment facility for all wells (2018), and first phase of non-potable reuse expansion (2018).



ANNUAL COST COMPARISON FOR RECOMMENDED PORTFOLIOS

FIGURE 5.7

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2060 STRATEGIC WATER SUPPLY PLAN

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pw://Carollo/Documents/Client/OK/Norman/8956A00/Deliverables/Report/Fig05_07.docx (Final)

Table 5.5 June 2014 Ad Hoc Committee and Public Meeting Feedback	
Portfolio 13: Regional Supply with Oklahoma City	**Portfolio 14: New Wells and Lake Thunderbird Augmentation**
• Interest in maintaining access to this supply in the future • Less local control over supply • Concerns regarding public acceptance of Southeast Oklahoma diversions • Concerns over size of up-front investment • Tribal litigation/mediation issues	• Provides local control of supply • Efficient use of resources • Better phasing potential • Potential for downstream water rights impacts • Public acceptance and outreach for indirect potable reuse • Uncertainty in water quality requirements for discharge to Lake Thunderbird • Concerns about impacts of reuse on Lake Thunderbird (capacity and water quality) • Potential Midwest City and Del City water quality concerns in shared Lake Thunderbird resource

SWSP IMPLEMENTATION

Like many communities in Oklahoma, Norman has experienced sustained growth supplied with primarily local sources of water. Today, Norman's portfolio of local groundwater and surface water from Lake Thunderbird is marginally capable of meeting annual demands and seasonal peak demands. Treated water from Oklahoma City is used to augment Norman's supplies when needed to meet demand, using an interconnection with Oklahoma City's potable water distribution system.

Looking ahead, Norman's ability to meet its customers' water needs is further challenged by a confluence of factors:

- Projected growth in the NUA service area.
- Regulatory and permit changes that may reduce the amount of water available from Norman's existing sources.
- Water quality regulations that will force further decisions between treatment investments and alternate supplies.

The 2060 SWSP evaluated numerous individual supply sources, combined the most viable sources into portfolios that were evaluated to determine which ones best meet Norman's long-term water needs. From this work, and in light of significant input received from the community, Portfolio 14 was recommended and formally adopted by the NUA (as described in Chapter 5).

As illustrated in Figure 6.1, Norman is not able to meet its current water needs without purchasing water from Oklahoma City. Addressing how Norman will meet its long-term water needs is critical and urgent. The SWSP (Portfolio 14) defines a path toward long-term water supply security.

Figure 6.2 illustrates the phased capacity increases recommended for implementation of the SWSP. Actual timing of supply implementation may vary based on external factors. For example:

