RAW WATER SUPPLY STUDY

PREPARED FOR:
CITY OF SALINA, KANSAS

PREPARED BY:
HDR ENGINEERING, INC.
WILSON & COMPANY ENGINEERS AND ARCHITECTS
LAYNE CHRISTENSEN COMPANY

FINAL: FEBRUARY, 2010

HDR NO. 0000094250

Table of Contents

Tables

Figures

Appendices

1 EXECUTIVE SUMMARY

In 2006 the City of Salina (City) experienced a historic drought event. Below-average precipitation during the period of 2000 to 2006 resulted in declining streamflows in the Smoky Hill River. The City declared a Water Emergency in July 2006 when the flow in the river declined to a historic low of 1.3 cfs. Based on that experience, the City wanted to evaluate their water supply system and potential options for developing additional water supply to avoid similar situations during future droughts.

HDR Engineering Inc., Wilson & Company Engineers & Architects, and Layne Christensen Company teamed to develop the Raw Water Supply Study for the City of Salina. The purpose of this study was to evaluate use of the City's existing water supply sources, the Smoky Hill River and the wellfields that tap the alluvial aquifer, and identify and evaluate sustainable alternatives to meet the City of Salina's water supply needs for the next fifty years. A Citizen's Advisory Board was set up to provide input to the project team throughout the process. The study evaluated the following potential solutions:

- Optimization of the existing water supply sources, including future use of the Smoky Hill River, recharge and future use of the existing wellfields, and the conjunctive use of the two existing supply sources
- Water conservation as a method of conserving the existing water supply sources and potentially delaying alternative water supplies
- Use of reclaimed water to meet large irrigation or industrial water needs
- Development of new sources of water supply including local reservoirs, rivers, aquifers, and a new water supply reservoir
- Acquisition of existing water rights
- Development of a water assurance district

In addition to the evaluations, background information such as demand projections, existing water rights, existing regulatory compliance were reviewed and evaluated.

Water use projections are the cornerstone of planning a water supply for the future. Future demands for this study are based on population projections to estimate residential and commercial demands and a reserve capacity for industrial development. Population projections from recent reports prepared for the City were reviewed and population was projected linearly through year 2060. A per capita use rate of 126 gpcd was used to determine projected demands for the residential and commercial sector; this per capita use rate is based on the previous 10 years of water use data. An industrial reserve capacity of 15% of the demands was used to account for future industrial development within the city. Maximum demands were determined based on a peaking factor reflective of the peak maximum day to average day ratio over the past 10 years to represent drought conditions. Ultimately, in 2060 the demand projections indicate that the City will need to supply 20 MGD to its customers.

The City currently has two main sources of supply, the Smoky Hill River and the Downtown Wellfield. During drought periods the flow in the Smoky Hill River is highly variable while increased reliance on the Downtown Wellfield can significantly lower aquifer levels. In addition to the Smoky Hill River and the Downtown Wellfield, the City also has water rights for the South Wellfield; however, this wellfield is not currently used due to water quality issues and lack of water treatment. The City of Salina maintains several active water rights with the Kansas Department of Agriculture Division of Water Resources for these water supply sources. The maximum total water available to the City (surface and groundwater) in any given year is 11,837 acre-ft at a maximum diversion rate of 25.8 MGD. The City maintains an active water right on the Smoky Hill River for 5,028 acre-ft at a maximum flow rate of 10.0 MGD. The City owns two vested water rights and two appropriated rights for groundwater use in the alluvial aquifer. Annual groundwater usage from the fifteen (15) wells at Downtown Wellfield cannot exceed 4,993 acre-ft at a maximum flow rate of 15.2 MGD. The maximum annual volume and maximum flow rate for wells in the Downtown Wellfield are governed on a per well basis. The five (5) wells located at the South Well Field have a total water right of 2,511 acre-ft at a maximum rate of 3.7 MGD.

The City currently holds a lot of water rights but they are considered “paper” water rights in that they do not guarantee that the water is always available during times of drought. The worst-case condition during a drought is that little to no flow is available from the Smoky Hill River, requiring the City to be nearly fully reliant upon the Downtown Wellfield. For planning purposes, it is assumed that under worst-case drought conditions in the future, no flow will be available in the Smoky Hill River. Water rights for the Downtown Wellfield will not of meet maximum day demands alone if a similar drought occurred now. If treatment is added to water from the South Wellfield so that this wellfield can be used to its full capabilities in conjunction with the Downtown Wellfield, the City still will not have enough water rights to meet maximum day demands after 2048. In order to meet maximum day demands during drought periods through the planning horizon, the City will need to expand their “paper” water rights.

As part of the Raw Water Supply it is essential to consider the impacts of current and future drinking water regulations. Any improvements that are recommended as a result of the study must account for continued long-term compliance with the current regulations while providing flexibility for future regulations. In general, past water quality data from the City exhibits compliance with regulations under the Safe Drinking Water Act. Recent and future regulations include the Stage 2 Disinfection By-Products Rule, the Long-Term 2 Surface Water Treatment Rule, the Contaminant Candidate List for establishing future regulations, Total Coliform Rule Revisions, and Lead and Copper Rule Revisions. Of these regulations, the Stage 2 Disinfection By-Products Rule and the Long-Term 2 Surface Water Treatment Rule would likely have the most impact on future raw water supply, although compliance with all regulations will be required as new sources are established.

A number of different items were studied related to the future water supply options for the City. The results are described below.

Optimization of Existing Sources

It is in the best interest of the City to maximize the use of existing water rights and water supply infrastructure. Existing wells at the Downtown Wellfield can be re-drilled in order to increase their pumping capacity and maximize the available water rights. Water produced from wells at the South Wellfield is currently not treated, except for chlorination, and is high in iron, manganese, and hardness. The addition of a water treatment plant that removes iron, manganese, and hardness would result in the South Wellfield becoming a reliable source of water supply for the City. In addition, the existing wells that do not currently have pumps installed should be re-drilled or rehabilitated in order to maximize the existing maximum diversion rate of 3.7 MGD allowed under the South Wellfield water rights.

Conservation

The City's existing Water Conservation Plan was evaluated for compliance with recent guidelines published by the Kansas Water Office. Conserving water can be beneficial in many ways, such as addressing short-term or long-term water supply shortages, providing environmental protection, and avoiding or postponing the high costs of new water and wastewater system improvements. The City of Salina can promote additional water conservation by modifying their existing Water Conservation Plan, addressing the impact of existing private wells, implementing additional water conservation measures.

One important modification to the City's existing Water Conservation Plan is including private wells within the City limits in the City's outdoor watering restrictions to lessen impacts to the alluvial aquifer levels, particularly during drought conditions. The City would be allowed to regulate private wells on the basis of the waste of water that occurs while watering during peak evaporation hours. The City currently has a City ordinance prohibiting customers of the City's water distribution system from outdoor watering with potable water between the hours of 10:00 am and 6:00 pm, effective between June 1 and September 30. On the basis of the defined waste of water ordinance, per state statutes and the 2007 Municipal Water Conservation Plan Guidelines the City can revise their current Water Conservation Plan and city ordinance to include private wells in the outdoor watering regulations.

Water conservation measures commonly used by numerous municipalities were evaluated for inclusion in the Water Conservation Plan to reduce water usage. These measures include system measures to reduce non-revenue water, outreach and education activities, distribution of plumbing hardware targeting specific customer categories, rebate programs, landscaping ordinances, conservation rate structures, and commercial and industrial incentive programs. It is recommended that the City of Salina continue with their current water conservation measures and implement the following measures within the next five years: Understandable and Informative Water Bill, Water Conservation Classes, Teaching Water Conservation in Schools, Public Awareness for Commercial & Industrial, Commercial High Efficiency Toilets, Residential High Efficiency or Low Flow Toilets Rebate, High Efficiency Clothes Washer Rebate, Water Conservation Garden, Xeriscape Ordinance, and Rain Sensor Rebates.

Water Reuse

The potential for water reuse for the purposes of irrigation, industrial use, and groundwater recharge was evaluated. The Kansas Department of Health and Environment (KDHE) Bureau of Water is responsible for regulations pertaining to water reuse in the State of Kansas. KDHE has published minimum design criteria that specify the treatment requirements for irrigation with treated wastewater. The feasibility of water reuse in the City of Salina was evaluated through review of the regulatory requirements, quality and quantity of the treated municipal wastewater available, potential application sites, and necessary infrastructure requirements.

The flows into the wastewater treatment facility and the existing effluent water quality data were evaluated for the past three years. The minimum flow into the plant over the past three years was approximately 3.0 MGD. At the minimum influent flow, there is adequate flow to support water reuse in Salina. The water quality appears to be satisfactory for irrigation, although further analysis of the wastewater constituents should be evaluated for use-specific suitability.

Various potential application sites that could make use of reclaimed water were identified, including irrigation sites and industrial sites. Irrigation sites identified include Bill Burke Park, the soccer complex, Salina Municipal Golf Course, and Salina Country Club among others. Many of the irrigation sites identified currently irrigate with private wells for which they have water rights. The reduction of private usage for irrigation could be factored into the reclaimed water system and benefit the aquifer. The average flow requirement for irrigation, based on 2006 usage data, was approximately 2.33 MGD including private water rights. Industrial sites identified include Exide Corporation, Philips Lighting, Great Plains Manufacturing, and others. The average flow requirement for industrial uses, based on 2006 usage data, was approximately 0.42 MGD. Further evaluation is needed to determine if these industries can use reclaimed water in their processes.

Per the KDHE minimum design criteria, if the City wanted to use treated effluent for irrigation of athletic fields or public parks with a high probability of body contact then filtration treatment would need to be added at the wastewater treatment plant. The goal of adding filtration is to further reduce TSS and BOD to allow the water to be more suitable for human contact. If KDHE includes a requirement in the NPDES permit for a lower fecal coliform or E. coli, additional disinfection would be required for a higher degree of inactivation of pathogens. The plant flow could be split downstream of the existing UV disinfection process to allow the desired amount of reuse water to be filtered and disinfected. If the City wanted to limit irrigation with treated wastewater effluent to areas with a low probability of body contact such as golf courses or certain public parks, no treatment improvements would be required per the KDHE minimum design criteria. In addition to any upgrades required at the wastewater treatment plant, a dedicated pipeline with pumping and storage facilities would be required to serve the identified irrigation sites.

New Sources of Supply

Potential new sources of supply for the City were evaluated. Sources examined included the Saline River, the confluence of the Smoky Hill and Solomon Rivers, acquisition of existing water rights, reservoir construction, Dakota Aquifer, Kanopolis Reservoir, Milford Reservior, Wilson Reservoir, and the development of a water assurance district. Each source was evaluated to determine existing and available water rights, water quality, and general infrastructure requirements. The City's water demands through the year 2060 were revisited and water supply deficits were quantified.

Alternatives Evaluation

Alternatives were identified, screened for feasibility, and then evaluated in detail to determine the most feasible alternatives to meet the City's water demands through the year 2060. Alternatives were first screened for feasibility based on their optimization of existing resources, increased reliability during drought periods, minimization of implementation risk, expansion capacity for future demands, and cost effectiveness. The alternatives that passed the initial screening criteria include the following:

- Improvements at the South Wellfield
- Obtaining a seasonal surface water right on the Smoky Hill River
- Improvements at Downtown Wellfield
- The confluence of the Smoky Hill and Solomon Rivers
- Acquisition of existing water rights
- Water reuse
- Milford Reservoir
- Dakota Aquifer
- Saline River
- Development of a water assurance district

Alternatives that passed the initial screening were further developed to determine the required infrastructure, implementation risks, environmental impacts, permitability, and the time to implement. Weighted criteria were developed for the alternative evaluation with input from the City and the Citizen's Advisory Board. Based on the developed criteria, each alternative was evaluated and ranked according to the evaluation criteria.

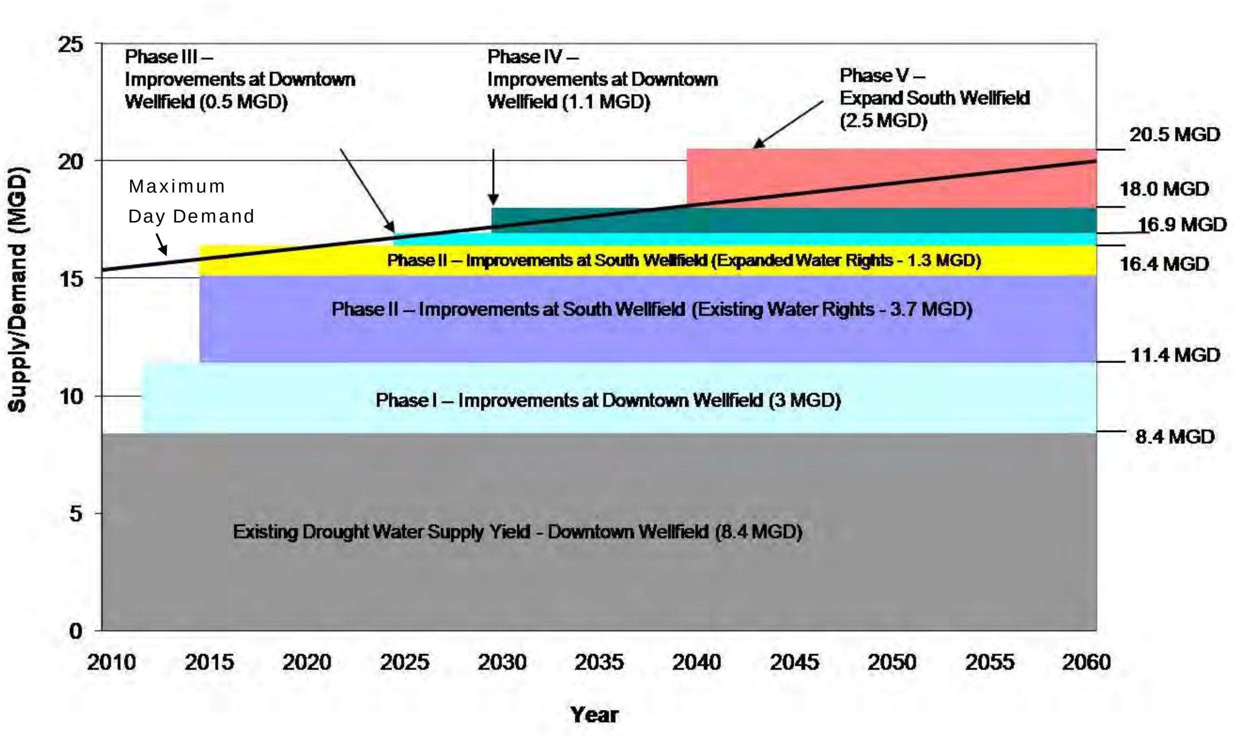
Recommendations

From the rankings, a Capital Improvements Plan (CIP) was developed and is summarized in the figures below. The CIP should provide the City with the most supply the quickest and at the lowest cost. The CIP was divided into five phases, which primarily include improvements to the Downtown Wellfield and the South Wellfield. The improvements are as follows:

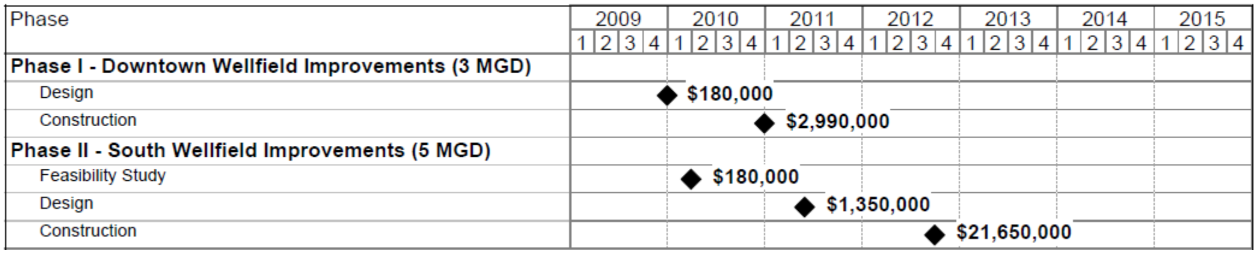
- Phase I – Improvements at Downtown Wellfield including re-drilling four wells for increased capacity, upgrades to raw water piping, and retrofit of the existing air strippers at the water treatment plant for an increase of 3.0 MGD.
- Phase II – Improvements at South Wellfield including demolition of the existing Schilling Water Treatment Plant, construction of a new 5 MGD water treatment plant with water storage and high service pumping, rehabilitation of the five existing wells, construction of three new wells, and

improvements to raw water piping. These improvements result in an increase in the capacity of the water supply system of 5.0 MGD.

- Phase III – Improvements at Downtown Wellfield for an additional 0.5 MGD including re-drilling 2 wells and raw water piping improvements.
- Phase IV – Improvements at Downtown Wellfield for an additional 1.1 MGD including re-drilling of wells and raw water piping improvements.
- Phase V – Expansion of the South Wellfield and the South Water Treatment Plant for an additional 2.5 MGD including addition of four wells, raw water piping, and finished water storage.



Capital Improvements Plan to Meet Maximum Day Demand Through 2060



Short-Term Capital Improvement Financing Plan (2009-2015)

Long-Term Capital Improvement Financing Plan (2016-2060)
(Includes Purchase or Acquisition of Water Rights)

Long-Term Capital Improvement Financing Plan (2016-2060)
(Assumes Acquisition of Water Rights Previously Completed)

2 INTRODUCTION

In 2006 the City of Salina (City) experienced a historic drought event. Below-average precipitation during the period of 2000 to 2006 resulted in declining streamflows in the Smoky Hill River. The City declared a Water Emergency in July 2006 when the flow in the river declined to a historic low of 1.3 cfs. Based on that experience, the City wanted to evaluate their water supply system and potential options for developing additional water supply to avoid similar situations during future droughts.

HDR Engineering Inc., Wilson & Company Engineers & Architects, and Layne Christensen Company teamed to develop the Raw Water Supply Study for the City of Salina. The purpose of this study was to evaluate use of the City's existing water supply sources, the Smoky Hill River and the wellfields that tap the alluvial aquifer, and identify and evaluate sustainable alternatives to meet the City of Salina's water supply needs for the next fifty years. A Citizen's Advisory Board was set up to provide input to the project team throughout the process. The study evaluated the following potential solutions:

- Optimization of the existing water supply sources, including future use of the Smoky Hill River, recharge and future use of the existing wellfields, and the conjunctive use of the two existing supply sources
- Water conservation as a method of conserving the existing water supply sources and potentially delaying alternative water supplies
- Use of reclaimed water to meet large irrigation or industrial water needs
- Development of new sources of water supply including local reservoirs, rivers, aquifers, and a new water supply reservoir
- Acquisition of existing water rights
- Development of a water assurance district

In addition to the evaluations, background information such as demand projections, existing water rights, existing regulatory compliance were reviewed and evaluated. The ultimate solution for the City of Salina will be a multi-faceted plan that may include one or more of the potential solutions listed above.

3 COMPREHENSIVE DESCRIPTION OF EXISTING SYSTEM

The purpose of this Chapter is to review the existing water supply, treatment, and distribution system within the City of Salina.

3.1 OVERVIEW OF STUDY AREA

The City of Salina is located in north central Kansas at the junction of Interstate 70 and Interstate 135. Refer to Figure 3-1 for the location of Salina and the boundaries of the existing City Limits. The City of Salina is the seventh largest city in Kansas with a current population of approximately 47,000.

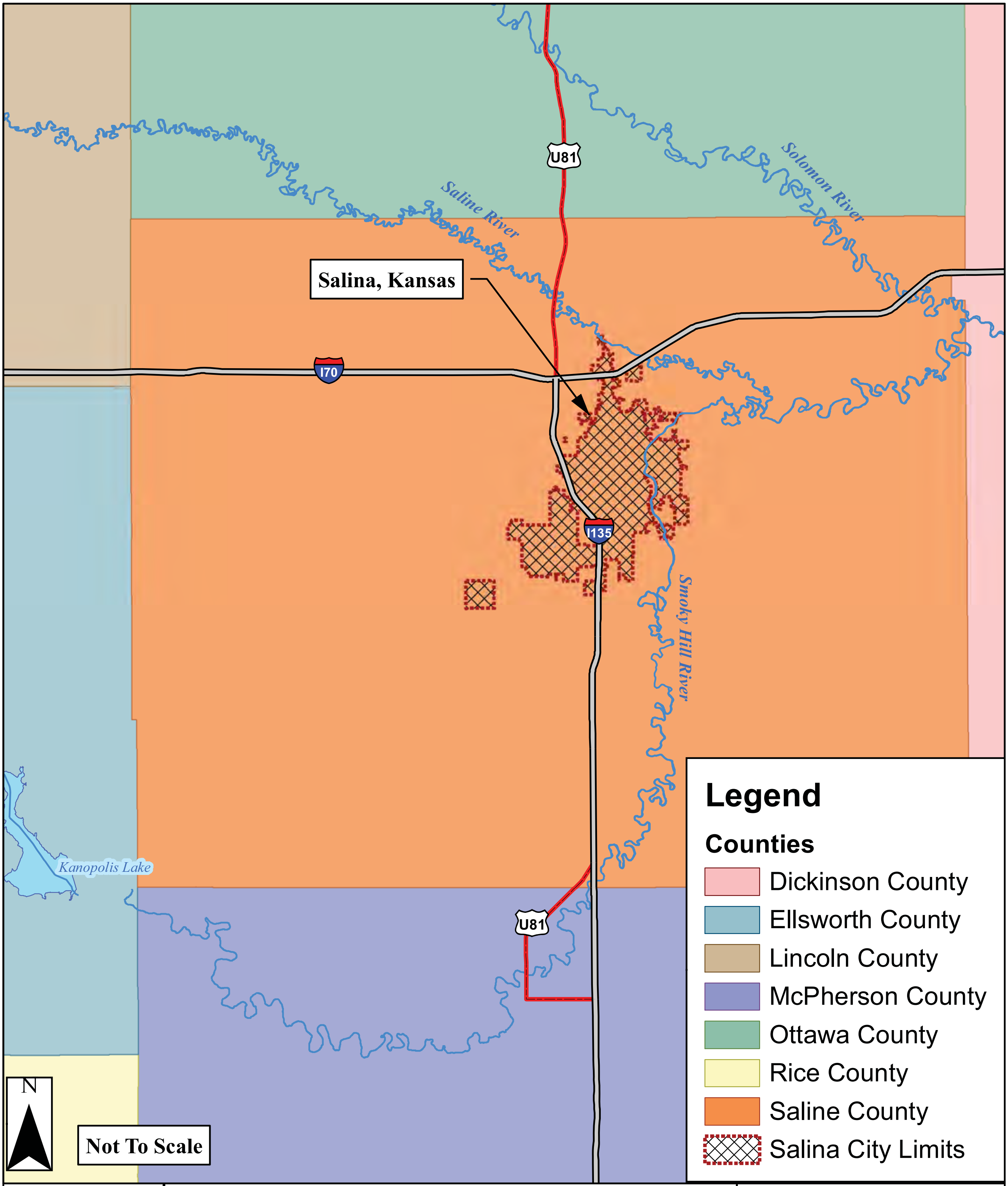
3.2 WATER SUPPLY SOURCES AND PRODUCTION

The City of Salina utilizes a combination of groundwater (wells) and surface water (Smoky Hill River) for their raw water supply. Refer to Figure 3-2 for the locations of these water supply sources. The current average distribution of water supply is forty (40) percent from groundwater and sixty (60) percent from surface water. In 2007, a total of approximately 2.3 billion gallons of raw water was diverted for water supply with approximately 1.0 billion gallons pumped from the groundwater wells and approximately 1.3 billion gallons pumped from the Smoky Hill River.