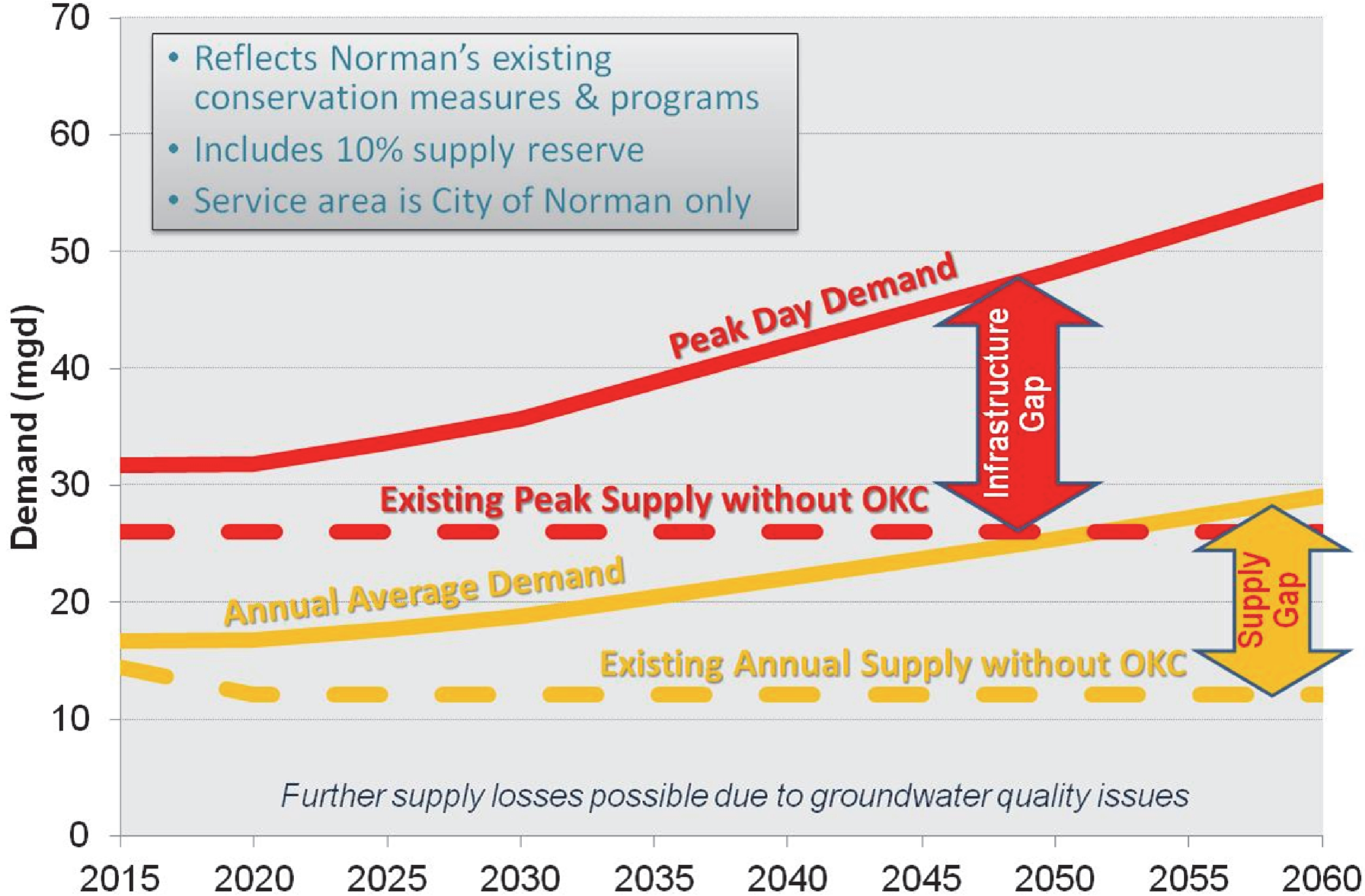
- Groundwater treatment of active and inactive wells will be triggered by the anticipated federal regulation of chromium-6, which could occur as soon as 2017 or 2018. However, water quality in the active groundwater wells will continue to be monitored for compliance with existing regulations (specifically arsenic and gross alphas [a naturally occurring radioactive element, which may negatively impact health through longtime exposure]); exceedances may result in additional wells being removed from service.
- Lake Thunderbird augmentation timing is dependent on ODEQ issuing rules on indirect potable reuse and defining the process for permitting discharges to SWS sources. The proposed non-potable reuse system expansion for irrigation and industrial uses can be implemented upon funding availability, as ODEQ has adopted rules governing those uses.

If trigger events occur sooner or later than assumed, implementation of corresponding capital projects should be adjusted.

In the interim, to address ongoing water quality issues with the existing Garber-Wellington wells and to meet demands until the SWSP elements can be phased in, NUA may negotiate with Oklahoma City to more consistently purchase treated water from Oklahoma City as a wholesale water customer (in place of the current contract which allows for intermittent water purchases).

Figure 6.3 illustrates the phasing of new infrastructure and associated capital costs. Significant costs will be incurred to maintain current production levels from NUA's existing sources, address anticipated new water quality regulations, and to develop new supplies. There are several ways to fund the new and rehabilitation projects. One example of funding is included in Chapter 5 and illustrates annual costs (which includes operation expenses as well as debt service payments) and bond packaging. Under any bonding strategy, however, water rates increases are likely necessary to fund the investments required to maintain existing sources and develop new supplies.

Altogether, the diverse supply portfolio NUA has designated as its water supply strategy will build on existing resources to provide reliable water service through the 2060 planning period and beyond.