The current conjunctive use of surface water and groundwater as sources of water supply allows the City some redundancy for their source of supply. However, the wells that provide the City their groundwater supply are connected to the river flows in the Smoky Hill River and when the City experiences a significant drought period as they have in recent years, both supply sources are strained.

3.2.1 Smoky Hill River Intake

The surface water is currently withdrawn from the Smoky Hill River that runs along the east side of Salina. A pumping station located along the river channel delivers water via raw water piping to the water treatment plant prior to distribution for public consumption. A total of approximately 10.0 million gallons per day (MGD) of surface water is currently available from the Smoky Hill River based on water rights and existing pumping capacity. The river intake and 24-inch ductile iron raw water pipeline were installed in 1989. The pumping station consists of three single stage vertical turbine pumps, each rated for 5,050 gpm at 46 total dynamic head (TDH). At design conditions with two pumps in operation (one for standby), a total of approximately 7,000 gpm (10.0 MGD) can be pumped. See Table 3-1 for the characteristics of the pumps under both pumping conditions.



City of Salina

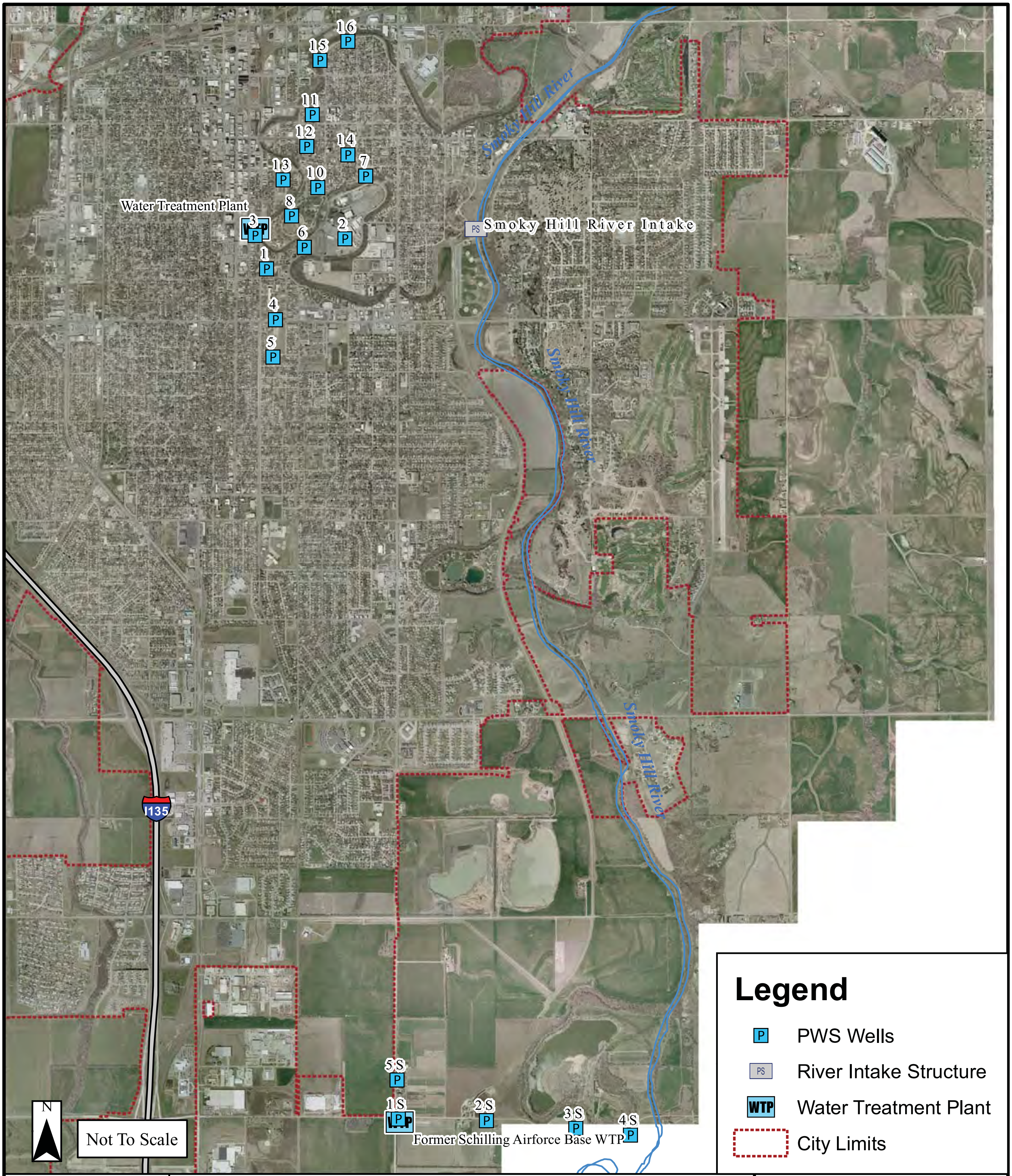
Raw Water Supply Study

Figure 3-1: General Location Map

HDR

WILSON & COMPANY ENGINEERS & ARCHITECTS

Layne



City of Salina

Raw Water Supply Study

Figure 3-2: General Location of Current Water Supply Sources

HDR

WILSON & COMPANY ENGINEERS & ARCHITECTS

Layne

Table 3-1
River Water Pumps Characteristics

Pump No. (1)	Design Conditions	RPM	HP	Control
P-103 P-104 P-105	5,050 gpm at 46 TDH(2) 7,000 gpm at 66 TDH(3)	1,180	75	On/Off and speed by telemetry. Speed control by variable frequency. Low level cutoff at Elevation 1210.00 feet.

(1) All three pumps are the same capacity
(2) Capacity with one pump in operation
(3) Capacity with two pumps in operation

3.2.2 Downtown Wellfield

Groundwater is currently supplied from fifteen (15) separate public water supply wells located near the center of the City of Salina. These wells draw from the Smoky Hill River alluvium aquifer. The raw water is piped to the water treatment plant prior to distribution for public consumption. A total of 10.0 million gallons per day can be supplied from this well system based on the capacity of the water treatment plant. The characteristics of the existing wells are shown in Table 3-2.

Table 3-2
Downtown Wellfield Characteristics

Well No.	Historical Pumping Rates(1) (gpm)	HP	RPM	Approx. Depth of Well (ft-in)
1	1,050 – 1,188	40	1,200	83’-2”
2	917 – 1,638	40	1,200	73’-6”
3	747 – 1,177	40	1,200	85’-6”
4	908 – 1,295	40	1,200	82’-10”
5	851 – 1,125	30	1,200	65’-11”
6	615 – 1,399	40	1,200	80’-6”
7	884 – 1,380	75	1,200	73’-1 ½”
8	986 – 1,223	30	1,200	74’-0”
10	1,264 – 1,525	40	1,200	75’-3”
11	706 – 1,199	40	1,200	72’-0”
12	1,184 – 1,240	40	1,200	74’-10”
13	484 – 807	40	1,800	75’-10”
14	1,015 – 1,165	50	1,800	72’-8”
15	738 – 1,071	50	1,800	82’-6”
16	547 - 900	40	1,800	78’-8”

(1) From the month of June in 2000 – 2006 taken from the Layne 2007 Wellfield Evaluation Report

3.2.3 South Wellfield

An additional three (3) public water supply wells are located south of Salina near the former Schilling Air Force Base water treatment plant and can provide additional groundwater supply if necessary. The water pumped from these wells is chlorinated and then pumped directly into the distribution system for public consumption. A total of 3.7 million gallons per day can be supplied from the south wells based on water rights limitations. These wells are currently only used for emergency purposes due to water quality (hardness and high iron & manganese) and are only pumped periodically. There are two additional wells for a total of five wells in this wellfield but these two wells do not currently have pumps installed in them. The characteristics of the existing wells are shown in Table 3-3.

Table 3-3
South Wellfield Characteristics

Well No.	Rated Pump Capacity (gpm)	HP
1	750	20
2	380	10
3	*	*
4	*	*
5	450	20

*No pump installed

3.3 WATER TREATMENT FACILITIES

The City of Salina treats both the groundwater and surface water at the water treatment plant located near the downtown Salina area. Refer to Figure 3-2 for the location of the water treatment plant. The treatment plant provides partial water softening, filtration, and disinfection as required to meet federal and state drinking water standards. The treatment plant was originally constructed in 1954 with major upgrades in 1955 (high service pump station No. 8), 1962 (filter addition), 1977 (sludge improvements), 1985 (filter improvements), 1989 (high service pump station, river intake, and river settling basin), 1993 (chlorine improvements), 1999 (solids contact clarifiers and air stripping towers) and 2002 (secondary clarifiers, lab/maintenance and administration building). The water treatment plant currently has a total treatment capacity of 20.0 million gallons per day, which is composed of 10.0 million gallons per day of groundwater treatment and 10.0 million gallons per day of surface water treatment. The surface water and groundwater sources are used concurrently and blended in varying proportions at the water treatment plant. Currently approximately forty (40) percent of the raw water supply comes from groundwater at the Downtown Wellfield and approximately sixty (60) percent comes from surface water at the Smoky Hill River Intake. The treatment plant currently consists of the following major components: air stripping towers (groundwater treatment only), river settling basin (surface water treatment only), solids contact softening basins, secondary clarifiers, gravity filters, underground storage reservoirs, and high service pumps. Refer to Figure 3-3 for a schematic of the treatment process flow at the Salina water treatment plant.

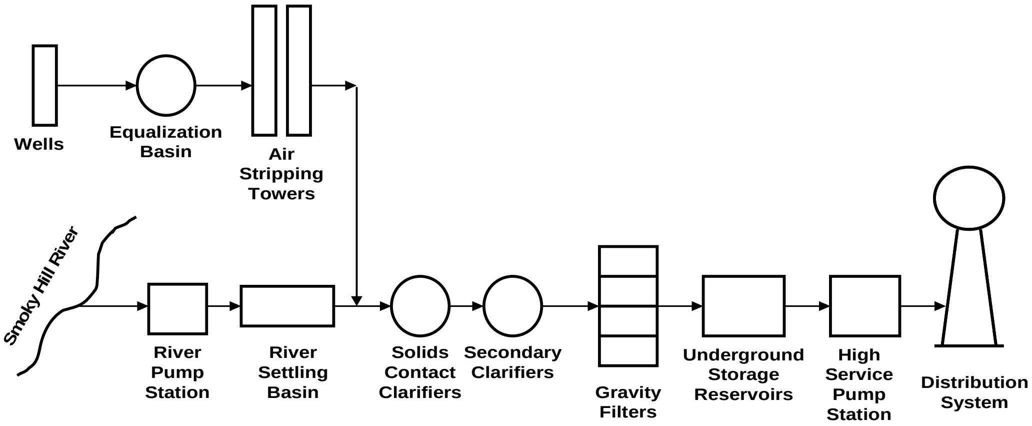


Figure 3-3
Schematic of Treatment Process Flow

3.4 WATER DISTRIBUTION SYSTEM

Treated water is distributed from the high service pumps at the water treatment plant to the public for consumption through a water distribution system comprised of separate pressure zones with distribution piping, pumping stations, and storage tanks.

3.4.1 Pressure Zones

Because of the topography of the City of Salina, separate pressure zones are necessary to avoid excessively high or low pressures within the distribution system. The distribution system includes five (5) separate pressure zones.

3.4.2 Distribution Piping

The distribution piping currently consists of approximately 322 miles of piping in various sizes. Refer to Table 3-4 for the distribution piping sizes. This piping is a variety of different materials such as cast iron, ductile iron, PVC, etc. The age of this piping ranges from brand new to 100 years old. There is an existing 24-inch water main connecting the South Wellfield to the distribution system. There is an existing 36-inch water main leaving the water treatment plant which immediately connects to a 30-inch water distribution main and various other sizes of water distribution lines. The 36-inch line has a capacity of approximately 27 MGD with a velocity of 6 feet per second. These water distribution lines supply water to approximately 20,000 service connections.

Table 3-4
Distribution Piping Sizes

Pipe Diameter (inches)	Total Length (miles)
1-3	3.40
4	11.32
6	201.16
8	36.48
10	10.92
12	42.25
16	5.55
20	5.70
24	3.82
30	1.42
36	0.01
Total	322

3.4.3 Pumping Stations

Booster pumping stations function to boost pressures or flows to a particular location in the distribution system. A common application of booster pumping stations is at the interface between two pressure zones. There are five (5) booster pumping stations within the water distribution system. Refer to Table 3-5 for the capacity of each of the booster pumping stations. Refer to Figure 3-4 which shows the location of the pumping stations.

Table 3-5
Booster Pumping Stations Capacities

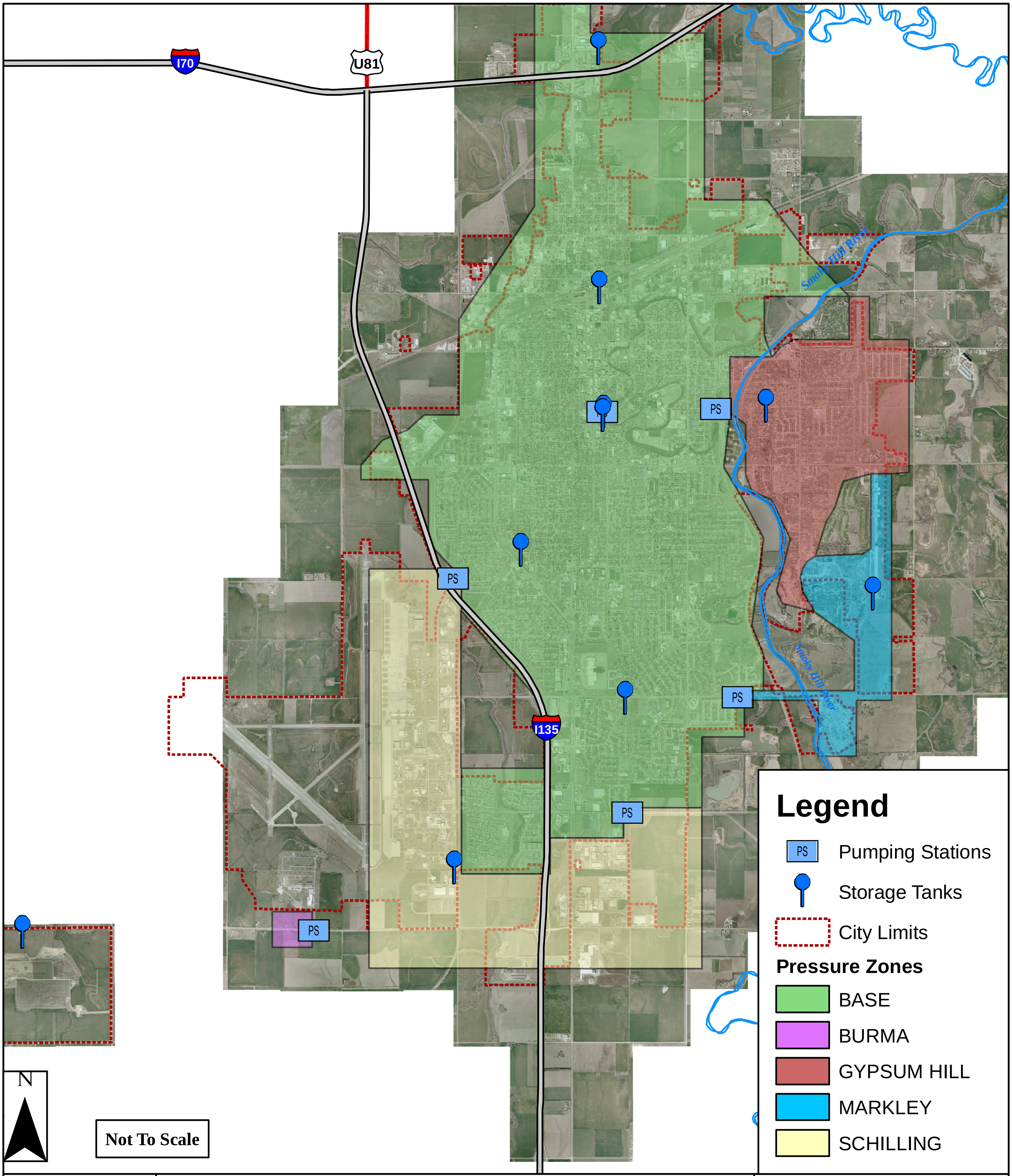
Booster Pumping Station	Capacity (gpm)
Cloud Street	800
Schilling Road	1,800
Magnolia Road	1,600
Gypsum Hill	600
Burma	180

3.4.4 Water Storage

There are two (2) underground storage reservoirs at the water treatment plant. One has a capacity of 2.0 million gallons and the other has a capacity of 1.0 million gallons. There are a total of eight (8) storage tanks located throughout the distribution system. Refer to Table 3-6 for the capacity of each of the storage tanks. Refer to Figure 3-4 which shows the location of all the storage tanks.

Table 3-6
Storage Tank Capacities

Elevated Storage Tank	Capacity (gallons)
Wyatt Elevated Tower	1,000,000
Gold Elevated Tower	500,000
Sunset Elevated Tower	500,000
Schilling Elevated Tower	500,000
Key Acres Elevated Tower	500,000
Markley Elevated Tower	500,000
Gypsum Elevated Tower	500,000
Burma Tank	75,000
Total	4,075,000



City of Salina

Raw Water Supply Study

Figure 3-4: Map of Pumping Station and Storage Tank Locations

HDR

WILSON & COMPANY ENGINEERS & ARCHITECTS

Layne

4 DEMAND PROJECTIONS

Determining future water use needs is an important part of developing a plan for future water supply. The objective of this Chapter is to review, validate, and update population and water use projections through the year 2060. Population projections from studies recently completed for the City of Salina were reviewed for application in the Raw Water Supply Study. In addition, historical water usage for Salina was reviewed and trends of water consumption were developed to estimate water use through year 2060.

4.1 POPULATION PROJECTIONS

4.1.1 Historical Population Trends

Population for the City of Salina and Saline County, the county in which Salina resides, has been recorded by the U.S. Bureau of Census since the year 1870. Historically, Salina's population has been increasing, with the exception of the middle 1960's when the Schilling Air Force Base closed causing the population in the City to decrease. As shown in Figure 4-1, the population of Salina and Saline County has been on the rise since 1970.

Table 4-1 compares the population of Salina to the population of Saline County. Salina experienced a faster rate of growth in the 1970s compared to the County. Since the 1980 Census, the growth rate of the City has been similar to the growth rate of the County; the population of Salina has consistently been approximately 85% of the population of Saline County and over the years grew at an average rate of 0.5% per year.

Table 4-1

Population of Salina and Saline County, 1970-2006 (1)

Year	Population of Salina	Avg % Growth per Year	Population of Saline County	% Growth	% of County that Resides in Salina
1970	37,714	-	46,592	-	80.9%
1980	41,843	1.09%	48,905	0.50%	85.6%
1990	42,303	0.11%	49,301	0.08%	85.8%
2000	45,679	0.80%	53,597	0.87%	85.2%
2005 (2)	45,956	0.12%	53,991	0.12%	85.2%
2006 (2)	46,140	0.40%	54,170	0.09%	85.2%

(1) Population data from U.S. Bureau of the Census unless otherwise noted.
(2) Population data from Kansas Division of the Budget

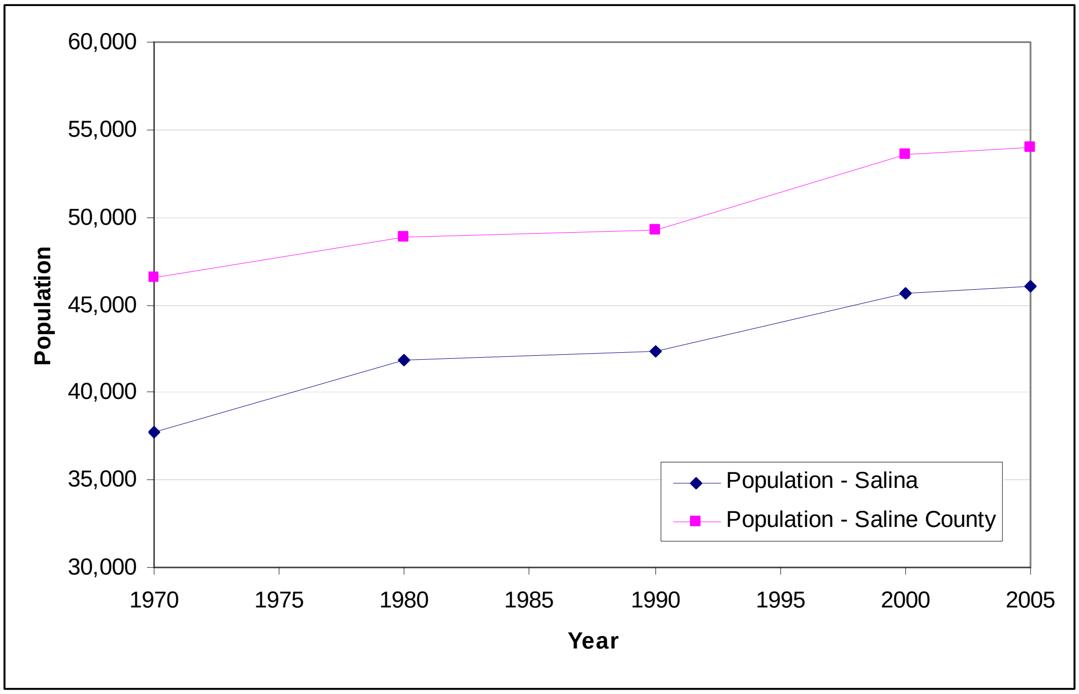


Figure 4-1
Population of Salina and Saline County, 1970-2006

4.1.2 Existing Population Projections

Like any other natural phenomena with multiple influencing factors, the prediction of future population is complex at best. Population generally depends on the combined effects of births, deaths, immigration, and emigration. Several sources of existing population projections that have been prepared for the City since the most recent census (2000) were reviewed to determine the population projections to be utilized for this study. These sources include:

- City of Salina Comprehensive Plan Update, Existing Conditions Report, Gould Evans, 2008
- Wastewater Treatment Facility Study, Professional Engineering Consultants (PEC), 2007
- City of Salina Population Projections by Cohort Survival Techniques, 2006

The City of Salina is in the process of updating the Comprehensive Plan. As a part of this update, population is being projected through year 2040. The basis of the population projections for the Comprehensive Plan is projections prepared by the Kansas Water Office (KWO). Their report, "Using Water Demands to Determine Population Estimates and Projections for Kansas," outlines the methodology for the projections and gives projections by county and city through year 2040 at 10-year intervals. The KWO website (www.kwo.org) states that their projections have been endorsed as the official projections by the Kansas Department of the Budget (the department of the state government that is responsible for presenting the State's official population projections).

PEC completed a study of the City's wastewater facilities in 2007. As a part of this study, population projections were performed to determine future wastewater loads. This study used projections for 2010 and 2030 that were provided by the City and anticipated to be used in the Comprehensive Plan update (however, these projections are different from what was actually used in the Comprehensive Plan update). The study used a linear interpolation to determine population projections for years 2015, 2020, and 2025.

The City of Salina Department of Planning performed population projections through 2035 using the cohort survival technique. This technique takes into account the age/gender distribution of the population as well as the influence of mortality, fertility, migration. These projections utilize mortality, fertility, and migration data from the U.S. Census Bureau.

Table 4-2 and Figure 4-2 show a comparison between the populations of the sources described above. The projections outlined in the Comprehensive Plan increase at a greater rate than the projections by PEC and the City of Salina Planning Department, which are approximately the same.

Table 4-2
Summary of Existing Population Projections

Year	2008 Comp Plan Population	2007 PEC Report Population	2006 City Planning Dept Population
2000	45,679	45,679	45,679
2005	-	45,956	46,717
2010	48,766	47,500	47,492
2015	-	48,790	48,807
2020	52,107	50,080	50,190
2025	-	51,360	51,523
2030	55,449	52,650	52,646
2035	-	-	53,588
2040	58,790	-	-

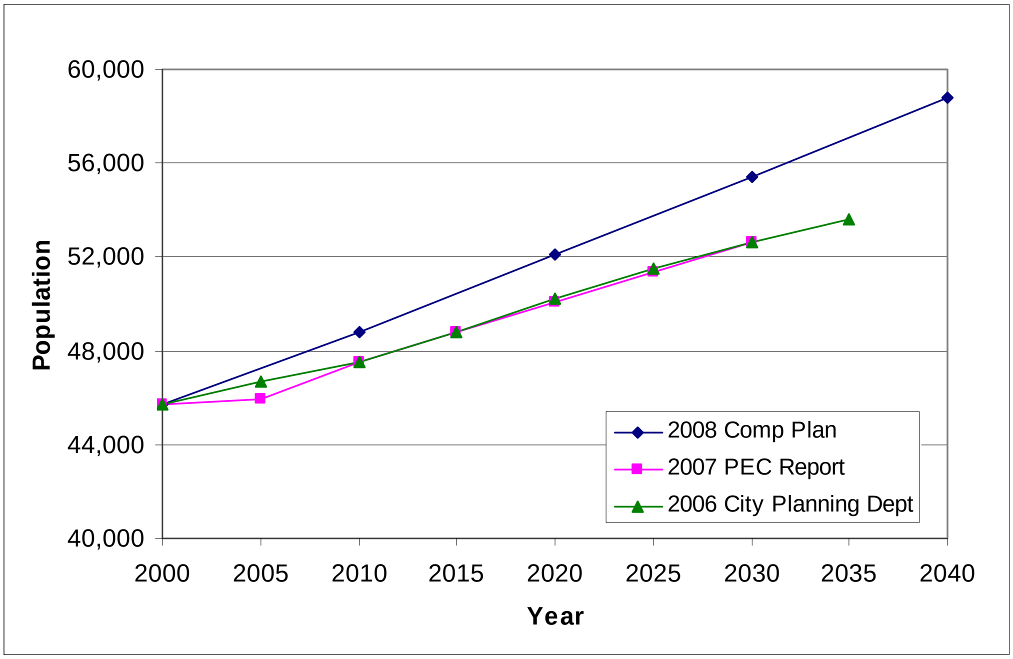


Figure 4-2
Comparison of Existing Population Projections

4.1.3 Population Projections for Planning Horizon

Populations for the current year (2008) and years 2010 through 2060 at 5-year increments were determined based on the sources described above. A linear relationship was used to project population beyond the limits of each study to year 2060. Figure 4-3 and Table 4-3 show the projections through year 2060 based on each of the sources. The figure illustrates that the differences of the population projections based on the PEC report and the projections by the City Planning Department are negligible, each predicting a population in 2060 of approximately 60,000. Projections based on the 2008 Comprehensive Plan are higher than the other two. In 2060, the projections based on the Comprehensive Plan are greater than the other projections by approximately 7.6%, or approximately 5,000 people.

The population projections based on the 2008 Comprehensive Plan Update (which are based on projections from the Kansas Water Office) will be used for the Raw Water Supply Study. The growth rate of these projections is approximately 329 people per year on average.

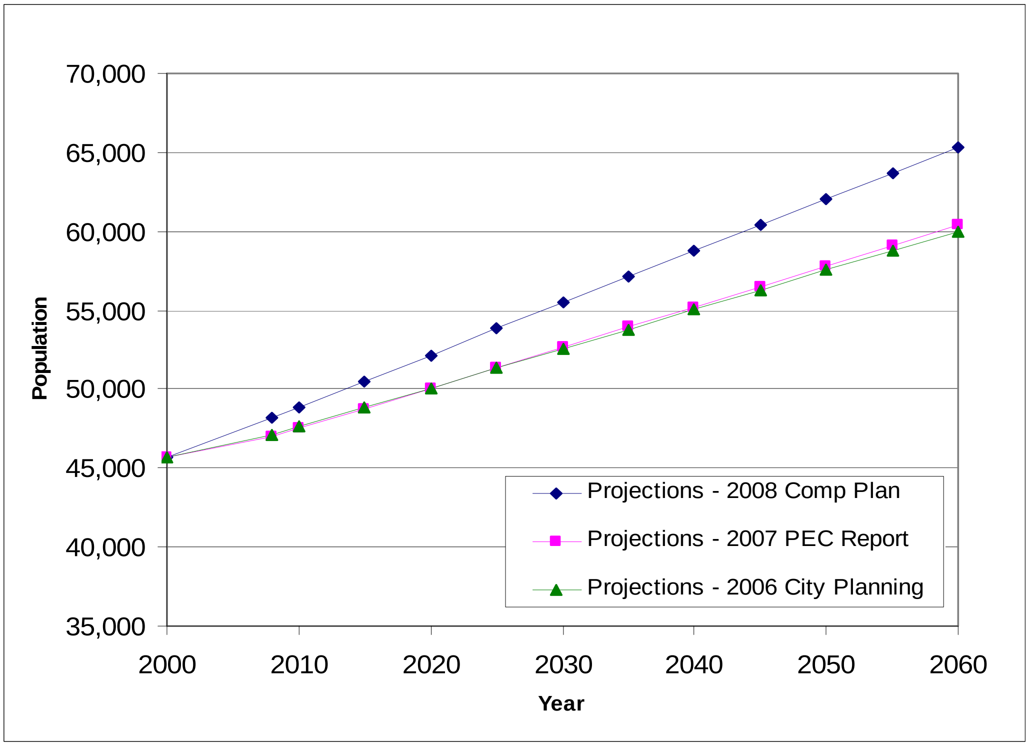


Figure 4-3
Population Projections for Planning Horizon
Based on Existing Sources

Table 4-3
Population Projections for Planning Horizon
Based on Existing Sources

Year	Population Projections – 2008 Comp Plan	Population Projections – 2007 PEC Report	Population Projections – 2006 City Planning Dept
2008	48,220	46,987	47,118
2010	48,877	47,502	47,613
2015	50,521	48,789	48,851
2020	52,165	50,076	50,089
2025	53,810	51,363	51,327
2030	55,454	52,650	52,565
2035	57,098	53,937	53,803
2040	58,742	55,224	55,041
2045	60,386	56,511	56,279
2050	62,030	57,798	57,517
2055	63,674	59,085	58,755
2060	65,318	60,372	59,993

4.2 HISTORICAL WATER USE

Water system demands vary on an hourly, daily, and seasonal basis. In addition, the rate of usage varies across the country. Variations of water consumption can best be explained by such factors as weather patterns, social patterns, economic factors, and technological advances. Because of the unique water characteristics of a community, historical system operating records typically serve as the primary basis for predicting future water requirements. The annual municipal water use reports to the Kansas Department of Agriculture Division of Water Resources (DWR) and maximum production data provided by the City of Salina for 1998 through 2007 were used in the preparation of this report.

The annual DWR reports divide municipal water requirements into five categories:

- Domestic consumption (generally residential, commercial, and institutional uses)
- Industrial consumption
- Wholesale to other public water suppliers
- Non-revenue water for public use (fire fighting, treatment processes, etc)
- Unaccounted for water (losses in the distribution water that are not metered)

The distribution of water usage and the average day (calculated based on DWR reports) and maximum day demands (provided by the City) for the period 1998 through 2007 are summarized in Table 4-4. Water sold to residential and commercial customers accounts for approximately 75% of the total water produced on average. Unaccounted-for water and non-revenue water accounts for approximately 12.5% of the total water produced and industrial users account for 11.4%. A small percentage of the water produced is sold to Saline County Rural Water District #3.

The worst-case maximum day to average day ratio over the ten year period was 2.05. This fits within the typical range of 1.5 to 3.0 for cities of similar size. The City initiated water restrictions in the summer of 2006 due to low levels in the Smoky Hill River; the City re-implemented the water restrictions during the months of April through December of 2007, which was effective at reducing the maximum day demand and the maximum day to average day ratio. A ratio of 2.05 will be used to project maximum day demands as it represents peak demands that will likely occur during a drought period.

A seasonal average for the months of June, July, and August was calculated for comparison to the maximum day based on historical data (1998-2007) from the annual DWR reports. June, July, and August are typically the months of peak water usage. Future water rights must be able to meet the demands over the peak summer season. Future water right needs will be evaluated in Chapter 5.

Table 4-4
Summary of Historical Water Usage

Year	Wholesale Usage (MGD)	Industrial Usage (MGD)	Res/ Comm Usage (MGD)	Non-Revenue Usage (MGD) (1)	Unacc.-For Water (MGD) (2)	Avg Day Usage (MGD)	Summer Avg Usage (MGD) (3)	Summer Avg / Avg Day Ratio	Max Day Usage (MGD)	Max Day / Avg Day Ratio
1998	0.07	0.73	5.02	0.15	0.28	6.26	7.86	1.26	11.94	1.91
1999	0.07	0.72	4.70	0.15	0.43	6.07	7.23	1.19	10.74	1.77
2000	0.08	0.76	5.19	0.15	0.25	6.41	8.01	1.25	13.15	2.05
2001	0.07	0.78	5.01	0.14	0.69	6.70	8.65	1.29	12.88	1.92
2002	0.08	0.76	5.40	0.17	1.01	7.42	10.04	1.35	13.64	1.84
2003	0.07	0.67	5.01	0.14	0.84	6.74	8.66	1.29	12.43	1.84
2004	0.07	0.75	4.69	0.14	0.82	6.47	7.62	1.18	11.36	1.75
2005	0.08	0.73	4.92	0.13	0.74	6.59	8.20	1.24	11.34	1.72
2006	0.08	0.74	4.71	0.15	0.95	6.64	8.51	1.28	12.13	1.83
2007	0.07	0.82	4.53	0.15	0.71	6.27	8.38	1.34	10.57	1.69
MAX		0.82						1.35		2.05

(1) Water that is supplied free for public service, fire-fighting, treatment process, etc.
(2) Un-metered losses in the distribution system
(3) Based on data from annual reports to DWR for months of June, July, and August.

As shown in Table 4-5, the average per capita water use for the ten-year period is 126 gallons per capita per day (gpcd), which is a typical value for communities in the Midwest. The per capita usage is based on residential and commercial demands, including non-revenue usage and unaccounted-for water. Industrial and wholesale users are not included in the average per capita consumption values. Typically the per capita usage rate inversely corresponds with the annual precipitation. The minimum water use of 116 gpcd in 2007 corresponds with the wettest year of the period; the City had also implemented water restrictions during 2007 to curtail high water usage during dry periods. The maximum water consumption of 144 gpcd occurred in 2002, which corresponds with the driest year of the period considered. Since most of the years during this ten-year period were below average in terms of precipitation, the average per capita usage of 126 gpcd will be used to determine the annual average demands and is representative of drought periods. This consumption rate includes non-revenue and unaccounted for water.

Table 4-5
Historical Per Capita Water Usage

Year	Avg Day Demand (MGD)	Population (1)	Avg Per Capita Consumption (gpcd)	Annual Precipitation (in.) (2)
1998	5.46	44,176	123	*
1999	5.29	44,290	119	*
2000	5.58	44,077	127	25.29
2001	5.84	45,607	128	24.80
2002	6.58	45,771	144	13.79
2003	5.99	46,000	130	25.22
2004	5.65	46,000	123	21.43
2005	5.79	46,000	126	23.21
2006	5.81	46,000	126	25.29
2007	5.38	46,500	116	35.58
Average			126	30-32

* Data not available
(1) Based on annual DWR reports
(2) Kansas State Research and Extension

4.3 FUTURE RESERVE CAPACITY

As shown in Table 4-4, industrial water usage has been relatively steady over the past ten years. In 2007, industrial usage increased to 0.82 MGD, the most over the 10-year period of 1998-2007. The Salina Chamber of Commerce is currently promoting industrial growth for the future; the potential for industrial development exists in the southeast and north portions of the City. A reserve capacity is included in the demand projections to account for future industrial development in addition to the current industrial usage (0.82 MGD). Planning an additional capacity for potential industrial users and the ability to easily implement additional capacity is valuable in attracting new industries that would be significant water users in the community. A water reserve could also be used for supplying water to rural water systems or other similar users.

A reserve capacity of 15% would be reasonable for a community the size of Salina. For this study, a reserve capacity of 15% for industrial development will be used.

4.4 DEMAND PROJECTIONS FOR PLANNING HORIZON

Based on the population projections and water use criteria discussed above, future water requirements were projected as shown in Table 4-6. Although water sold to the rural water district has been fairly constant over the past 10 years, they have projected a future water need of 100,000 gpd to account for growth within their district.

A seasonal average for the months of June, July, and August was calculated for comparison to the maximum day based on historical data (1998-2007) from the annual DWR reports. June, July, and August are typically the months of peak water usage. Future water rights must be able to meet the demands over the peak summer season. Future water right needs will be evaluated in Chapter 5.

Table 4-6
Future Water Usage Requirements

Year	Population	Commercial & Residential Usage (MGD) (1)	Wholesale Usage (MGD) (2)	Industrial Usage (MGD) (3)	Average Day (MGD)	Industrial Reserve (MGD) (4)	Average Day w/ Reserve (MGD)	Summer Average Day (MGD) (5)	Summer Average Day w/ Reserve (MGD) (5)	Maximum Day (MGD) (6)	Maximum Day w/ Reserve (MGD) (6)
2008	48,220	6.08	0.10	0.82	7.00	1.05	8.05	10.86	11.91	14.34	15.39
2010	48,877	6.16	0.10	0.82	7.08	1.06	8.14	10.99	12.05	14.51	15.57
2015	50,521	6.37	0.10	0.82	7.29	1.09	8.38	11.31	12.40	14.94	16.03
2020	52,165	6.57	0.10	0.82	7.49	1.12	8.62	11.63	12.76	15.36	16.48
2025	53,810	6.78	0.10	0.82	7.70	1.15	8.85	11.95	13.11	15.78	16.94
2030	55,454	6.99	0.10	0.82	7.91	1.19	9.09	12.28	13.46	16.21	17.40
2035	57,098	7.19	0.10	0.82	8.11	1.22	9.33	12.60	13.81	16.63	17.85
2040	58,742	7.40	0.10	0.82	8.32	1.25	9.57	12.92	14.17	17.06	18.31
2045	60,386	7.61	0.10	0.82	8.53	1.28	9.81	13.24	14.52	17.48	18.76
2050	62,030	7.82	0.10	0.82	8.74	1.31	10.05	13.56	14.87	17.91	19.22
2055	63,674	8.02	0.10	0.82	8.94	1.34	10.28	13.88	15.23	18.33	19.67
2060	65,318	8.23	0.10	0.82	9.15	1.37	10.52	14.21	15.58	18.76	20.13

(1) Based on 10-year average of per capita water use of 126 gpcd. Also includes non-revenue and unaccounted-for water.

(2) Based on BWR projections for Saline County RWD #3

(3) Based on maximum industrial usage over past 10 years

(4) Based 15% of average day demands

(5) Uses a peaking factor of 1.35, which is the maximum peaking factor over the past 10 years. Peaking factor is based on use data (DWR reports) from months of June, July, and August over the past 10 years

(6) Uses a peaking factor of 2.05, which is the maximum peaking factor over the past 10 years

5 WATER RIGHTS

A firm understanding of the City of Salina's existing water rights and their seniority are critical elements in developing a plan for future water supply. The objective of this Chapter is to review the City's existing water rights and to quantify existing water rights as they relate to future customer demand scenarios.

5.1 EXISTING WATER RIGHTS

On June 28, 1945, the State of Kansas enacted the Kansas Water Appropriation Act, which allows the State to conserve, protect, control, and regulate the use, development, diversion, and appropriation of water for beneficial and public purposes. Under the Water Appropriation Act, the right to use water is based on a "first in time, first in right" priority system. Prior to the Water Appropriation Act water rights were tied to land ownership and withdrawal was not regulated. A water right is not ownership of the water, rather the right to divert and use the water for beneficial purposes with certain limitations. The law is administered by the DWR. The DWR issues permits to appropriate water, regulates usage, and keeps records of all water rights in the state.

There are two types of water rights: vested rights, and appropriated rights. Vested and appropriated water rights, as used in the Water Appropriation Act, are defined as follows:

- VESTED RIGHT--right to continue the use of water having actually been used for a beneficial use on or before June 28, 1945, when the Kansas Water Appropriation Act became effective.
- APPROPRIATIVE RIGHTS--appropriative water rights are created by diversion of water and putting it to beneficial use. Appropriative water rights have a priority based on the date of first usage. In times of shortage, the water use of junior appropriators is curtailed while senior appropriators receive their full allotment.

Vested rights always have priority over appropriated rights. All vested rights have the same priority date, and relative priority amongst vested rights is determined through adjudication.

5.1.1 Summary of Vested and Appropriate Rights

This section presents the current interpretation of the City of Salina's existing water rights. This interpretation was developed by reviewing the water right certificates presented in Appendix A and through discussions with DWR. Water rights under the Water Appropriation Act can be complex and subsequently should be reviewed by attorneys who specialize in water rights law.

The City maintains both vested rights and appropriated rights for beneficial use of groundwater, and an appropriated right for surface water. The City currently maintains the following water rights:

- Vested Right SA002 – 15 wells in Downtown Wellfield. The total annual volume for this right is 3,536 acre-ft. The maximum flow rate associated with this right is 5,550 gallons per minute (gpm), or 8.0 MGD.
- Vested Right SA035 – 5 wells in South Wellfield. The annual volume for these 5 wells is 2,511 acre-ft with a maximum flow rate of 2,559 gpm (3.7 MGD). This right also combines all existing water rights (vested and appropriated) and assigns a maximum appropriation and flow rate. When combined with the Downtown Wellfield, the Smoky Hill River Intake, and all other appropriation certificates (excluding Cert 31,636) the maximum total annual volume is 11,760 acre-ft. The maximum flow rate is 16,450 gpm (23.7).
- Appropriated Right Certificate 3043 – This right is for a surface water diversion from the Smoky Hill River. The total annual volume appropriated is 5,028 acre-ft and the maximum flow rate is 6,955 gpm (10.0 MGD). This right has a priority date of October 16, 1954.
- Appropriated Right Certificate 7635 – 15 wells in Downtown Wellfield. Under this certificate, each well is assigned a maximum flow rate. Additionally, this right was combined with Vested Right SA002 and in total, the combined appropriations allow for an annual withdrawal of 4,916 acre-ft at a maximum rate of 9,118 gpm (13.1 MGD). This right has a priority date of October 30, 1957.
- Appropriated Right 31,636 – This right increased the total volume available from Certificate 7635 by 77 acre-ft and slightly revised the maximum flow rate for each well. This certificate was developed to support development of Rural Water District No. 3. Each well received some distribution of the 77 acre-ft. When operating simultaneously, this right increases the maximum flow rate limit in Certificate 7635 by 1,450 gpm (2.1 MGD). This right has a priority date of April 11, 1978.

Table 5-1 presents a summary of the total water rights available at the Downtown Wellfield, which are a combination of the water rights available from Vested Right SA002, Appropriated Right Certificate 7635, and Appropriated Right Certificate 31,636. The total pumping volume and maximum instantaneous pumping rate are limited on a *per well basis* by Appropriated Right 7635 and Appropriated Right 31,636.

The total Downtown Wellfield pumping volume and instantaneous pumping rate are also limited by Appropriated Right 7635 and Appropriated Right 31,636. The total pumping volume is limited to the sum of the maximum annual withdrawal of 4,916 acre-ft (Appropriated Right 7635) and the 77 acre-ft provided by Appropriated Right 31,636. The sum of those two appropriated rights provides a total annual pumping volume of 4,993 acre-ft to the Downtown Wellfield. The maximum instantaneous pumping rate from the wellfield is limited to the sum of the 9,118 gpm maximum rate of Appropriated Right 7635 and the 1,450 gpm provided by Appropriated Right 31,636. The sum of those two appropriated right provides a maximum instantaneous pumping rate of 10,568 gpm (15.2 MGD) to the Downtown Wellfield.

Table 5-1
Summary of Downtown Wellfield Water Rights
SA002, Certificate 7,635 and Certificate 31,636

Well Number	Maximum Rate (GPM)	Maximum Annual Volume (acre-ft)
1	870	481.22
2	1,085	393.99
3	1,000	222.60
4	1,160	573.37
5	1,000	516.60
6	1,140	487.37
7	1,215	497.37
8	1,140	193.37
10	1,310	316.14
11	1,195	118.37
12	1,270	176.14
13	1,160	268.37
14	1,085	498.99
15	965	259.60
16	905	462.22
Total	16,500	5,465.72
Limits	10,568	4,993

Note: Well #9 was previously abandoned and does not currently exist.

In summary, the City of Salina maintains several active water rights. The total water available to the City is a combination of two water rights, Vested Right SA035 and Appropriated Right 31,636. Vested Right SA035 caps the water available from Vested Right SA002 (Downtown Wellfield), Appropriated Right Certificate 3043 (Smoky Hill River), and Appropriated Right Certificate 7635 (Downtown Wellfield) and assigns a maximum volume and flow rate to the wells at the South Wellfield. Appropriated Right 31,636 adds to the water available, both flow rate and volume, for use at the Downtown Wellfield. The maximum total water available to the City (surface and groundwater) in one year is the sum of 11,760 acre-ft (SA0035) and the 77 acre-ft provided by Appropriated Right 31,636, or 11,837 acre-ft. The maximum combined instantaneous flow rate for surface water and groundwater is the sum of 16,450 gpm (SA0035) and the 1,450 gpm provided by Appropriated Right 31,636, or 17,900 gpm (25.8 MGD).