EXISTING SUPPLY AND FUTURE DEMANDS

FIGURE 6.1

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2060 STRATEGIC WATER SUPPLY PLAN

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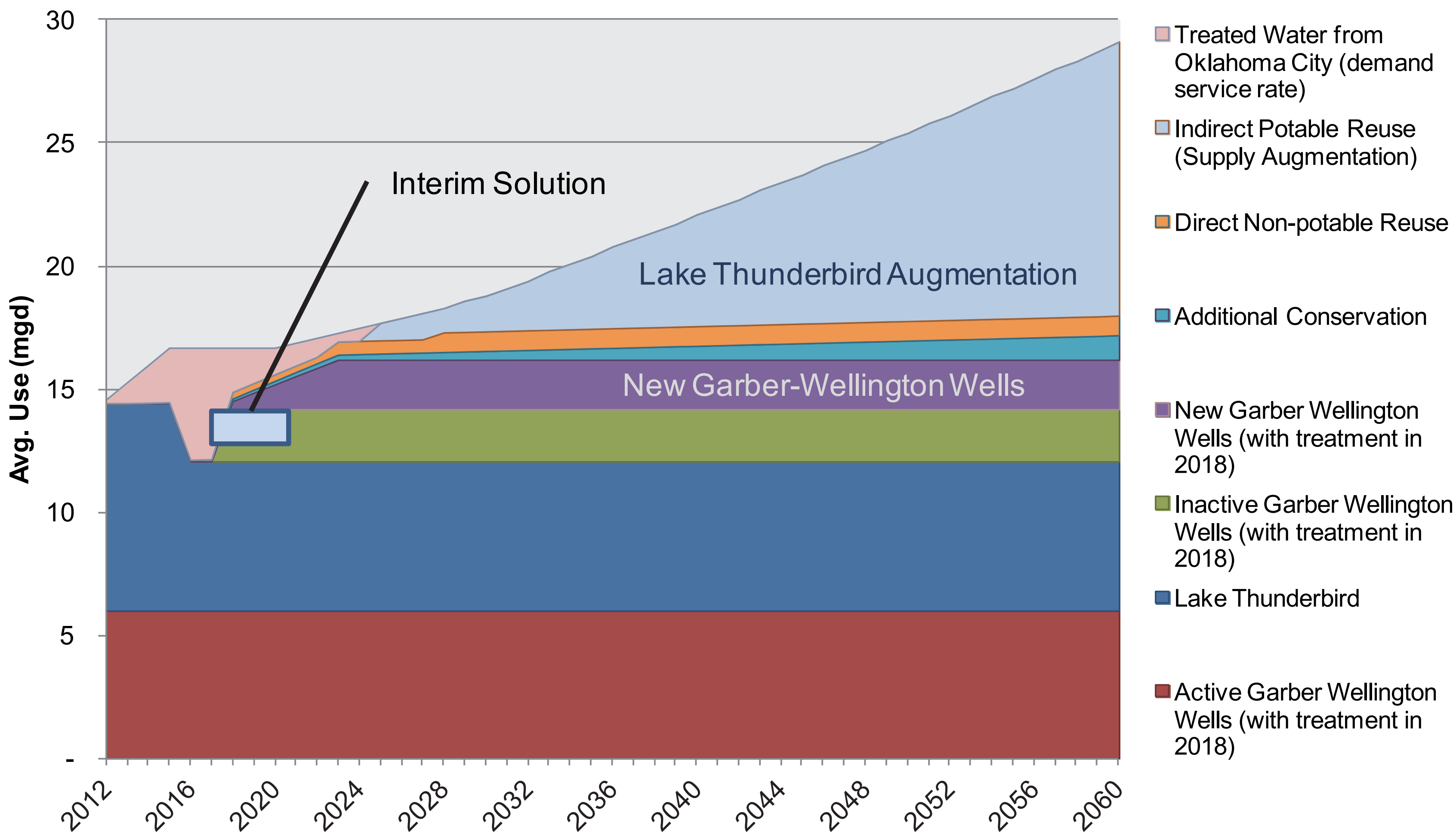
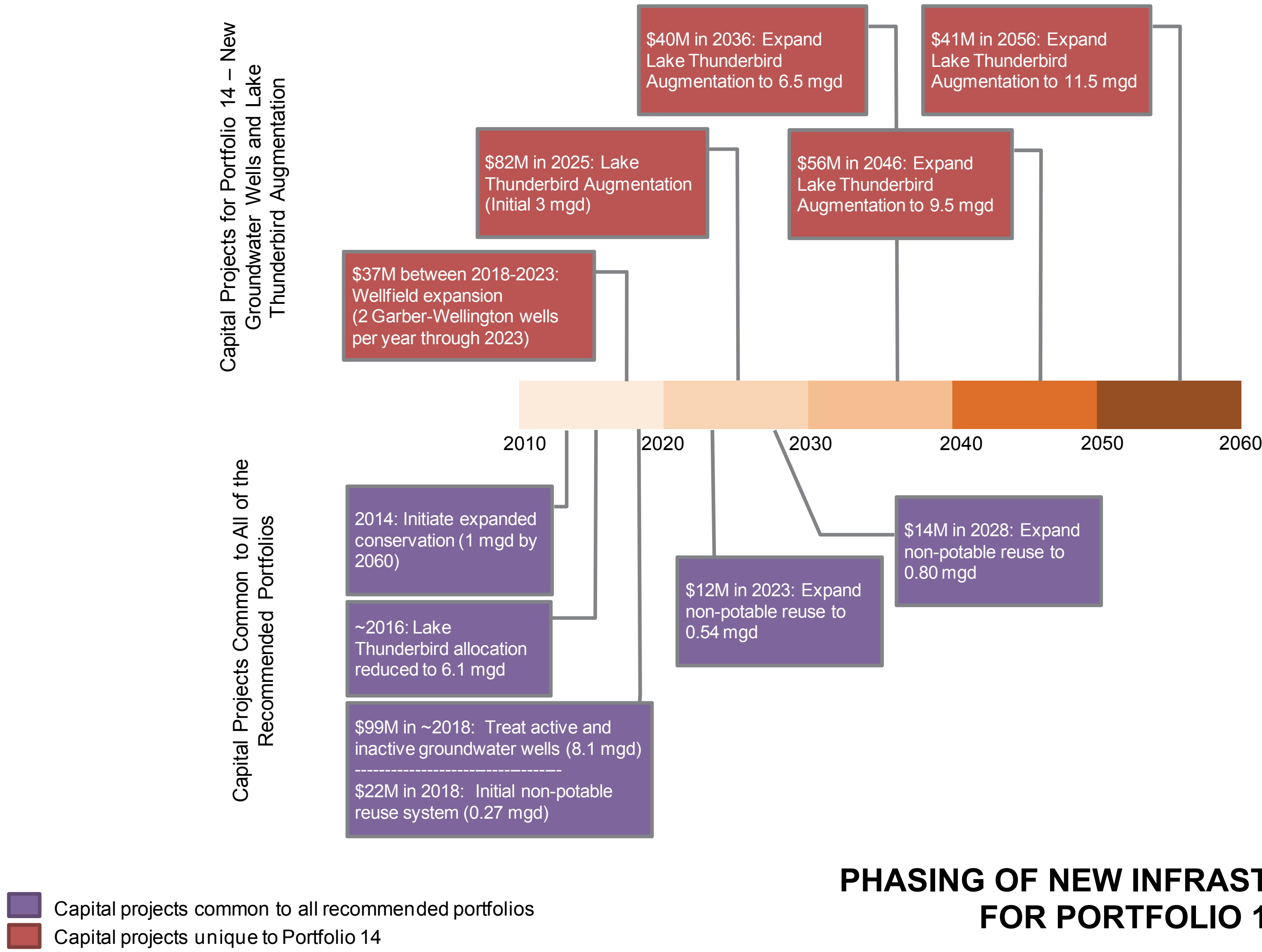


PORTFOLIO 14 PHASED CAPACITY

FIGURE 6.2

NORMAN UTILITIES AUTHORITY
2060 STRATEGIC WATER SUPPLY PLAN



Note: All supplies are listed in annual average flow. Rehabilitation/replacement projects not shown. Capital expenditures shown in escalated (future) dollars.

PHASING OF NEW INFRASTRUCTURE FOR PORTFOLIO 14

FIGURE 6.3

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2060 STRATEGIC WATER SUPPLY PLAN

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