As summarized in Table 5-1, the annual groundwater usage from the Downtown Wellfield cannot exceed 4,993 acre-ft and the maximum instantaneous flow rate cannot exceed 10,568 gpm (15.2 MGD). The maximum annual volume and maximum flow rate for wells in the Downtown Wellfield are governed on a per well basis, as shown on Table 5-1.

The five (5) wells located at the South Wellfield have a total water right of 2,511 acre-ft, limited to a maximum instantaneous flow rate of 2,558 gpm (3.7 MGD). Finally, per Certificate 3043, annual surface water usage cannot exceed 5,028 acre-ft and the maximum flow rate for surface water is 6,955 gpm (10 MGD). A summary of the City's existing water rights is shown in Table 5-2.

Table 5-2
Summary of Existing Water Rights

Supply Source	Max Annual Volume (ac-ft)	Avg Diversion Rate (MGD) (1)	Max Diversion Rate (MGD)
Smoky Hill River (Cert. 3043)	5,028	4.5	10.0
Downtown Wellfield (SA002/Cert. 7635/Cert. 31,636)	4,993	4.5	15.2
South Wellfield (SA0035)	2,511	2.2	3.7
Total	12,532	11.2	28.9
Limitations (SA0035 + Cert. 31,636)	11,837	10.6	25.8

5.1.2 Impacts of Senority

This section summarizes the City's priority status for both surface water and groundwater rights compared to other water right holders.

Surface Water (Between Kanopolis Reservoir and the City of Salina)

A total of six (6) active vested rights (011, 012, 018, 019, 021and 037) have a higher priority than the City's appropriated surface water right (DWR/KGS, 2009). These rights are used for irrigation and total 11.76 MGD (on a maximum diversion rate basis).

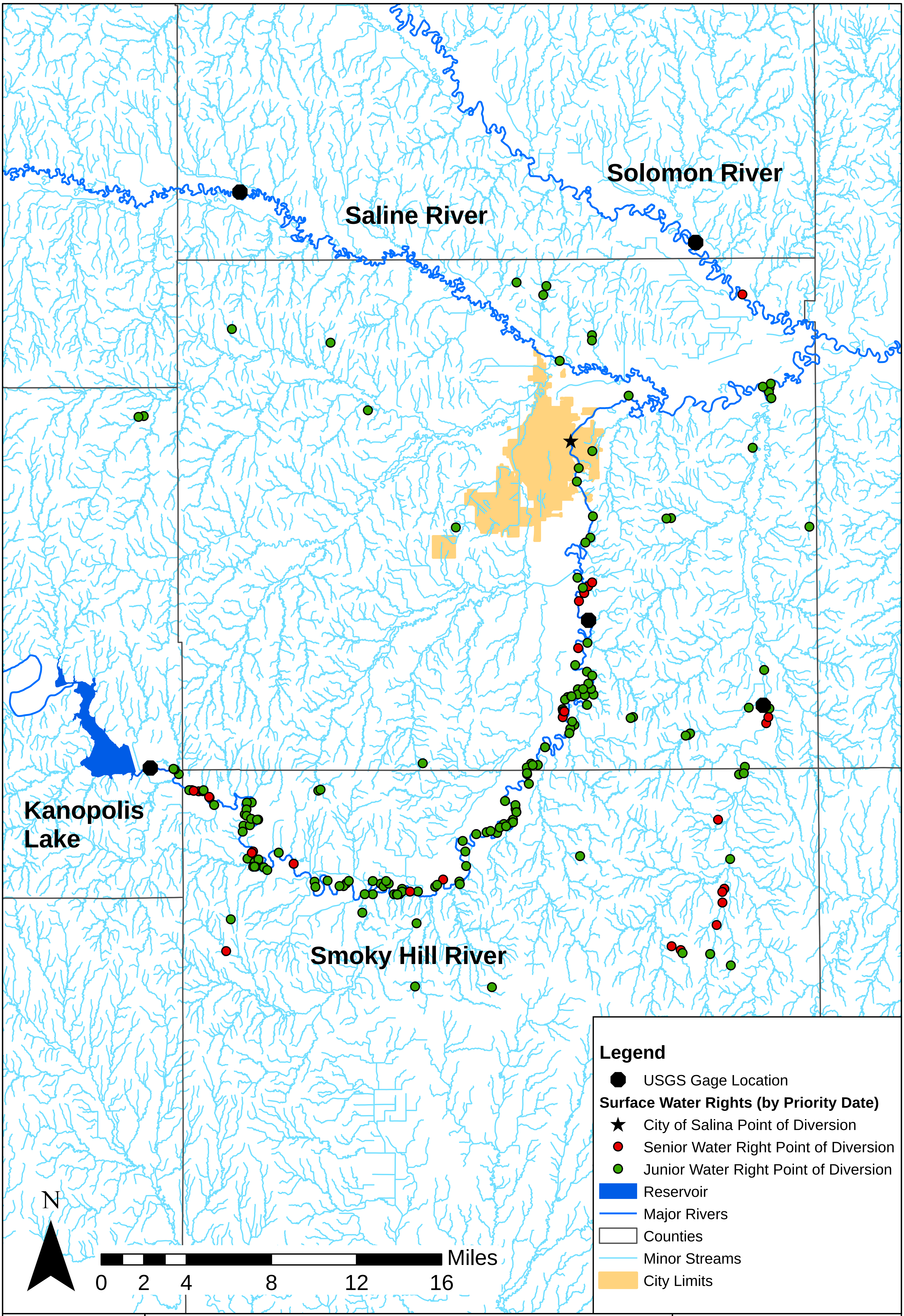
A total of ten (10) active appropriated rights (569, 573, 613, 1928, 2223, 2355, 2425, 2516, 2839, and 2960) have a higher priority than the City's appropriated surface water right (DWR/KGS, 2009). These rights are used for irrigation and total 11.38 MGD (on a maximum diversion rate basis).

Between Kanopolis Reservoir and the City of Salina, there are 23.14 MGD of water rights total that are senior to the City of Salina's appropriated surface rights (on a maximum diversion rate basis). Figure 5-1 shows the locations of points of diversion that represent senior water rights and the City of Salina's Smoky Hill River intake.

Ground Water

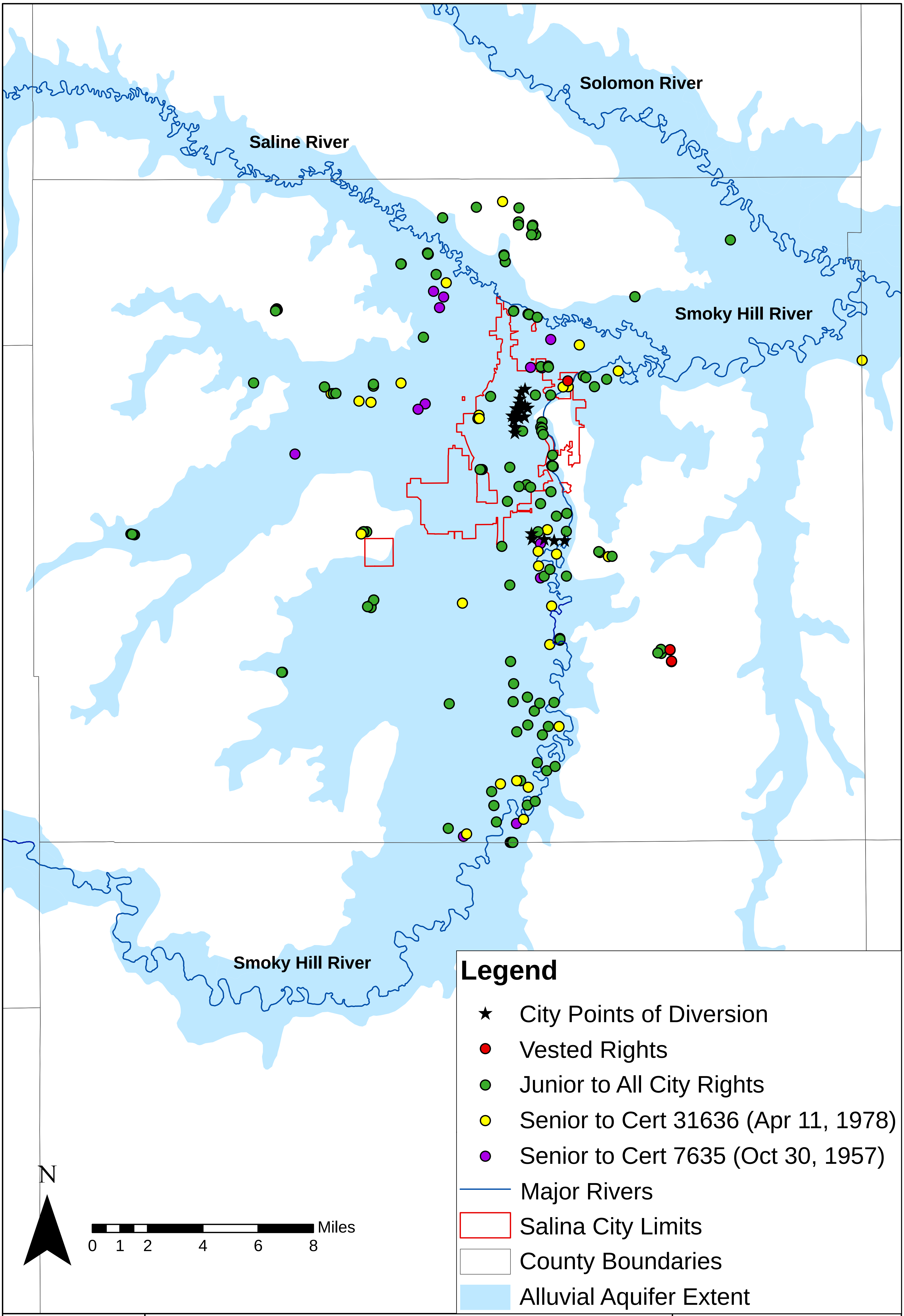
Two (2) other vested rights (SA001 and SA012) share the highest priority with the City's vested rights SA002 and SA035 (DWR/KGS, 2009). SA012 is used for irrigation, while SA001 is a municipal right associated with the City of Gypsum. These rights total to 2.9 MGD (on a maximum diversion rate basis).

A total of 18 active appropriated rights (920, 3049, 3830, 3865, 3958, 4208, 4914, 5442, 5963, 6164, 6173, 6333, 6393, 6406, 6701, 7087, 7148, and 7175) have a higher priority than the City's appropriated rights (DWR/KGS, 2009). These rights mostly used for irrigation; one water right is for industrial use. These rights total to 16.8 MGD (on a maximum diversion rate basis). The locations of these senior water rights are shown in Figure 5-2.



Raw Water Supply Study

Figure 5-1: Surface Water Right Diversion Points



Raw Water Supply Study

Figure 5-2: Ground Water Right Diversion Points

5.2 WATER RIGHTS AND FUTURE DEMANDS

This section addresses the adequacy of the City's existing water rights to meet projected demands through year 2060. Two scenarios were evaluated to determine water right adequacy: 1) normal conditions, where flow in the Smoky Hill River is adequate and the City can utilize their full water right on an annual volume basis and on a maximum diversion basis, and 2) drought conditions on a maximum diversion basis such as experienced in July 2006, when flow in the Smoky Hill River declined to a record low of 0.82 MGD and was essentially dry.

The scenarios presented below only consider the "paper" water rights the City already owns to meet projected future demands and potential service limitations. The scenarios do not consider the capabilities of the equipment, current operating scenarios, and other characteristics. The Smoky Hill River, Downtown Wellfield, and South Wellfield will be evaluated for capacity, quality, and other characteristics in Chapter 7.

5.2.1 Normal Conditions

Under normal conditions, the City uses the Smoky Hill River and the Downtown Wellfield to meet customer demands. Combined these two sources have a total of 10,021 acre-ft available on an annual basis through existing water rights (see Table 5-2). Water from the South Wellfield is currently used for emergency conditions only due to water quality limitations. The addition of treatment at South Wellfield will allow this source to be usable and will provide an additional 1,816 acre-ft in combination with the Smoky Hill River and Downtown Wellfield for an annual total of 11,837 acre-ft (see Table 5-2).

Annual water use for the planning horizon (through 2060) was presented in Chapter 4 and is shown in Figure 5-3 in conjunction with the water rights for the City's three sources of supply. As shown annual water use will exceed current water rights for the Smoky Hill River and the Downtown Wellfield in approximately 2027. The addition of treatment at the South Wellfield will extend annual supply based on water rights to meet demands through the planning horizon.

As discussed previously, the Smoky Hill River has a maximum diversion rate of 10 MGD and the Downtown Wellfield has a maximum diversion rate of 15.2 MGD for a total maximum diversion rate of 25.2 MGD (see Table 5-2) compared to the projected maximum day demand of 20.1 MGD in 2060. As shown in Figure 5-4, the maximum diversion rate under the water rights for the Smoky Hill River and the Downtown Wellfield are adequate to meet maximum day projections through 2060 assuming normal conditions averaged over a year.

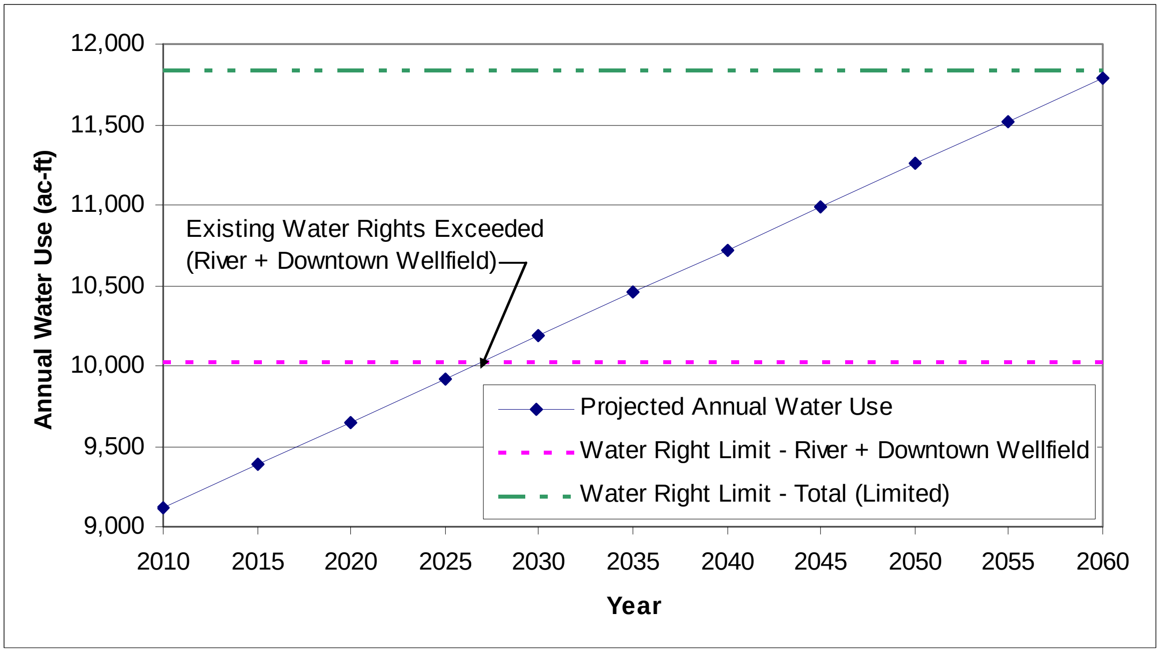


Figure 5-3
Annual Water Use and Existing Water Rights
Normal Conditions

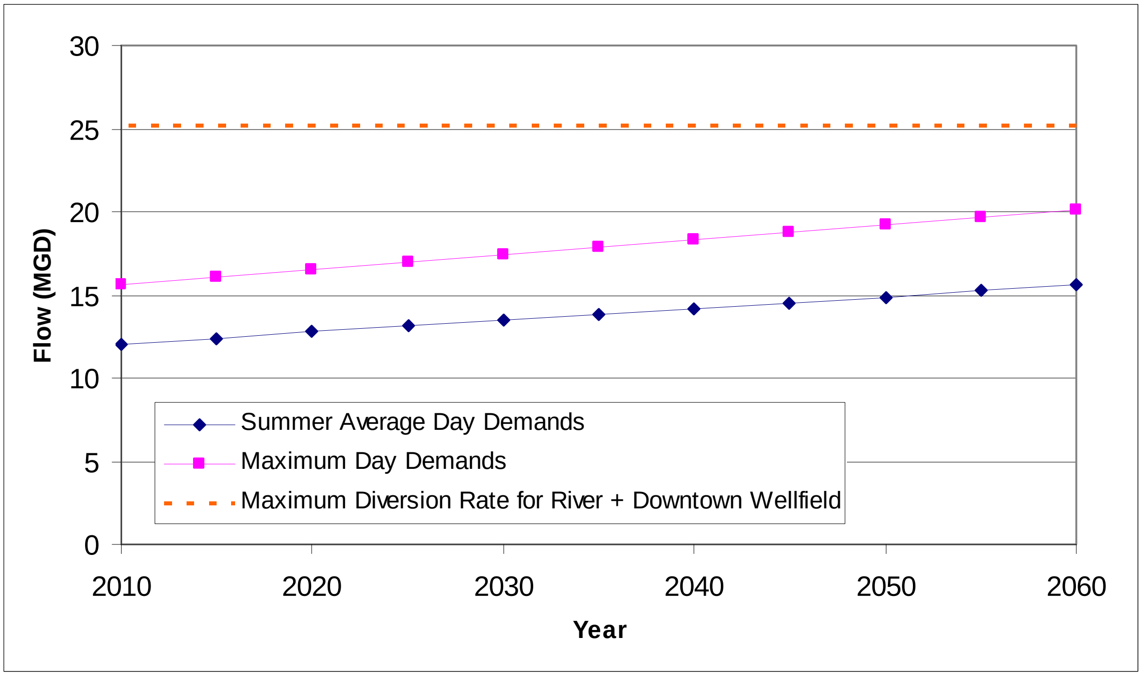


Figure 5-4
Demands and Existing Water Rights
Normal Conditions

5.2.2 Drought Conditions

In July, 2006 the City experienced unprecedented drought conditions that affected flow in the Smoky Hill River and the City's ability to withdraw water. At that time, flow at the United States Geological Survey (USGS) stream flow gage at Mentor, Kansas declined to a record low of 1.2 cfs (0.82 MGD). This prompted the City to request that DWR administer water rights along the Smoky Hill River to 5 MGD at Salina, half of the water rights allowed by City on the Smoky Hill River. From this experience the City has learned that flow in the Smoky Hill River may not be reliable for water supply during drought conditions. Although the City has sufficient water rights to use the water in the river, declining flow trends in the Smoky Hill River indicate that future drought conditions are likely to mimic the most recent drought conditions of 2000-2006 or be even worse (Putnam, 2008).

A conservative approach for planning purposes would be to plan for the worst-case condition during a drought of no flow available from the Smoky Hill River, requiring the City to be nearly fully reliant upon the Downtown Wellfield. Although the City has some ability to store water behind a low-head dam at the river intake and can also request administration of water rights that are junior to the City, future drought conditions are unknown and are assumed to be worse than 2000-2006 for planning purposes. The City likely cannot pump large quantities from the water stored behind the dam for an extended period of time during extreme drought conditions. In addition the water quality in the river during an extreme drought is likely heavily degraded with total dissolved solids which may impact the level of treatment the City can provide for its customers. If future droughts are worse than those experienced previously, water right holders along the Smoky Hill River that are senior to Salina could request administration of water rights; under such conditions the City of Salina would be a junior water right holder and usage could be curtailed. Due to the reasoning described above and for planning purposes, this study will use the assumption that under worst-case drought conditions in the future, no flow will be available in the Smoky Hill River.

Figure 5-5 shows the available water rights, if only the Downtown Wellfield is available for use during a drought. The summer average day demand will exceed the existing water right for the Downtown Wellfield in approximately 2054. Presently and throughout the planning horizon water rights at the Downtown Wellfield alone can not meet maximum day demands. In such a situation, the City would be forced to put extreme restrictions on its customers to conserve water. This planning horizon drought condition only considers the "paper" water rights available to the City and does not consider the capabilities of the equipment; these items will be addressed in Chapter 7.

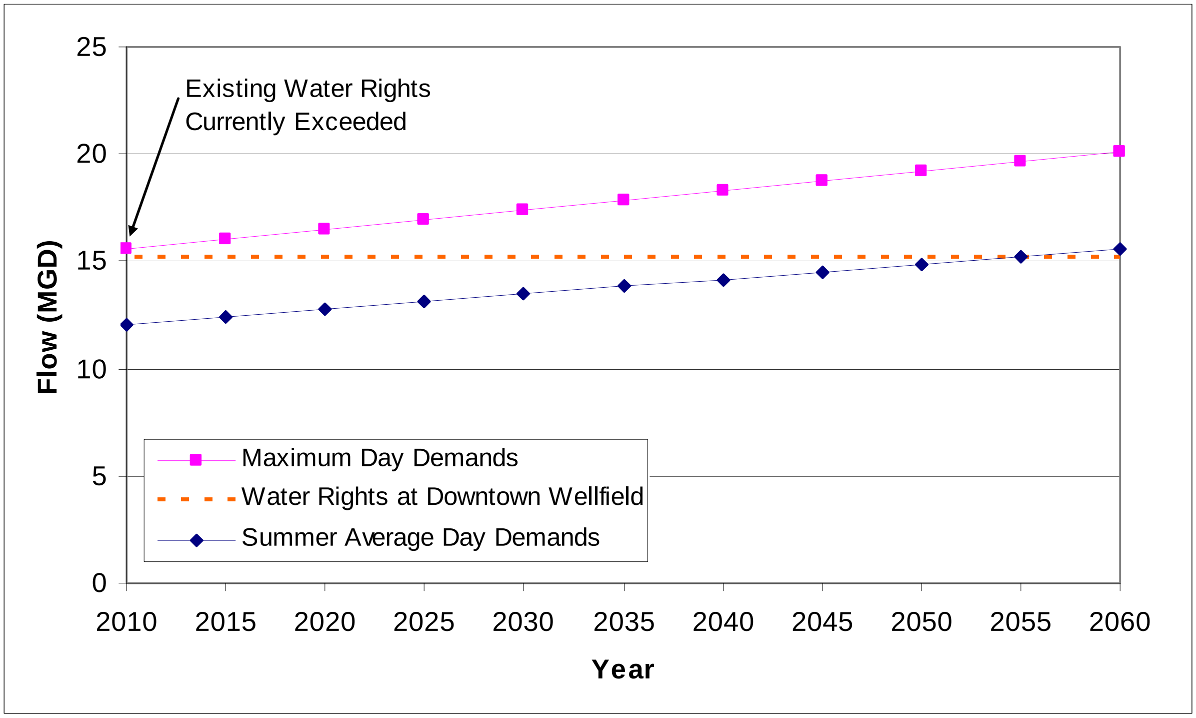


Figure 5-5
Shortfall of Water Rights Compared to Demands
(Downtown Wellfield Only)

The City also has water rights at the South Wellfield available for emergency situations, but they were not used during the water emergency in 2006. Although the water rights are available to the City, the South Wellfield currently is not used due to excessive hardness, iron, and manganese. An additional 3.7 MGD (maximum withdrawal rate) based on water rights is available from this source provided the total water rights in use at one time are not more than 25.8 MGD. Figure 5-6 shows the water rights for the summer average day and the maximum day if only the Downtown Wellfield and South Wellfield are able to be used during a drought. The summer average demand will be met by the water right through the planning horizon. In approximately year 2048 the existing water rights for the wellfields would not be able to meet maximum day demands. In order to use the water rights at the South Wellfield as described in this scenario the addition of treatment would likely be required.

More detailed information regarding the figures presented in this section is presented in Appendix B.

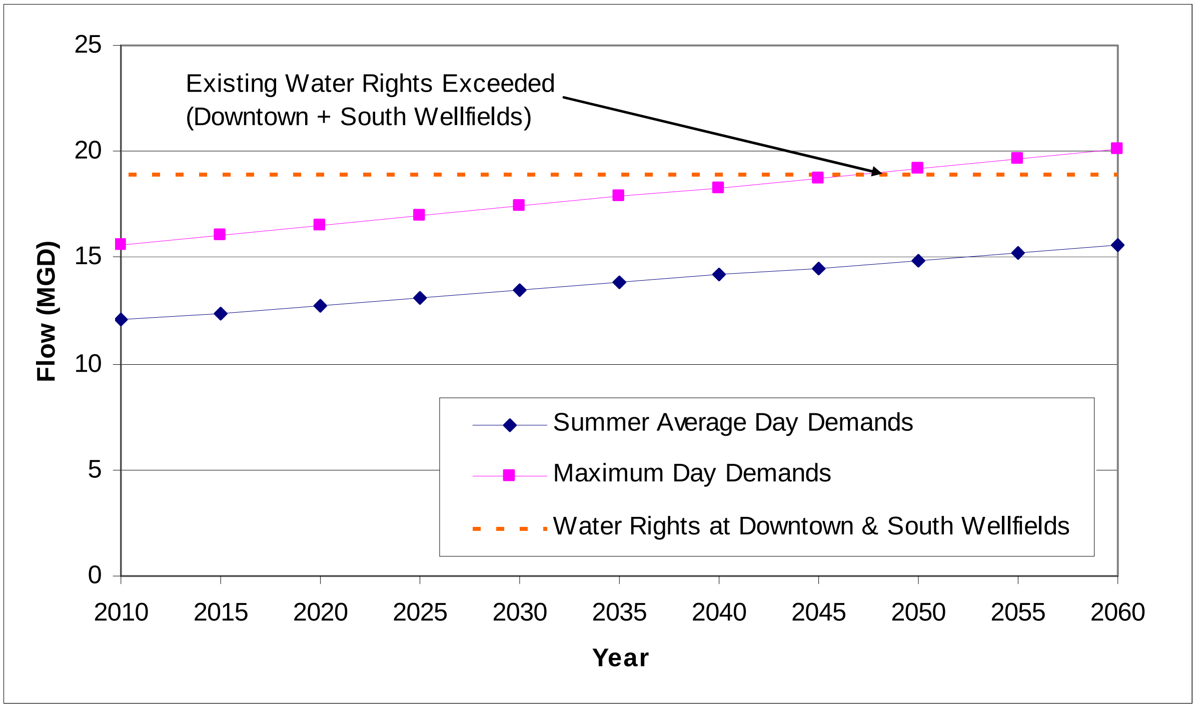


Figure 5-6
Shortfall of Water Rights Compared to Demands
(Downtown Wellfield & South Wellfield)

6 EXISTING AND FUTURE REGULATORY REVIEW

Existing regulatory compliance and potential future regulations are critical elements in developing a plan for future water supply. The objective of this Chapter is to review the City's existing regulatory compliance and to consider the impact of future water quality regulations.

6.1 EXISTING REGULATORY REVIEW

To determine viability and cost effectiveness of alternative supplies in the Raw Water Supply Study consideration of the impacts of current and anticipated future drinking water regulations is essential. Any changes that are recommended as a result of the study must account for continued long-term compliance with current and impending State and Federal regulations. Because the drinking water regulatory framework is complex, compliance with the regulations can often govern available options for operational and treatment improvements. As alternative water supply sources are developed, the impacts on compliance with drinking water regulations will be assessed.

The City of Salina water system is subject to the federal drinking water regulations that arise under the Safe Drinking Water Act (SDWA) which are enforced through primacy agreement by the State of Kansas. In Kansas, the primacy agency is the Kansas Department of Health and Environment (KDHE). Taken as a group, the thrust of the current drinking water regulations is to ensure that drinking water is microbially safe, that it contains minimal disinfection byproducts, and that it does not contain excess levels of organic or inorganic contaminants. Compliance with the regulations requires each treatment plant not only to produce water that meets the regulated water quality standards, or maximum contaminant levels (MCLs), but also meet specific monitoring requirements and treatment techniques.

As presented in Chapter 3, the City of Salina currently treats water from the Smoky Hill River and the Downtown Wellfield at a partial water softening plant prior to distribution for consumption. Water from the South Wellfield, when used, is treated with chlorination only. Table 6-1 summarizes the finished water quality from the water treatment plant over the past five years (2003-2007) for the City of Salina. The data presented represents the best available data obtained for this analysis and is a combination of data collected and provided by the City and the Consumer Confidence Reports. In general, the data below indicates compliance with regulations under the SDWA. The following are conclusions about the water quality trends:

- In general, source water TOC is between 4.0 mg/l and alkalinity is > 120 mg/l. This data corresponds to TOC removal requirements of 25% under the Stage 1 Disinfectants and Disinfection By-Products (DBP) Rule. The data below indicate TOC removals exceed the required 25% removal.
- Data collected for 2006 indicates atrazine levels that are higher than the MCL of 3.0 ug/l. This is likely due to a decrease in surface water runoff due to drought conditions and associated lower

atrazine dilution levels. Atrazine is widely found in herbicides and atrazine contamination is a common concern for surface water users in Kansas. KDHE recommends quarterly or monthly sampling to reduce the average concentrations of atrazine that are sampled. The City has indicated that their laboratory has put them on increased atrazine sampling.

- Years 2003-2006 indicate higher than recommended TDS concentrations. These years correspond with drought years when water quality in the river was likely degraded with high TDS at low flow conditions. The TDS concentration presented for 2007, which was a wetter-than-average year, is below the recommended concentration. TDS is a secondary standard and is not enforced by the State but rather is an aesthetic consideration.
- Total hardness over 2003-2007 ranges from 84 mg/l to as high as 140 mg/l. The average hardness over the five-year period is 113 mg/l. These values indicate relatively hard water, however this is common in this geographic region.

Table 6-1
Finished Water Quality Summary
City of Salina Water Treatment Plant

Primary Regulations (1)

Contaminant	MCL	units	2003	2004	2005	2006	2007	Compliant?
Antimony	6.0	ug/l	<1.0	<1.0	<1.0	<1.0	<1.0	YES
Arsenic	10.0	ug/l	1.3	1.1	1.5	1.4	<1.0	YES
Atrazine	3.0	ug/l	ND	ND	ND	8.7	0.4	*
Barium	2.0	mg/l	0.018	0.012	0.013	0.0088	0.013	YES
Beryllium	4.0	ug/l	<1.0	<1.0	<1.0	<1.0	<1.0	YES
Cadmium	5.0	mg/l	<1.0	<1.0	<1.0	<1.0	<1.0	YES
Chromium	0.10	mg/l	0.0029	0.003	0.0032	<0.001	0.003	YES
Copper	1.3	mg/l	0.0054	0.0015	0.0026	0.0013	0.0014	YES
Fluoride	4.0	mg/l	0.00097	0.00084	0.0012	0.00023	0.00097	YES
Lead	15.0	ug/l	<1.0	<1.0	<1.0	<1.0	<1.0	YES
Mercury	2.0	ug/l	<0.50	<0.50	<0.50	<0.50	<0.50	YES
Nitrate (as N)	10.0	mg/l	0.13	0.36	0.59	1.2	1.1	YES
Selenium	50.0	ug/l	10.0	12.0	9.3	9.5	20.0	YES
Thallium	2.0	mg/l	<1.0	<1.0	<1.0	<1.0	<1.0	YES
Chloramines (as Cl2)	4.0	mg/l	3.2	2.8	ND	ND	ND	YES
TTHMs	80.0	ug/l	52.1	50.8	51.1	61.9	61.6	YES
HAA5s	60.0	ug/l	24.6	29.9	24.8	29.2	44.8	YES
TOC (2)	TT	%	45.3%	54.5%	55.7%	46.2%	58.8%	YES
Turbidity (3)	TT	NTU	<0.15	0.38	<0.15	<0.15	0.34	-

Secondary Standards (1)

Contaminant	Sec. MCL	units	2003	2004	2005	2006	2007
Aluminum	0.05-0.2	mg/l	0.08	0.046	0.081	0.11	0.44
Chloride	250	mg/l	180	140	150	130	75
Iron	0.30	mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Manganese	50.0	ug/l	<1.0	<1.0	<1.0	<1.0	<1.0
pH	6.5-8.5		7.5	7.4	7.7	7.7	7.1
Silver	100.0	mg/l	<1.0	<1.0	<1.0	<1.0	<1.0
Sulfate	250	mg/l	200	180	180	180	190
TDS	500	mg/l	690	560	570	590	470
Zinc	5	mg/l	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Other Parameters of Interest

Parameter	units	2003	2004	2005	2006	2007
Alkalinity	mg/l	87	65	66.4	97.7	46.7
Total Hardness	mg/l	110	100	130	140	84

- TT = Treatment Technique
- ND = No Data Available
- *High levels in 2006, compliant in 2007. The laboratory has recommended that the City increase the frequency of their atrizine sampling.
- (1) Primary regulations are regulations that are enforceable by the EPA and KDHE and are known to cause various health effects. Secondary standards are guidelines that are non-enforceable but improve the aesthetic quality of the water.
- (2) Compliance is based on running annual averages of TOC removal ratios. Removal ratio requirements depend on the TOC and alkalinity of the source water.
- (3) Compliance is based on combined effluent turbidity ≤ 0.3 NTU in 95% of measurements taken each month

6.2 RECENT REGULATIONS

It is important to consider the impacts of impending water quality regulations when considering long-term water supply. Any changes that are recommended as a result of the Raw Water Supply Study must be flexible to account for continued long-term compliance with regulations. Two major rules have been introduced in recent years, the Stage 2 Disinfection Byproducts Rule (DBPR) and the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). Some of the requirements are underway but many of the requirements as well as compliance with the rules are yet to come.

6.2.1 Stage 2 Disinfection Byproducts Rule (DBPR)

The Stage 2 DBPR was published in 2006 and applies to all drinking water systems. Part of the requirements of the rule and compliance with the rule are yet to come. The Stage 2 DBPR will change disinfection by-product (DBP) compliance to be based on locational running annual averages (LRAA), rather than system-wide averages, using the same MCLs as the Stage 1 DBPR (80 μg/L for total trihalomethanes (TTHMs) and 60 μg/L for haloacetic acids (HAA5)). This means that the results from DBP sampling will no longer be averaged across the entire distribution system. Instead, the results of sampling will be averaged each quarter at each sampling site, and the running annual average of the results at each location must meet the MCL's.

The Stage 2 DBPR contains a requirement for every utility (regardless of water source) to complete an Initial Distribution System Evaluation (IDSE). The purpose of the IDSE is to locate new sampling points for DBP sampling in the distribution system. Two basic approaches are available for completing the IDSE, the Standard Monitoring Plan approach and the System Specific Study approach. The Environmental Protection Agency (EPA) expects most water systems to use the Standard Monitoring Plan approach which requires a utility to identify sites in the distribution system that represent locations where THMs and HAA5s are highest. Utilities must identify a certain number of such sites based on the population served. Monitoring must then be completed at the selected sites for TTHMs and HAA5 at a specified interval over one year. Using these sampling results and Stage 1 DBPR compliance monitoring results, systems must select new DBP compliance monitoring sites. If a system elects to use the System Specific Study approach a well calibrated hydraulic model is used to select the new long-term compliance monitoring sites.

For systems serving between 10,000 and 49,999 people, such as the City of Salina, the schedule for completing the IDSE is as follows:

- Submit either a Standard Monitoring Plan or System Specific Study Plan to the regulatory agency by October 1, 2007. This has been completed by the City as of the date of this report.
- The primacy agency will review the plan and notify systems of approval before September 30, 2008. This has been completed by the City as of the date of this report.
- Standard monitoring will be conducted between October 1, 2008 and September 30, 2009. This step is wrapping up at the time of this report.
- Submit the final IDSE Report to the regulatory agency by January 1, 2010.
- Final compliance with new MCLs by October 1, 2013.

The final IDSE Report will contain all the information obtained during the study and will designate new compliance monitoring sites for the water system. The new monitoring sites will be located at sites where DBPs are expected to be the highest in the system. Treatment alternatives as well as operational changes that can reduce TTHM formation in the system must be part of the treatment evaluation for the system.

This rule may have an impact on the Raw Water Supply Study as it relates to disinfection at the plant and associated TTHM and HAA5 formation. The City is currently meeting the MCLs for TTHMs and HAA5 on the LRAA basis as required by the Stage 2 DBPR, however, some of the individual samples have been increasing over the past 5 years as the City favors surface water over groundwater (WCI, 2008), which may lead to higher LRAAs at each sampling site. Any increases in surface water utilization should take into account the possibility of increased TTHM and HAA5 formation.

6.2.2 Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)

Similar to the Stage 2 DBPR the LT2ESWTR was published in 2006 and applies to all surface water or groundwater under direct influence (GWUDI) of surface water. This rule applies to the City's use of the Smoky Hill River; the Downtown Wellfield and South Wellfield are not considered GWUDI and do not require compliance under this rule. Part of the requirements of the rule and compliance with the rule are yet to come. The objective of the rule is to reduce the risk associated with *Cryptosporidium* in drinking water. Sampling of raw water sources for *Cryptosporidium* for 24 months is required under the LT2ESWTR for filtering systems the size of Salina (serving between 10,000 and 49,999 people). According to the LT2ESWTR schedule, sampling for systems the size of Salina began in April 2008 and continues through April 2010. Systems have the option of sampling more frequently than once a month and must submit monthly results directly to EPA within a month of the sampling event.

Each utility will determine a bin classification based on the *Cryptosporidium* sample results. Per the LT2ESWTR schedule, Salina must determine their bin classification by September 2010. If the system takes a total of at least 48 samples during the monitoring period (2 times per month), the bin concentration is equal to the mean of all sample concentrations. If at least 24, but less than 47 samples are taken, the bin concentration is equal to the highest average of all sample concentrations in any twelve consecutive months. Proposed treatment bins under the rule are shown in Table 6-2.

Table 6-2
LT2ESWTR Treatment Bin Summary

Bin	Average *Cryptosporidium* Concentration	Additional treatment requirements for systems with conventional treatment
1	Crypto < 0.075/L	No action
2	0.075/L $\leq$ Crypto < 1.0/L	1.0-log treatment (0.5-log removal + 0.5-log inactivation or 1.0 log or greater from microbial toolbox)
3	1.0 $\leq$ Crypto < 3.0/L	2-log treatment (with at least 1.0 log inactivation – e.g., UV, O_3, ClO_2, membranes, bag filters or bank filtration)
4	Crypto $\geq$ 3.0/L	2.5-log treatment (with at least 1.0 log inactivation – e.g., UV, O_3, ClO_2, membranes, bag filters or bank filtration)

UV = ultra-violet
O_3 = ozone
ClO_2 = chlorine dioxide

Once the level of treatment for *Cryptosporidium* is defined, a number of methods of meeting the treatment requirement can be considered. Systems the size of Salina must comply with the treatment techniques required under the rule by October 1, 2013; the State may allow an extra two years, until October 1, 2015 to complete capital improvements projects for the treatment techniques. An additional round of sampling will start in 2016 to determine if source water conditions have changed.

Beginning April, 2008 the City was required to begin monitoring for *Cryptosporidium* in the Smoky Hill River a minimum of once a month for 24 months. Based on the results of the monitoring, the system will be classified into a treatment bin. If that bin is 2, 3, or 4, some additional treatment will be required to provide removal or inactivation of *Cryptosporidium*. Monitoring results as of February, 2008 are shown in Table 6-3 and indicate the current source will be classified into Bin 3 requiring 2-log treatment.

Table 6-3
Cryptosporidium Sampling Data

Date	Sample Concentration (oocysts/L)
4/23/2008	1
5/21/2008	1
6/18/2008	2
7/23/2008	2
8/20/2008	2
9/17/2008	10
10/30/2008	0
11/19/2008	5
Average	2.875

If new sources of supply are recommended in the Raw Water Supply Study, monitoring of the new source will be required under the LT2ESWTR on a schedule KDHE approves. This applies to both new water treatment plants that begin operation and previously operating water treatment plants that bring a new source on-line after the required monitoring date for the public water system (PWS). KDHE may determine that monitoring should be conducted before a new water treatment plant or raw water source is brought on-line or initiated within some time period afterward. If a new plant is recommended monitoring may be conducted prior to finalizing the design of the treatment plant so that any requirements for treatment of *Cryptosporidium* may be incorporated. The new source monitoring must meet all LT2ESWTR requirements as specified previously. The PWS must also determine its treatment bin classification and comply with any additional *Cryptosporidium* treatment requirements based on the monitoring results on a schedule approved by KDHE.

6.3 FUTURE REGULATIONS

It is important to consider the impacts of anticipated future water quality regulations when considering long-term water supply. Any changes that are recommended as a result of the study must also account for continued long-term compliance with anticipated future regulations. The anticipated future regulations outlined below are based on the best available data from the EPA and KDHE at the time of this report. It is unknown what the future regulations will end up being and what the schedule of compliance will be. The anticipated regulations will be considered in raw water supply planning.

6.3.1 Containment Candidate List (CCL)

The Safe Drinking Water Act directs the EPA to periodically publish a contaminant candidate list (CCL). The CCL is the primary source of priority contaminants for which research will be conducted to make decisions about whether regulations are needed. The contaminants on the list are known or anticipated to occur in public water systems. However, they are currently unregulated by existing national primary drinking water regulations. The first CCL (CCL 1) was published in March 1998 and contained 60 contaminants. CCL 2 was published in February 2005 and contained 51 contaminants. The draft of CCL 3 was published on February 21, 2008 and is currently up for public comments. The draft CCL 3 currently includes 93 chemical contaminants and 11 microbiological contaminants. The draft CCL 3 is listed in Appendix C. The final CCL 3 will be released following the public comment period. The CCL 3, along with the regular six-year review of existing regulations, will continue into the future to provide EPA with information for determining what additional regulations should be developed. At this time, the CCL 3 is not expected to have an impact on the Raw Water Supply Study unless regulations are developed from the list that would impact treatment requirements.

6.3.2 Total Coliform Rule Revisions

The Total Coliform Rule Revisions are scheduled for proposal in 2010, with the expectation of a final rule by 2012. EPA formed the Total Coliform Rule/Distribution System Advisory Committee (TCRDSAC) which has 16 members that represent a range of organizations including utilities, federal and state regulators, cities, public health and environmental advocates. This committee met between July 2007 and September 2008 to develop the agreement-in-principle regarding the content of rule revisions that will form the foundation of the proposed rule. The agreement-in-principle was signed by the members on September 18, 2008.

The goals of the revisions are to achieve the objectives of the original rule more effectively and efficiently, considering changes in implementing the Safe Drinking Water Act and past experiences with the Total Coliform Rule. The revised rule is designed to trigger systems with positive total coliform/*E. coli* monitoring results to do an assessment to identify whether sanitary defects are present and to correct the defects accordingly. Under the agreement-in-principle, *E. coli* will remain a regulated contaminant, but the fecal coliform MCL/MCL-goal will be removed. In addition, total coliform will be used as an indicator as part of a treatment technique, but will no longer include an MCL or MCLG.

The revisions may include changes in the analytical methods to detect total coliform and *E. coli*. These changes include methods that allow for more timely results and evaluating all currently approved coliform analytical methods to determine whether the methods continue to be appropriate for use in drinking water compliance monitoring. Monitoring frequency requirements for public water systems serving >1,000 persons will not change under the revisions, with the exception of the new requirements for repeat or additional routine monitoring revisions.

The repeat monitoring revisions include a requirement for all systems, regardless of system type and size, to take three repeat samples for any routine positive total coliform samples. Additional routine monitoring must be conducted following a single positive total coliform sample by all systems collecting samples on a quarterly or annual frequency. The additional monitoring will consist of three samples per month for one month following the positive sample.

As discussed previously, systems with positive total coliform/*E. coli* monitoring results will be required to do an assessment. The agreement-in-principle identifies two levels of assessments. A Level 1 assessment is triggered if the Public Water System (PWS) exceeds 5% positive total coliform samples if 40 samples or more are taken in one month or if fewer than 40 samples are taken and the PWS has two or more positive samples in the month. The Level 1 assessment will consist of a simple examination of the system and operational practices. The assessment form will identify sanitary defects that are detected and summarize the corrective actions that were completed or a timetable for corrective actions that are to be completed. A Level 2 assessment is triggered if there is an *E. coli* MCL violation, an *E. coli* monitoring violation, or a second Level 1 trigger within a 12 month period. The Level 2 assessment is a more detailed examination of the system.

At this time, the Total Coliform Rule Revisions are not expected to have an impact on the Raw Water Supply Study unless regulations are developed that would impact treatment requirements.

6.3.3 Lead and Copper Rule Revisions

EPA is currently developing issue papers for potential revisions to the Lead and Copper Rule (LCR). A stakeholder meeting was held in mid-October, 2008 to develop long-term issues associated with the Lead and Copper Rule. The revisions could potentially be proposed in 2009. The topics discussed included issues raised but not addressed during preparation for the Short-Term Lead and Copper Rule Revisions of 2007. Issues discussed included:

- Sampling: sites with highest potential for elevated copper are different than sites with high lead–should the sample sites be different? (i.e. different tiering criteria for regulatory monitoring)
- Should sites with newer brass components (which might release higher levels of lead and copper) be part of the tiering criteria for the LCR?
- Lead service replacement – what should be done about partial lead service line replacement, which may have elevated lead in the short term. What best practices can prevent that and should it be continued?
- Lead IV – there is a new understanding of lead solubility under higher oxidation conditions (maintaining a high free chlorine residual in the distribution system for example), which might impact what treatment solutions should be used under certain circumstances
- Chloride/sulfate mass ratio – what is the impact on lead release (the issue is utilities switching from alum based to chloride base coagulants, and does this increase in chloride exacerbate lead release)
- Stannous chloride – a newer inhibitor, and is it effective for lead control?
- How emerging corrosion control strategies fit within the LCR treatment technique framework

The EPA is currently collecting comments on the issue papers described above. At the time of this report, it is unknown how the EPA will proceed with these issues and the revisions of the LCR. At this time it is not expected that the revisions will have an impact on the Raw Water Supply Study.

6.4 REGULATORY MEETING

On October 31, 2008 a meeting was held with the various regulatory agencies of the State of Kansas to discuss future water supply for the City of Salina. The purpose of this meeting was for the City and the project team to meet with the regulators to gain general information that will be taken into consideration when planning for the City's water supply future and be incorporated in the Raw Water Supply Study. The following were the objectives of the meeting:

- Introduce the challenges the City faces related to water supply and potential water supply solutions to the regulatory agencies and receive big-picture feedback
- Better understand area water rights and opportunities for acquisition of irrigation water rights
- Understand future regulatory impacts related to conservation, water reuse, and new sources of supply that will affect the future of Salina's water supply
- Understand the future availability of potential new sources of supply and the considerations that must be factored into the Raw Water Supply Study

In addition to the project team and City staff, the following regulatory agencies of the State of Kansas were in attendance at the meeting:

- Kansas Department of Agriculture Division of Water Resources

- Kansas Department of Health and Environment
    - Public Water Supply Section
    - Municipal Section
    - North Central District
    - Bureau of Remediation
- Kansas Water Office
- Kansas Farm Bureau
- United States Army Corps of Engineers

Various topics were discussed at the meeting, including anticipated future drinking water regulations, remediation of the existing contamination at the Downtown Wellfield, conservation and the potential of incorporating private wells into the conservation plan, water reuse, groundwater recharge, and various sources of new supply. Feedback obtained from the regulatory meeting will be included in the Raw Water Supply study where appropriate. Meeting notes from the regulatory meeting are included in Appendix D.

7 REVIEW OF EXISTING SOURCES OF SUPPLY

Prior to considering alternative sources it is important to consider full utilization of the existing water supply sources and associated infrastructure. The objective of this Chapter is to review the City's existing sources of supply and to evaluate future uses of these sources of supply. This Chapter evaluates the conjunctive use of the Smoky Hill River and the existing wellfields as supply sources, as well as evaluates the potential for recharge of the Downtown Wellfield. In addition, the infrastructure at the existing water treatment facility is evaluated for capacity as it relates to future water supply strategies.

7.1 SMOKY HILL RIVER ASSESSMENT

The Smoky Hill River is formed in eastern Colorado and flows east through Salina to Junction City, where it joins the Republican River to form the Kansas River. Two reservoirs were constructed along the Smoky Hill River, Cedar Bluff and Kanopolis. Cedar Bluff Reservoir was constructed by and is maintained by the United States Department of the Interior, Bureau of Reclamation. Kanopolis Reservoir was constructed by and is maintained by the United States Army Corps of Engineers (USACE). Two major tributaries, the Saline River and the Solomon River, join the Smoky Hill River approximately 5 and 12 miles downstream of Salina, respectively.

7.1.1 Supply Characteristics

The Smoky Hill River currently provides the City of Salina with nearly 60% of its water supply. In 2007 maximum day demands totaled to 10.6 MGD; therefore the City withdrew as much as 6.3 MGD from the Smoky Hill River in 2007 on a maximum day. Since 1998, the City has withdrawn potentially as much as 8.2 MGD from the Smoky Hill River (based on maximum day water use and 60% of supply from surface water). As discussed in Chapter 5, the City has an active appropriated water right for withdrawal from the Smoky Hill River. The water right is limited to a total volume of 5,028 ac-ft per year and a maximum instantaneous diversion of 6,955 gpm (10 MGD).

Flow in the Smoky Hill River at the City's intake structure is controlled by upstream releases from Kanopolis Reservoir by the USACE, precipitation/runoff events, upstream diversions (mostly irrigation uses), and interflow between the adjacent alluvial aquifer and the river. The Smoky Hill River for the most part is a gaining stream, meaning that water generally flows from the aquifer to the river. However, during drought conditions, as in 2006, the river can transition to a losing stream, meaning that flow is lost from the stream to the aquifer. Figure 7-1 shows the difference between a gaining and a losing stream.

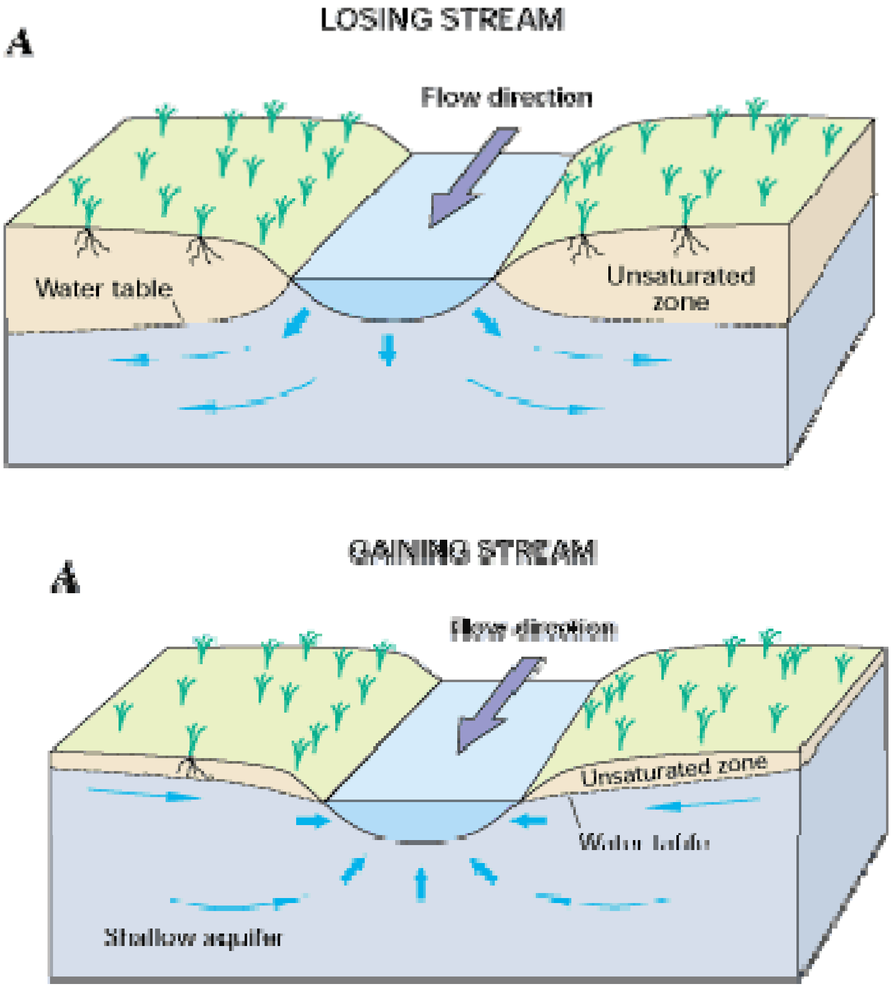


Figure 7-1
Gaining Streams vs. Losing Streams
(Figure Courtesy of USGS)

Recent flows in the Smoky Hill River have been declining compared to historical flows. A series of flow-duration curves, which is a plot of daily mean stream flow and the percent of the time that the flow is likely to be equaled or exceeded, demonstrates this declining trend – see Figure 7-2. The USGS stream flow gage at Mentor, Kansas is the closest stream flow gage upstream of Salina. This gage has been in operation since 1923. Table 7-1 shows the stream flows at various % of time exceeded values for 1) historical operation of the gage (1923-2007), 2) the past 20 years (1987-2007) and 3) the most recent drought period (2000-2006). A comparison of the frequency curves from 1923 – 2007, the historical period of record for the gage, and 1987 – 2007 shows that the flows that are exceeded 50% of the time or less (the high flows) are approximately the same, whereas the flows that are exceeded more than 50% of the time (the low flows) are lower during the period of 1987 – 2007 than the historical period of record. The whole spectrum of flows during the drought period of 2000 – 2006 is significantly lower than the historical period of record, particularly during the high flow periods. July 2006 represents the lowest stream flow of record at this gage of 1.2 cfs (0.82 MGD). The low stream flows are not capable of sustaining Salina's water rights of 15.5 cfs (10 MGD) at the river intake.

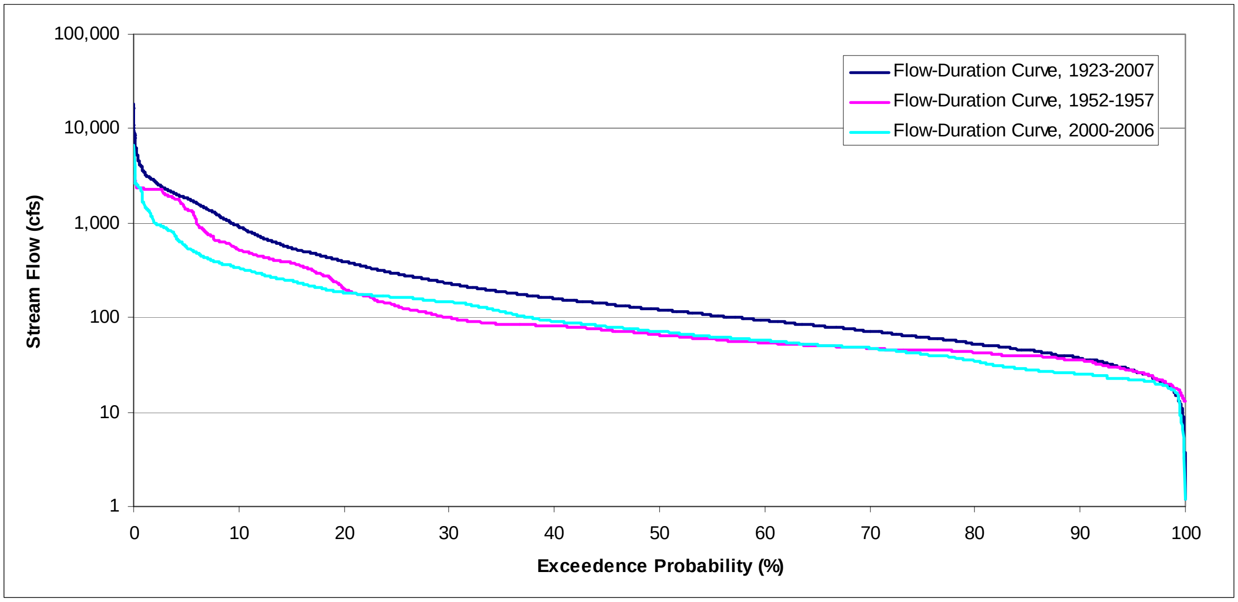


Figure 7-2
Smoky Hill River Flow Duration Curves
USGS Stream Flow Gage at Mentor, KS

Table 7-1
Smoky Hill River Stream Flow Trends
USGS Stream Flow Gage at Mentor, KS

% of Time	Stream Flow (cfs)		
Exceeded	1923-2007	1987-2007	2000-2006
10%	922	859	335
20%	393	359	184
50%	121	115	71
80%	53	40	34
90%	37	26	25

A potential factor for declining flows in the Smoky Hill River may be increased groundwater pumping within the watershed. Water rights for groundwater within the alluvial aquifer have been on the rise since the enactment of the Kansas Water Appropriation Act in 1945. Points of diversion for groundwater rights are concentrated directly adjacent to the Smoky Hill River within the alluvial aquifer. Groundwater naturally flows toward streams; pumping near the streambed captures some of the flow that otherwise may go to the stream. In addition, groundwater pumping lowers the water table. If the water table is lowered enough, flow may be induced from the stream into the aquifer.

The KWO and the Kansas Geological Survey (KGS) recently completed a study to develop an understanding of the interactions between the Smoky Hill River and the alluvial aquifer between Kanopolis Reservoir to the confluence of the Saline and Smoky Hill Rivers (KGS, 2008). The study looked at flows at the USGS gage at Mentor versus flows at the USGS gage at Langley (upstream of Mentor, downstream of Kanopolis Reservoir) and determined that there have been three periods of a few years of continuously low tributary flows and either little gain or a small loss in the river flow between the two gages. Specifically, the losses occurred in the mid-1950s, 1988-1992, and 2002-2006, all known drought periods. The study compared these losses to the Palmer Drought Severity Index (PDSI) and concluded that in general the flow losses between the two gages have occurred during increasing less severe PDSI drought conditions since the mid-1950s. Model results for an average annual stream flow budget from 1962 through 2006 also showed that the stream is generally gaining until it reaches the Salina area, where it becomes a losing stream (KGS, 2008). It is expected that during future drought conditions the Smoky Hill River will likely be a losing stream.

During drought periods the main source of flow in the Smoky Hill River is due to flow released from Kanopolis Reservoir. Water is currently released from water quality storage (water released to meet downstream water quality needs), which makes up 53.3% of the multipurpose pool (the remaining 46.7% of the multipurpose pool is for water supply storage). In 2006, Kanopolis Reservoir experienced low lake levels which prompted the KWO to request a deviation from the minimum release schedule from the USACE in 2007. The KWO requested that the minimum release be maintained between 10 cfs and 20 cfs, with the release determined on a weekly basis based on flow at the USGS gage on the Smoky Hill River at Ellsworth, Kansas. The reasoning for the request was to conserve the water quality pool, lessen negative impacts on Post Rock Rural Water District's water supply intake at Kanopolis Reservoir and lessen impacts to recreational facilities at the Lake (KWO, 2007). Table 7-2 shows the current minimum release schedule the USACE follows for Kanopolis Reservoir.

Table 7-2
USACE Minimum Releases
From Kanopolis Reservoir

Flows in CFS											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10	10	15	20	30	50	50	50	50	25	15	10

Between Kanopolis Reservoir and the confluence of the Smoky Hill River and the Saline River there are more than 90 surface water diversion points. The water rights for these diversions total 7,750 ac-ft per year, or a maximum rate of 191 cfs. Of this 191 cfs, approximately 38 cfs are water rights that are senior to the City's surface water right (DWR, 2008). Without consideration of the interaction between the river and the alluvial aquifer, the current minimum release of 50 cfs during the months of peak demand (June-August) should be capable of meeting 12 cfs (7.75 MGD) of the City's 15.5 cfs (10 MGD) water right during water rights administration (junior water right holders usage is curtailed, and senior water rights use 38 of the 50 cfs).

A decrease in the minimum release during the summer months to a maximum of 20 cfs as requested by KWO in 2007 could be detrimental for the City's water supply and the City's ability to meet customer's water needs given the current sources of supply available to the City. During drought periods and when water rights are administered, it is likely that no flow would be available to the City of Salina at their river intake if the release from Kanopolis Reservoir is 20 cfs and senior water rights total to 38 cfs. A release of 20 cfs would not provide enough water to the irrigators upstream of Salina that have senior water rights, leaving no water for the City during water rights administration.

Upon release of their request for deviation from the minimum releases, the KWO provided a period for interested parties to comment on the request. The City used this opportunity to provide their concerns regarding the deviation request to the KWO. Below is a summary of the City's comments.

- Downstream users have relied on the minimum releases for over 60 years.
- The minimum releases will not maintain water quality and no comprehensive and scientifically based water quality stream analysis has been completed to justify that the minimum releases will maintain water quality.
- Surface water would not be available based on the drought experience in July 2006.

In addition, the City requested the following items:

- Minimum releases remain as outlined in the Lake Regulation Manual (Table 7-2)
- KWO to not execute long-term water supply contracts from Kanopolis Reservoir
- KWO complete a yield analysis for Kanopolis Reservoir
- Kansas Geological Survey (KGS) complete a model to study interaction of Smoky Hill River and alluvial aquifer

In April 2007 water levels at Kanopolis Reservoir rose to normal operating levels. At that time the KWO dropped the request for deviation. The KWO believes that there is a better way to regulate the releases from the reservoir and are currently working with the USACE to determine what releases are needed to meet downstream needs. The KWO study on optimizing releases has not been finalized; however, they have identified three different alternatives to analyze the effect of releases on water levels in the reservoir. The KWO is building upon the Smoky Hill Groundwater Model to determine how to make releases to meet downstream needs.

The first alternative is to apply the current release schedule, as shown in Table 7-2. If these releases do not meet downstream demands, inflows to Kanopolis would be bypassed to downstream of the reservoir. If demands are still not met, water would be released from the water supply pool (KWO, 2008).

The second alternative is an "improved" water quality release schedule. This improved release schedule would operate in a similar way to the current release schedule except that the releases would be reduced during certain months. Table 7-3 compares the improved release schedule proposed by KWO and the current release schedule (KWO, 2008).

Table 7-3
Proposed Improved Water Quality Release Schedule
From Kanopolis Reservoir

	Flows in CFS											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Proposed	5	10	10	15	20	20	55	50	20	10	5	5
Current	10	10	15	20	30	50	50	50	50	25	15	10

The third alternative is to make releases to meet downstream demands. There is no set schedule for this alternative. The objective of this alternative is to optimize the releases so that downstream needs along the river are met but water is not wasted and volume is therefore conserved in the reservoir (KWO, 2008). The following outlines the procedures for this alternative:

- If demands downstream are > 0, release up to 20 cfs from the water quality pool
- If demands are not met, bypass Kanopolis inflows
- If demands are still not met, release from water supply pool

As stated previously, at the time of this report the recommendations of the KWO's study have not been determined. However, the results of the KWO study should be considered for future water supply planning as the releases made from the reservoir have a significant effect on the streamflow at Salina.

7.1.2 Raw Water Quality

Raw water quality data was obtained for the Smoky Hill River from three different sources: the City's data logger from 2003-present (measures pH, alkalinity, total hardness, and turbidity), a one-time analysis done in December 2007 by Wilson & Company for a study on taste and odor issues, and data from KDHE's stream monitoring network for a site near Salina from 1990 to 2006. Average results from the data logger information for 2003-present are summarized in Table 7-4. The water quality analysis for the KDHE and Wilson data are shown in Table 7-5.

Table 7-4
Smoky Hill River Raw Water Quality
City of Salina Data Loggers
2003-present

Parameter	Mean	Maximum	Median
Alkalinity	187	1660	190
pH	8.24	8.80	8.30
Hardness	306	552	306
Turbidity	68.6	4206.0	49.2

Table 7-5
Smoky Hill River Raw Water Quality
KDHE & Wilson Study Data
1990-2007

		1990-2006				2007
Parameter	Unit	Mean	Standard Deviation	Median	Max	Conc.
Alkalinity, total (as CaCO3)	ppm	169	40	171	260	186
Chloride	ppm	155	44	152	290	105
Fluoride	ppm	0.35	0.12	0.33	0.87	0.2
Hardness, total (as CaCO3)	ppm	313	62	306	444	317
Iron, total recoverable	ppm	1.91	2.12	1.37	16.25	0.95
Manganese, total recoverable	ppm	0.16	0.1	0.15	0.77	0.055
Nitrate (as N)	ppm	1.45	1.65	1	10.71	0.8
Sulfate	ppm	153	46	152	293	158
Total dissolved solids (TDS)	ppm	659	126	665	955	581
Total Nitrogen (calculated)	ppm	2.46	1.63	2.1	9.35	-
Total organic carbon	ppm	7.3	3.2	6.5	18.7	-
Total Suspended Solids	ppm	109	145	67	980	-
Turbidity	NTU	46	66	29	542	-

The following are conclusions about the water quality of the Smoky Hill River:

- The river is classified as having hard water (>300 mg/L).
- Average TDS are above the secondary guideline of 500 ppm.
- Average iron concentration is above the secondary guideline of 0.3 mg/L.

- High turbidities occur during rainfall events; drought periods generally have low turbidities.

Overall the quality is suitable for a water supply source, as evidenced by historical treated water quality data. As discussed in Chapter 6, the current treatment processes are capable of treating water from the Smoky Hill River to comply with the Safe Drinking Water Act requirements and consumer expectations. During drought conditions, as was the case in 2000-2006, low flows may cause high TDS, sometimes related to chlorides, and associated taste problems. During high flows, turbidities can be an issue. Water quality during extreme conditions, both droughts and high flows, should be an important consideration for future water supply planning.

7.1.3 Standard Procedures for Withdrawal

The City's point of diversion of water from the Smoky Hill River is from the main river channel near Indian Rock Park. In 1989 the City installed a river intake and pump station at this location as well as a 24-inch ductile iron raw water pipeline connected to the water treatment plant.

The river intake pump station has three single stage vertical turbine pumps. At design conditions with two pumps in operation (one for standby), a total of 7,000 gpm (10 MGD) can be pumped. The current equipment is sufficient to maximize use of the City's existing water right of 6,955 gpm (10.0 MGD). If the City were to obtain additional water rights to pump more than 10 MGD additional infrastructure would be required.

Historically the use of water from the river has been generally based on the turbidity and temperature of the water in the river. Generally, if turbidity in the river is greater than 800 NTU, which can happen during periods of high flow, the City discontinues use of the surface water and the Downtown Wellfield is used for the water supply. If demands are greater than what the groundwater air strippers can handle, the surface water must be utilized even if the turbidity is greater than 800 NTU.

7.1.4 Smoky Hill River Recommendations

It is recommended that the City evaluate obtaining a seasonal water right on the Smoky Hill River to divert flows during off-season times when surface water diversions along the river due to irrigation are minimal and flow in the river is sufficient to support demands. Section 7.5 of this report examines the possibility of acquiring a seasonal water right on the Smoky Hill River.

7.2 DOWNTOWN WELLFIELD ASSESSMENT

The primary groundwater source of supply for the City is the Downtown Wellfield. Groundwater is currently supplied from fifteen (15) public water supply wells located near the center of the City of Salina. These wells withdraw water from the Smoky Hill River alluvium and transmit it to the water treatment plant via a wellfield collection pipe. The following sections present an assessment of the current conditions of the Downtown Wellfield. The wellfield assessment focuses on:

- Evaluating the water rights associated with the wellfield;

- Evaluating the current condition of the supply wells;
- Estimating the water production capability from the wellfield;
- Evaluating the raw water quality;
- Evaluating the hydrogeologic conditions at the wellfield; and
- Evaluating the distribution of anthropogenic contaminants near the wellfield.

7.2.1 Water Rights

The City maintains both vested rights and appropriated rights for beneficial use of groundwater. A detailed summary of the water rights associated with each vested right and appropriated certificate is presented in Chapter 5. The City currently maintains the following water rights specific to the Downtown Wellfield:

- Vested Right 002
- Appropriated Right Certificate 7,635
- Appropriated Right Certificate 31,636

Per Certificates 7,635 and 31,636, annual groundwater usage from the Downtown Wellfield cannot exceed 4,993 acre-ft and the maximum total flow rate cannot exceed 10,568 gpm (15.2 MGD). In addition to these restrictions, the maximum annual volume and maximum instantaneous flow rate is governed on a per well basis, as summarized in Table 7-6.

In addition to the above-listed restrictions, the area around the City's Downtown Wellfield is fully appropriated based on the DWR's "safe yield" provision (K.A.R 5-3-11). To calculate the safe yield of an unconfined aquifer, the DWR calculates the total precipitation recharge entering a two-mile radial circle of a well and compares that total volume to the total volume of each appropriation located within the two-mile radial circle. If the total volume of water exiting the two-mile radial circle (from pumping) is greater than the volume entering the two-mile radial circle (from precipitation), then the area is determined to be above the safe yield. This means that no new points of diversion can be authorized near the wellfield. New water supply wells within the Downtown Wellfield will only be authorized as replacements to existing wells that have failed structurally or are beyond their design life. Any future replacement wells will be permitted with the same water right restrictions as the wells they replace.

7.2.2 Well Capacity Estimates

Layne Christensen field crews conducted a well performance field test on 14 of the 15 City water supply wells in May, 2007 (Layne, 2007). These tests constitute the most current data available on the performance of individual wells within the Downtown Wellfield. The objective of the performance tests was to determine the current specific capacity, defined as the flow rate divided by observed drawdown in the well, and to use that information to project a maximum pumping rate for each supply well. Prior to starting each test, a static water level was collected from the test well to identify the pre-test conditions. Then, a step rate test was conducted at each well, which consisted of up to four (4) steps lasting thirty (30) minutes per step at varying discharge rates. The results of the specific capacity tests are summarized in Table 7-6.

The well performance data from the tests described above were compiled and analyzed to evaluate individual well yields and estimate the maximum pumping rate for each well based on one of the following two options.

Option 1 – Well yield based on pumping water level equal to two (2) feet above top of screen.
Option 2 – Well yield based on pumping water level equal to ten (10) feet above pump intake.

In the 2007 study, Layne Christensen recommended that the maximum pumping rate should be calculated using Option 1, which uses the top of screen as the design point. This method protects the City's pumping equipment as it reduces the potential for pump cavitation. The results of these calculations are shown in Table 7-6. Based on the pumping rates recommended by Layne Christensen the yield of the wellfield is currently 8,420 gpm or 12.1 MGD.

Table 7-6
Downtown Wellfield
Calculated Pumping Rates and Available Water Rights

Well #	Average Specific Capacity (gpm/ft)	Pumping Rate above Screen (gpm)	Pumping Rate above Intake (gpm)	Recommended Pumping Rate (gpm)	Water Right Flow Rate Limit (gpm)	Difference Between Pumping Rate and Water Right (gpm)	Maximum Annual Volume (acre-ft)
1	89	440	2,298	440	870	430	481.22
2	62	295	912	295	1,085	790	393.99
3	61	850	1,618	850	1,000	150	516.6
4	79	310	1,998	310	1,160	850	573.37
5	97	175	753	175	1,000	825	222.6
6	120	365	1,979	365	1,140	775	487.37
7	71	405	1,108	405	1,215	810	497.37
8	126	525	2,324	525	1,140	615	193.37
10	83	450	1,635	450	1,310	860	316.14
11	86	720	1,848	720	1,195	475	118.37
12	140	835	2,464	835	1,270	435	176.14
13A	60	930	1,348	930	1,160	230	268.37
14	84	845	1,393	845	1,085	240	498.99
15	NA	NA	NA	400 *	965	NA	259.6
16	53	875	1,567	875	905	30	462.22
Total				8,420	16,500		5,465.72
Limits					10,568		4,993

Note: Well No. 9 was previously retired and does not currently exist
NA = No data available
* Assumed approximate capacity

7.2.3 Hydrogeology

Near the Downtown Wellfield, the Smoky Hill River alluvial aquifer is an unconfined system and the hydraulic level in the aquifer is a function of the stage in the river. The depth to water in the aquifer, outside the influence of the wellfield, ranges seasonally from 20 to 30 feet below ground surface (bgs). The base of the alluvial aquifer consists of a shale unit associated with the Permian age Wellington Formation. In the vicinity of the Downtown Wellfield, the base of the alluvial aquifer is encountered at depths ranging from approximately 70 to 85 feet bgs.

An estimate of the transmissivity of the alluvial aquifer near the Downtown Wellfield was developed by evaluating the results of the specific capacity tests performed by Layne Christensen in May, 2007. An average of the specific capacities of the 14 wells was used to calculate an estimated average transmissivity of 129,850 gallons per day per foot (gpd/ft) for the Downtown Wellfield. Based on the high aquifer transmissivity, replacement supply wells drilled in the Downtown Wellfield should be able to produce 800 to 1,200 gpm (Layne, 2007).

7.2.4 Drought Impacts

The impact of drought conditions on the Downtown Wellfield was evaluated by reviewing long term groundwater level data provided by the City. The historical water level data (1968 to 2007) collected from the monitoring wells and historical streamflows of the Smoky Hill River at the Mentor gage are presented on Figure 7-3. The water level data are collected from three observation wells, the locations of which are shown on Figure 7-4. The KWU and Ohio observation wells are located outside the footprint of the wellfield, while the Oakdale well is located within the wellfield.

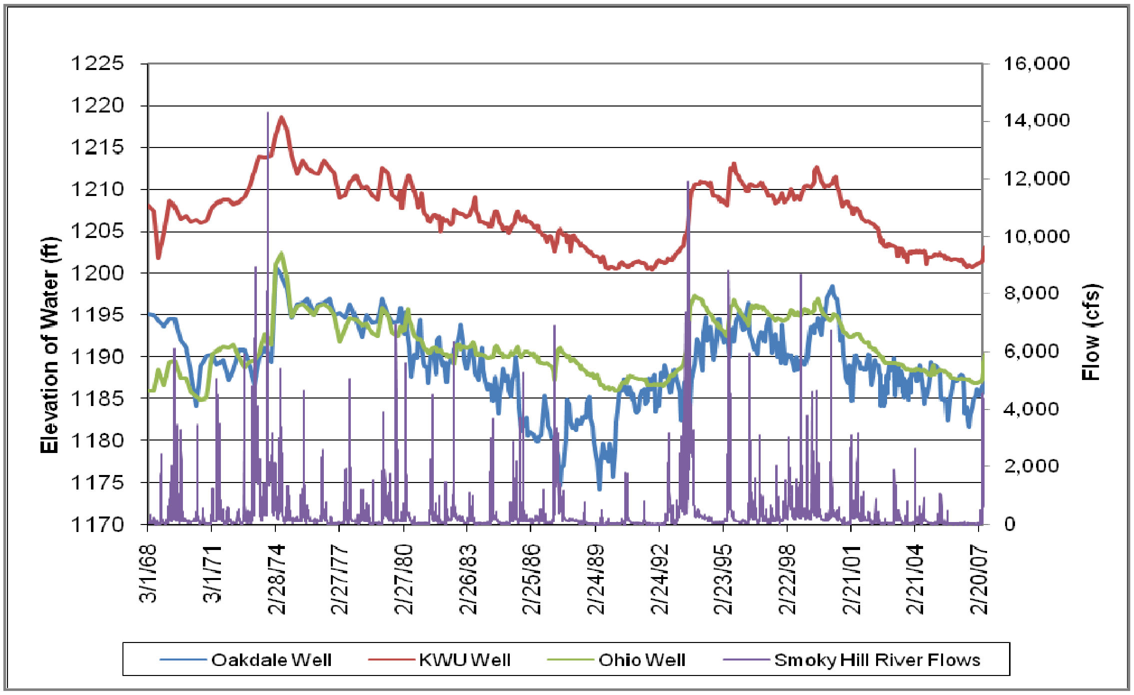
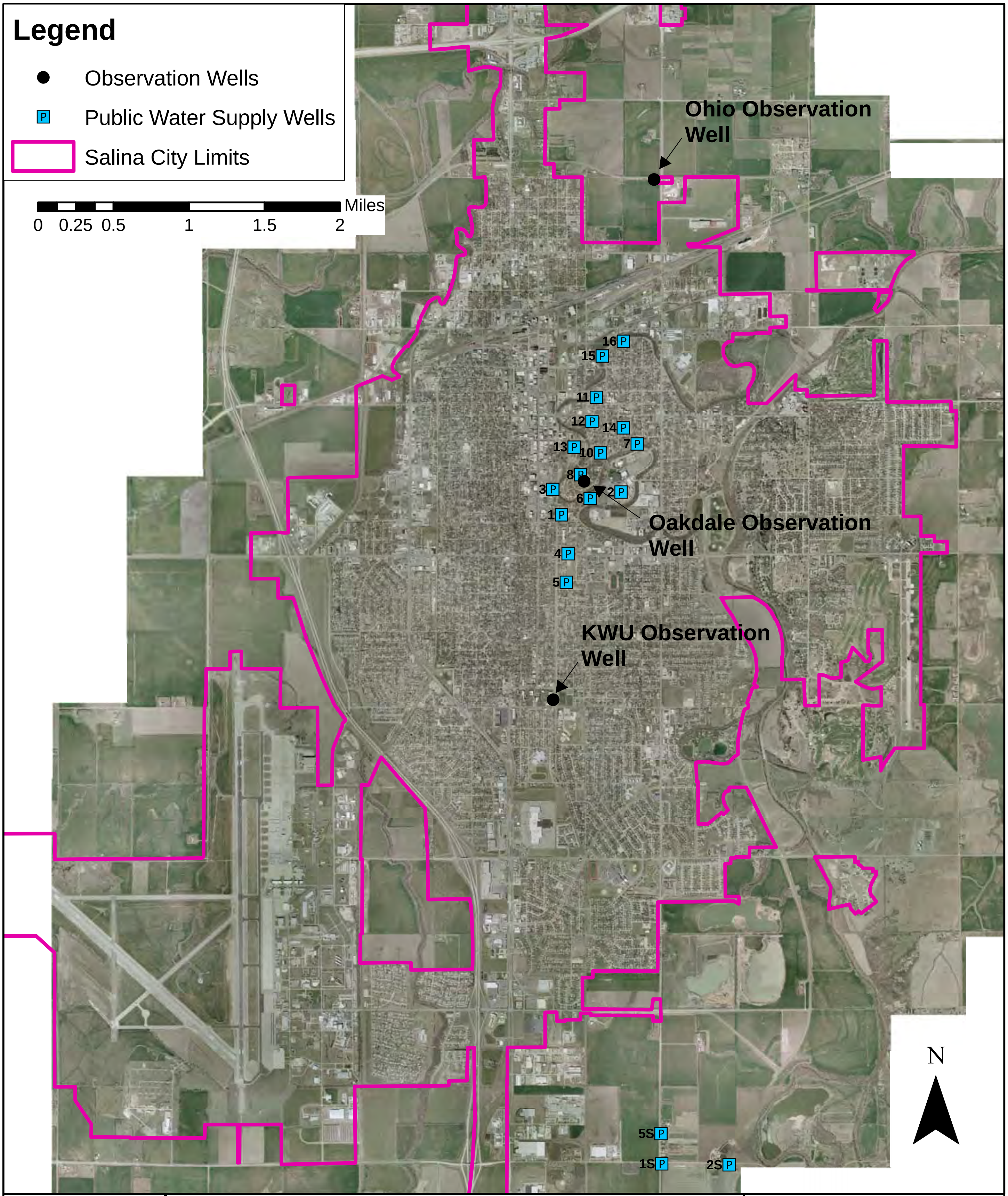


Figure 7-3
Historical Water Level Elevations
Near Downtown Wellfield

The water level data presented for the KWU and Ohio monitoring wells on Figure 7-3 is typical of alluvial systems near major rivers. Both monitoring wells show water level responses which are tied to increases and decreases in the stream flow of the Smoky Hill River. The two significant water level increases evident in the hydrographs (1973 and 1993) are a direct result of two sustained flood events in which stream flow within the Smoky Hill River was in excess of 10,000 cfs for several days and above 1,000 cfs for many months. The water level responses at these two monitoring wells generally mirror one another and no sustained water level trend is observable from reviewing this data. Based on this information, water levels within the Smoky Hill alluvial aquifer, away from the wellfield, are not declining due to over-pumping.



Raw Water Supply Study

Figure 7-4: Observation Wells

A plot of the saturated thickness of the aquifer during the most recent drought for the period of 2002-2007 at each observation well is presented as Figure 7-5. A regression line has been added to highlight the seasonal highs and lows. A review of the saturated thickness for the period of 2002 to 2007 indicates a progressive decrease in the saturated thickness of the aquifer in and around the Downtown Wellfield. The Oakdale observation well is most indicative of this decrease, where the average saturated thickness of the aquifer is approximately 35 feet. The Oakdale Observation well is the most responsive to changes in pumping rates as it is located near the center of the wellfield. As shown in Figure 7-5, there is an approximate 4-foot decline in the saturated thickness of the aquifer, although during periods of peak pumping the decline is more significant within the well field. For example, in the summer of 2006, the decline in the saturated thickness of the aquifer within the wellfield was over 6 feet. Summer water level declines in individual pumping wells are likely much higher than the decline observed in the Oakdale monitoring well.

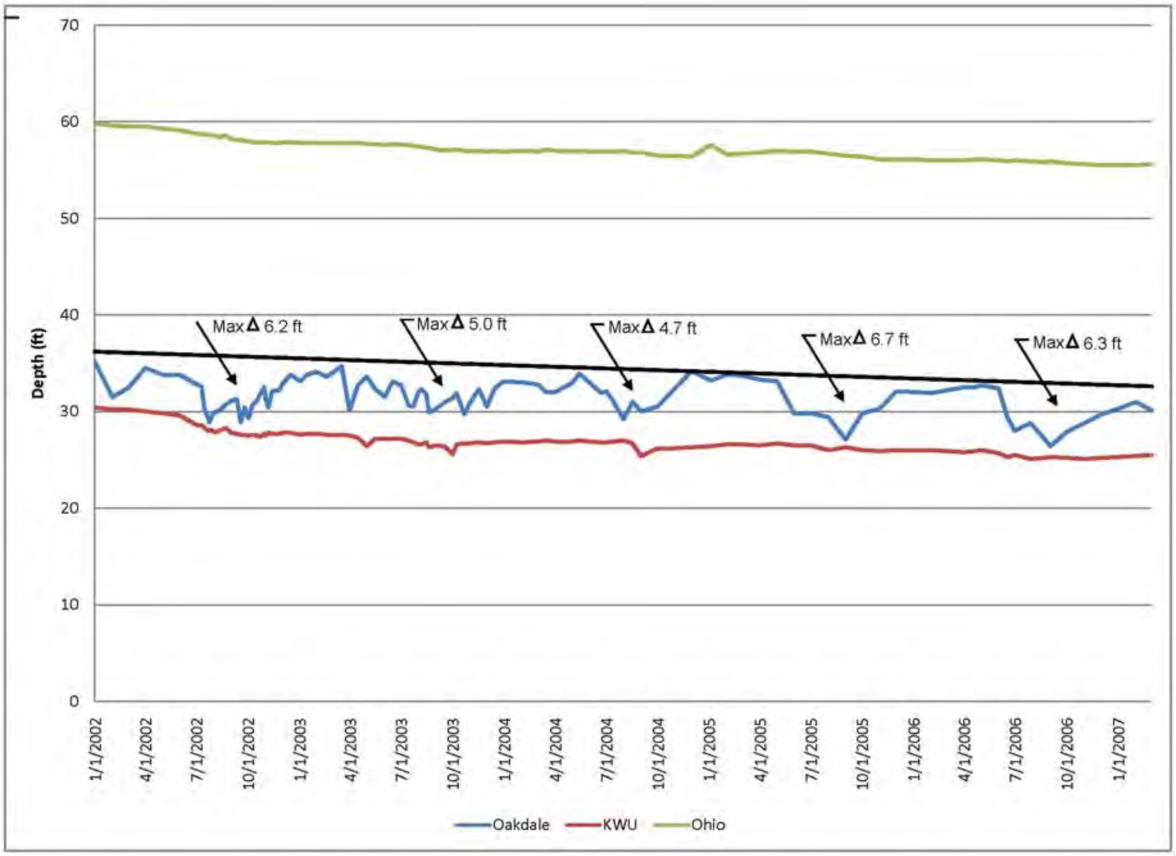


Figure 7-5
Aquifer Saturated Thickness
2002 through 2006

Based on the existing data, it appears that:

- There is a decreasing linear trend in maximum saturated thickness from 2002 to 2007.

- The maximum saturated thickness of the aquifer within the wellfield occurs seasonally during March through May.
- The water level decline occurs in direct response to pumping of the wellfield.
- The water levels in the aquifer are lowest when water supply from the wellfield is most needed (i.e., summer months).

During a sustained drought, the Downtown Wellfield will likely see a decrease in the pumping capabilities due to water level declines. As the water table in the aquifer declines, there is less drawdown available to the design point used in evaluating the pumping capacities (two feet above the top of the screen). As shown in Figure 7-5, the maximum decline in the water table within the wellfield is approximately 7 feet (in 2006). On average during a drought similar to the drought of 2006 the wellfield may see an average decline of 3.5 feet (half of the maximum decline). To estimate the reduced capacity of the wellfield during a similar drought, a factor of 3.5 feet divided by 35 feet (the average saturated thickness) was multiplied by the wellfield yield determined in Table 7-6. On average the wellfield will see its capacity reduced from 12.1 MGD to 10.9 MGD with all wells in service and a water level decline of 3.5 feet on average.

7.2.5 Raw Water Quality

The quality of the raw water at the Downtown Wellfield was evaluated by reviewing data provided by the City. The data provided by the City was collected in 2000 and 2001 and is presented in Table 7-7. A comparison of the Downtown Wellfield raw water quality to several key water quality parameters is presented in the Table 7-7.

Table 7-7
Downtown Wellfield Raw Water Quality

Parameter	EPA Standard (mg/L)	Flow Rate Weighted Average (mg/L)	EPA Standard/Hardness Classification
Sulfate	250	230	Secondary
Chlorides	250	148	Secondary
TDS	500	969	Secondary
Total Hardness as $CaC0_3$	NA	629	Very hard
Iron	0.3	0.26	Secondary
Manganese	0.05	0.4	Secondary
Nitrate	10	7	Primary

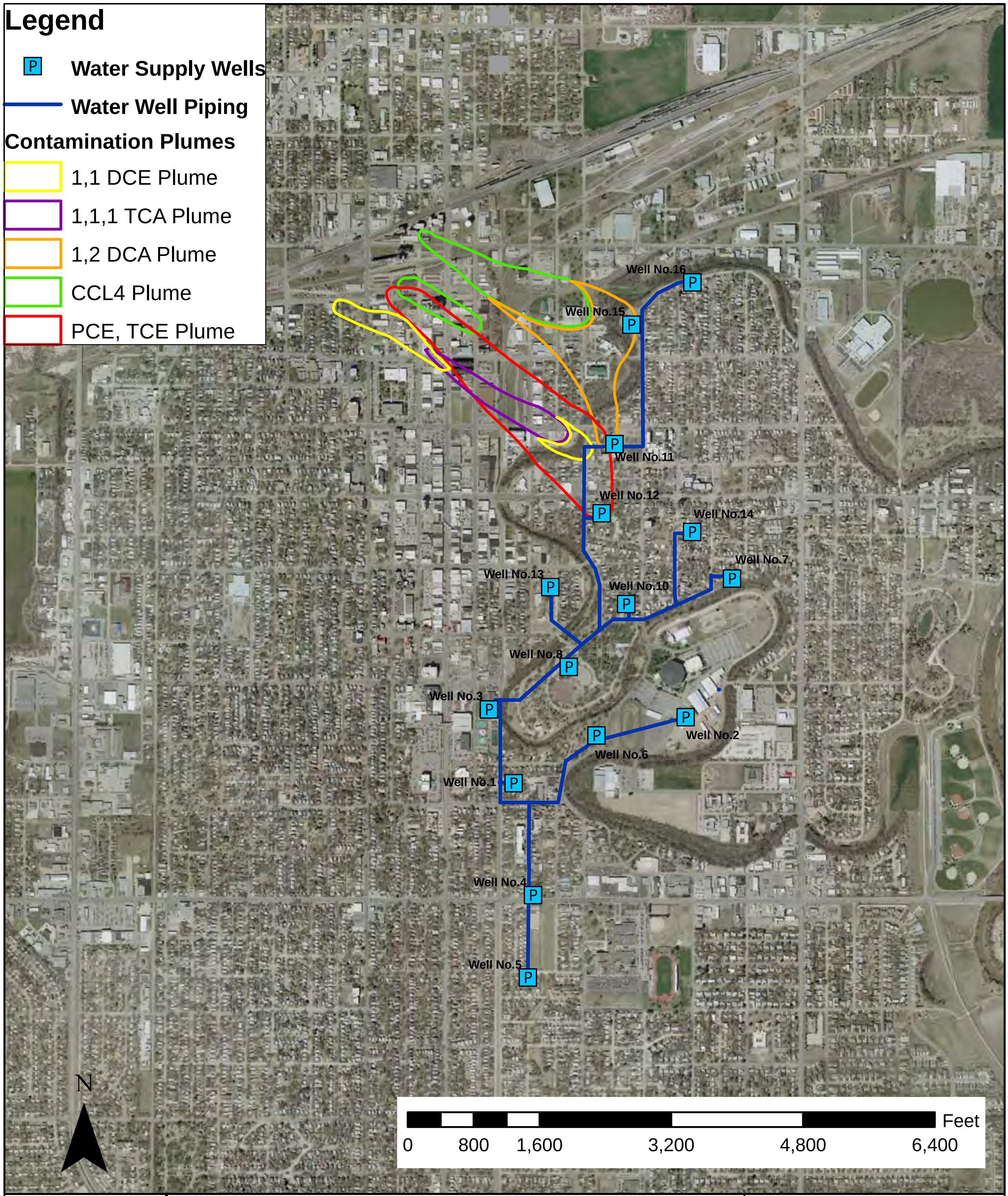
As shown in the Table 7-7 comparison, the Downtown Wellfield's raw water can be described as very hard/brackish, with high concentrations of sulfate, TDS, and manganese. Overall the quality is suitable for a water supply source, as evidenced by historical treated water quality data. As discussed in Chapter 6, the current treatment processes are capable of treating water from the Downtown Wellfield to comply with the Safe Drinking Water Act requirements and consumer expectations.

7.2.6 Anthropogenic Contamination

There are two large groundwater contaminant plumes that impact the northern section of the Downtown Wellfiield. Specifically, these plumes have impacted wells 11, 12, 15, and 16 with a variety of anthropogenic contaminants (primarily solvents), including: tetrachloroethene (PCE), trichloroethene (TCE), carbon tetrachloride, 1,1,1 trichloroethane, Dioxane, 1,1 dichloroethene (DCE), and 1,2 dichloroethane (DCA). Of these contaminants 1,2 DCA is seen in high concentrations and is impacting the water supply wells. As a result, use of wells 11, 15, and 16 have been discontinued. The locations of the contamination plumes in relation to the wells are shown in Figure 7-6.

Burns & McDonnell recently completed a steady-state groundwater and solute transport model and associated report for KDHE to determine how to contain the contamination from impacting the Downtown Wellfield. In order to mitigate impacts of the contamination plume at the Downtown Wellfield, Burns & McDonnell/KDHE recommended adding a capture well in the vicinity of North 2nd Street and East Elm Street. This well would be equipped with a Granular Activated Carbon (GAC) system to treat the high levels of contamination and one option would be to pump continuously at 300 gpm to intercept the contaminants prior to reaching the wellfield. This pre-treated water from the capture well would then be piped to the water treatment plant for further treatment and consumption (Burns & McDonnell, 2008).

Under the capture well scenario it is possible that the wellfield as a whole could experience reduced pumping capacities due to the increased stress to the aquifer by the capture well. Burns & McDonnell stated that the wellfield as a whole would see a reduction in total wellfield production by 120 gpm based on average flow conditions (Burns & McDonnell, 2008). It is unknown what impact on withdrawls the wellfield would experience under peak summer conditions. A transient model would need to be developed to simulate the changes in demand, which was not part of Burns & McDonnell's contract with KDHE. KDHE is currently investigating this situation further; it is unknown when KDHE will act to mitigate the impact of the contamination plume on the City's public water supply wells. The wells that are impacted are some of the City's highest producing wells. The City desires to maximize the use of this wellfield, therefore KDHE will need to implement a plan to mitigate or treat the contamination.



City of Salina

Raw Water Supply Study

Figure 7-6: Downtown Wellfield Contamination Plumes

HDR

WILSON & COMPANY
ENGINEERS & ARCHITECTS

Layne

7.2.7 Downtown Wellfield Recommendations

As shown in Table 7-6, the recommended pumping rate of some wells is below what is permitted under the existing water right. Optimization of the City's existing water supply infrastructure is a primary goal of the Raw Water Supply Study; several of these wells represent opportunities for infrastructure improvements to maximize use of the existing groundwater right. Based on step drawdown testing the total pumpage available from the existing wells is 8,420 gpm, or 12.1 MGD. The existing water right limits the wellfield to a maximum diversion of 10,568 gpm, or 15.2 MGD; therefore there is a potential to get an additional 2,148 gpm (3.0 MGD) from the existing wellfield to maximize use of the existing water right. It is recommended that one or more of the wells be closed and re-drilled at an offset of 300-600 feet from their current location in order to obtain an additional 3.0 MGD from the wellfield. The replacement well should be capable of producing at least 800 gpm.

The Layne 2007 study identified potential candidates for well replacement. These wells have screen intervals of 25-35 feet long. Replacement wells should be drilled with shorter screen intervals which results in additional drawdown available to the top of the screen and additional capacity. Issues to consider when choosing which wells to replace include age of the well, location with respect to the contamination plume, ability to move well with respect to surrounding surface features, and availability of capacity per the water rights.

In addition, the 2007 Layne report recommended installation of variable frequency drives (VFDs) at the wells in order to control the speed of the pump motors based on the water available in the well. The City should consider this on a case by case basis as improvements are implemented in the wellfield.

The City should continue to advocate for cleanup of the groundwater contamination in order to maximize pumping capabilities under the water right. The discontinuation of use of wells 11, 15, and 16 due to the contamination impacts decreases the yield of the wellfield by approximately 3.0 MGD.

7.3 SOUTH WELLFIELD ASSESSMENT

The secondary groundwater source for the City is the South Wellfield (located near the former Schilling Air Force Base). Five (5) public water supply wells are located south of Salina near the former Schilling Water Treatment Plant and three (3) can provide additional groundwater supply if necessary. The two additional wells for a total of five wells in this wellfield do not currently have pumps installed in them. The two wells without pumps have been inactive since their pumps were removed in 1945. The water pumped from the South Wellfield is currently pumped to the Schilling Water Treatment Plant, where it is chlorinated and pumped into the distribution system.

The South Wellfield is only pumped to maintain current water rights and is generally only used during emergency situations due to water quality issues, primarily manganese and hardness concentrations above secondary drinking water standards. The following sections present an assessment of the current conditions of the South Wellfield. The wellfield assessment focuses on:

- Evaluating the water rights associated with the wellfield;
- Evaluating the current condition of the supply wells;
- Estimating the water production capability from the wellfield;
- Evaluating the raw water quality;
- Evaluating the hydrogeologic conditions at the well field; and
- Evaluating the distribution of anthropogenic contaminants near the well field.

7.3.1 Water Rights

Groundwater obtained from the South Wellfield is included in the total water right for the City (surface water and groundwater combined), which is limited to a total annual volume of 11,837 acre-ft and a maximum instantaneous flow rate of 25.8 MGD. Specific to the South Wellfield, the City currently maintains the following water right:

- Vested Right SA035

The maximum total water available from this water right alone is 2,511 acre-ft per year (2.24 MGD on average). Because this is a vested water right, there are no maximum instantaneous flow rates assigned to individual wells. The wellfield as a whole, however, is restricted to a maximum instantaneous flow rate of 3.7 MGD.

7.3.2 Well Capacity Estimates

Individual well yields and recommended maximum pumping rates for each well cannot be estimated at this time due to lack of construction data for existing wells and lack of recent performance tests. Based on the installed pump capacities, it appears that the current South Wellfield wells are capable of producing anywhere from 400 to 700 gpm per well. The City operated the wells in November, 2008 and provided the pumping rates. The characteristics of the existing wells are shown in Table 7-8.

Table 7-8

South Wellfield Rated Pumping Capacities

Well No.	Rated Pump Capacity (gpm)	2008 Pumping Rates (gpm) (2)
1	730	696
2	380	297
3	(1)	(1)
4	(1)	(1)
5	450	442
Total(3)	1,560	1,435

(1) No pump currently installed

(2) Operated in November, 2008; based on clearwell fill and draw rates. No metering is operational at the Schilling WTP.

(3) South Wellfield Water Right allows a maximum of 3.7 MGD instantaneous flow (2,569 gpd)

Layne Christensen field crews conducted a well performance field test on Well No. 1 of the South Wellfield on October 24, 1990. The objective of the performance test was to determine the current specific capacity, defined as the flow rate divided by drawdown in the well. Based on the results of that test, the specific capacity in Well No. 1 was approximately 67 gpm/ft of drawdown. This value is similar to the specific capacity values measured from the supply wells in the Downtown Wellfield. It is recommended that further performance testing be done on the existing wells to determine their recommended pumping rates similar to the testing that was done at the Downtown Wellfield in 2007.

7.3.3 Hydrogeology

The supply wells located in the South Wellfield are screened in the Smoky Hill River alluvial aquifer. In this area, the aquifer appears to be an unconfined system and the hydraulic level in the aquifer is likely a function of the stage in the river. Based on limited historical data, the depth to water near the wellfield is approximately 25 to 30 feet bgs. As with the Downtown Wellfield, the base of the alluvial aquifer consists of a shale unit associated with the Permian age Wellington Formation. In the vicinity of the South Wellfield, the base of the alluvial aquifer is encountered at depths ranging from 55 to 60 feet bgs.

On October 24, 1990 an eight (8) hour constant rate aquifer test was conducted using Well No. 1 as the pumping well. Water levels were measured within Well No. 1 while the well was pumped at a rate of approximately 676 gpm. A time-drawdown plot of the data was developed and used to estimate the transmissivity of the aquifer near the South Wellfield. From this analysis, the aquifer transmissivity was estimated at 103,500 gallons per day per foot (gpd/ft). A properly designed well should be able to produce between 500 and 800 gpm.

7.3.4 Drought Impacts

The South Wellfield could also be impacted by drought conditions, similar to the Downtown Wellfield. However, the City does not operate observation wells in the vicinity of the South Wellfield to provide a historical record of aquifer levels and their response to pumping. The wells in the South Wellfield are spaced further apart than wells in the Downtown Wellfield; therefore, pumping may not have as big of an impact on aquifer levels as pumping in Downtown Wellfield does.

7.3.5 Raw Water Quality

As discussed previously, the City operated the wells at South Wellfield in November, 2008; at that time, the City took water quality samples at each of the wells for analysis by a laboratory. The results of the water quality analyses from November, 2008 are summarized in Table 7-9.

Table 7-9
South Wellfield Raw Water Quality
November 2008

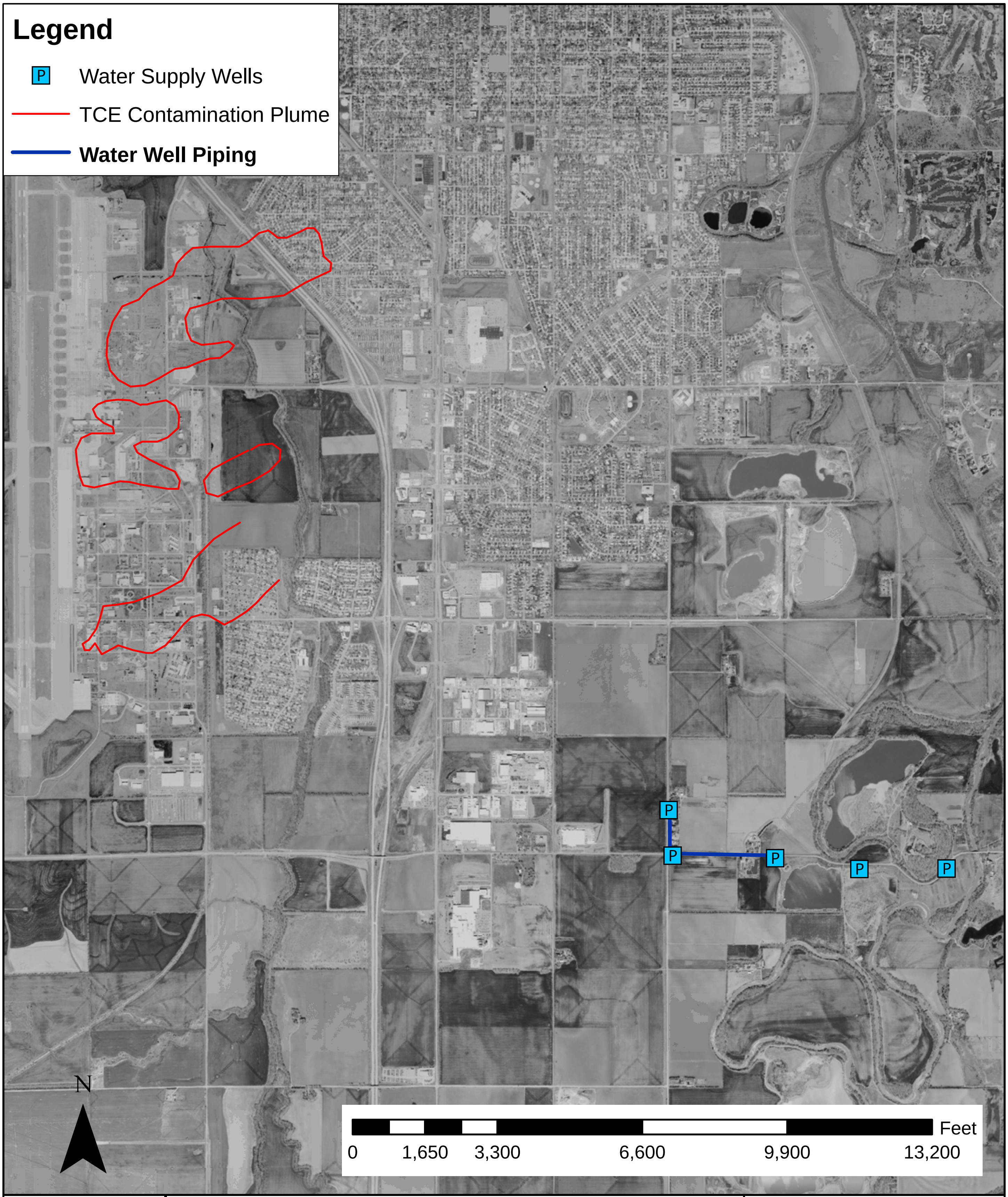
Parameter	EPA Standard (mg/L)	Flow Rate Weighted Average (mg/L)	EPA Standard/Hardness Classification
Sulfate	250	94	Secondary
TDS	500	620	Secondary
Total Hardness as $CaC0_3$	NA	431	Very hard/brackish
Iron	0.3	0	Secondary
Manganese	0.05	0.47	Secondary

In addition to these data, three water quality reports, varying in time from 1955 to 1971, were provided by the City to evaluate the raw water quality of the South Wellfield. These data showed similar water quality properties with the exception of iron and manganese. The Air Force Softening Plant Operating Manual, 1958 showed that the iron concentration was 0.4 mg/L whereas the most recent data collected by the City shows that iron was non-detectable (0 mg/L). In addition, the report showed that the manganese concentration was 1.15 mg/L compared to the 0.47 mg/L found from the recent results collected by the City.

As shown, the raw water concentrations indicate high levels of manganese and hardness compared to secondary drinking water standards. These standards are not enforceable by the State or EPA, but are guidelines to enhance the aesthetic quality of the water. As discussed previously, treatment of these constituents is not currently provided as the water is only chlorinated prior to distribution. Waters high in manganese can cause brown stains imparted to laundry and porcelain as well as being bitter tasting, whereas hardness can result in excessive soap consumption and scaling in the pumps and distribution system. The City has found that industries are generally unable to use the water due to the hardness. In comparison to the raw water quality of the Downtown Wellfield, the South Wellfield has lower concentrations of sulfate, TDS, and hardness. The manganese concentrations measured in the South Wellfield wells are much higher than the concentrations observed at the Downtown Wellfield.

7.3.6 Anthropogenic Contamination

Groundwater contamination, in the form of TCE and associated daughter products, has been detected approximately 2.5 miles northwest of the South Wellfield. This plume originates from the old Schilling Air Force Base and is being monitored and studied by the USACE. Based on past history the movement of the plume is to the east-northeast away from the South Wellfield; therefore the plume is not currently impacting or threatening any of the wells at the South Wellfield. A map of the groundwater plume is shown on Figure 7-7.



City of Salina

Raw Water Supply Study

Figure 7-7: South Wellfield Contamination Plumes

HDR

WILSON & COMPANY
ENGINEERS & ARCHITECTS

Layne

7.3.7 South Wellfield Recommendations

Optimization of the City's existing water supply infrastructure is a primary goal of the Raw Water Supply Study. The poor water quality associated with the South Wellfield wells and lack of treatment is the primary reason this source has not been utilized on a consistent basis in the past. As discussed previously, the City has a vested water right to extract 2,511 acre feet per year (2.24 MGD on average) or 3.7 MGD maximum of groundwater from the South Wellfield. A total of five (5) wells are permissible based on Vested Right SA035, however only three (3) wells are active and in service at this time. Based on the transmissivity of the aquifer, a properly designed well should be able to produce between 500 and 800 gpm.

Development of an onsite treatment facility designed to remove iron, manganese, and hardness could result in the South Wellfield becoming a reliable source of water for the City. The existing Schilling Water Treatment Plant, most of which is not in service, used a treatment process consisting of aeration, flocculation/clarification with lime softening, recarbonation, filtration, and disinfection. The aeration serves to oxidize iron and manganese, while the flocculation/clarification removes iron, manganese, and hardness. It is likely that a similar treatment scheme could produce water of a quality suitable for domestic and industrial use. Water quality testing should be completed prior to selection of a treatment scheme.

The current operable wells are capable of producing between 1,430 gpm and 1,560 gpm. Consideration should be given to rehabilitating or offsetting and replacing the two existing wells (Well No. 3 and Well No. 4), which have not been used since the 1940's when their pumps were removed. The water right allows for a maximum of 3.7 MGD, or 2,555 gpm; therefore there is a potential to add an additional 995 gpm to 1125 gpm to maximize the use of the water right. The replacement of Wells 3 and 4 would add the necessary capacity to maximize the water right use. These two wells, in addition to the three existing wells, would also allow for better utilization of the South Wellfield by decreasing the effect of overlapping cones of depression which would occur as a result of more evenly distributed pumping rates. It is recommended that the City conduct performance testing on the existing wells to determine their recommended pumping rates for protection of pumping equipment.

In addition the City, in conjunction with the USACE, should continue to monitor the existing contamination plume to ensure it does not threaten the South Wellfield.

7.4 EXISTING FACILITIES

7.4.1 Treatment Process Evaluation

The existing water treatment facility has a nominal treatment capacity of 20.0 MGD. The treatment facility currently consists of the following major components: groundwater equalization basin, groundwater air stripping towers, river settling basin, solids contact clarifiers (softening basins), secondary clarifiers, gravity filters, and underground storage reservoirs. Figure 7-8 presents a schematic of the treatment process flow at the Salina water treatment facility.

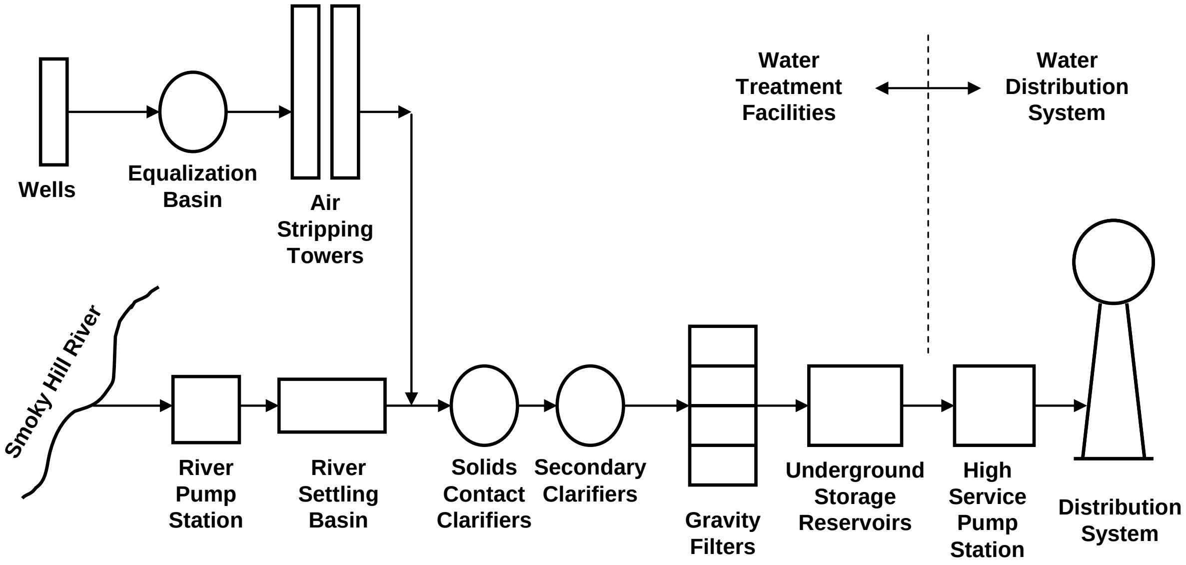


Figure 7-8
General Schematic of Treatment Process Flow

The following paragraphs evaluate the reliable capacity of the water treatment plant processes to determine potential limitations as they relate the Raw Water Supply Study.

<u>Equalization Basin (Groundwater Treatment Only)</u>
Purpose: To control and maintain constant water flows into air stripping towers
Tank Diameter: 35’-0”
Sidewater Depth: 17’-0”
Volume: 122,350 gallons

<u>Transfer Pumps (Groundwater Treatment Only)</u>
Purpose: Pumps water from the equalization basin to the air stripping towers
Number of Pumps: 3
Pump Capacity: 3,500 gpm (5.0 MGD) each
Reliable Capacity (with largest pump out of service): 10.0 MGD

<u>Air Blowers (Groundwater Treatment Only)</u>
Purpose: Blows air through the air stripping towers
Number of Blowers: 3
Blower Capacity: 25,560 cfm each

Air Stripping Towers (Groundwater Treatment Only)
Purpose: Removal of VOC contaminants from groundwater
Number of Towers: 2
Tower Diameter: 12'-0"
Overall Tower Height: 55'-0"
Design Flow: 5.0 MGD each
Total Capacity: 10.0 MGD
Reliable Capacity: 10.0 MGD (reliability is provided by redundant pumps and blowers)

Flash Mix Basin (Surface Water Treatment Only)
Purpose: Blend chemicals into raw water
Volume: 8,600 gallons
Detention Time: 1.2 minutes
Reliable Capacity: 10 MGD

Flocculator (Surface Water Treatment Only)
Purpose: Aggregation of particles prior to settling
Size: 69'-6" x 28'-0"
Sidewater Depth: 12'-5"
Volume: 180,800 gallons
Design Flow: 10 MGD
Detention Time: 26 minutes (KDHE req't = 20 minutes min)
Reliable Capacity: 10 MGD

River Settling Basin (Surface Water Treatment Only)
Purpose: Allows particles in surface water to settle out
Size: 197'-0" x 69'-6" (does not include flash mix zone or flocculation zone)
Sidewater Depth: 12'-5"
Volume: 1,272,000 gallons
Design Flow: 10.0 MGD
Detention Time: 3.05 hrs (KDHE req't = 3 hrs min)
Overflow Rate: 730 gpd/ft^2 (KDHE req't = 600 gpd/ft^2 max)
Weir Loading Rate: 14,388 gpd/ft (KDHE req't = 20,000 gpd/ft max)
Reliable Capacity: 8.2 MGD based on Overflow Rate of 600 gpd/ft^2

Solids Contact Clarifiers (Softening Basins)
Purpose: Reduces hardness of water and treats surface water
Number of Basins: 2
Basin Diameter: 90'-0"
Sidewater Depth: 19'-0"
Design Flow: 10.0 MGD each

Detention Time: 2.17 hrs (KDHE req't = 2 to 4 hrs)
Overflow Rate: 1.09 gpm/ft^2 (KDHE req't = 1.75 gpm/ft^2 max)
Weir Loading Rate: 8.8 gpm/ft (KDHE req't = 10 gpm/ft max)
Total Capacity: 20.0 MGD
Reliable Capacity (with one clarifier out of service): 10.0 MGD

Secondary Clarifiers
Purpose: Provides settling between first-stage and second-stage recarbonation
Number of Clarifiers: 2
Clarifier Diameter: 90'-0"
Sidewater Depth: 12'-0"
Design Flow: 10.0 MGD each
Detention Time: 82.2 minutes (KDHE req't = 45 minutes min)
Overflow Rate: 1,572 gpd/ft^2 (KDHE req't = 1,500 gpd/ft^2 max*)
Weir Loading Rate: 12,210 gpd/ft (KDHE req't = 15,000 gpd/ft max)
Total Capacity: 20.0 MGD
Reliable Capacity (with one clarifier out of service): 10.0 MGD
* Secondary Clarifiers were originally designed at a diameter of 92'-0", which would meet the overflow rate, but due to site constraints KDHE allowed the clarifiers to be a diameter of 90'-0".

Gravity Filters
Purpose: Removes non-settling particles, suspended precipitates, etc.
Number of Filters: 16
Size: 21'-0" x 16'-6"
Design Flow: 1,386 gpm each
Filtration Rate: 4.0 gpm/ft^2 (KDHE req't = 4.0 gpm/ft^2)
Total Capacity: 31.9 MGD
Reliable Capacity (with one filter out of service): 29.9 MGD

Underground Storage Reservoirs
Purpose: Store treated water prior to pumping into distribution system
Number of Reservoirs: 2
Capacity: 1 million gallons and 2 million gallons
Total Capacity: 3 million gallons

<u>High Service Pumps</u>
Purpose: Deliver treated water to the distribution system
Number of Pumps: 7 (6 pumps pump to the Base pressure zone, 1 pump pumps through a dedicated line to the southern portion of the City)
Total Capacity: 25.0 MGD for the pumps that pump to the Base pressure zone
Reliable Capacity (with the largest pump out of service): 23.0 MGD for the pumps that pump to the Base pressure zone

7.4.2 Distribution Systems Evaluation

Professional Engineering Consultants, (PEC) completed the draft 2007 Water Distribution System Model – Phase 1 report. As part of this report, an evaluation of the City's existing distribution system (high service pumps, booster pumps, water mains, fire hydrants, and water storage) was completed utilizing a computerized hydraulic model. The hydraulic model analyzed the water distribution system for adequate pressures, fire flow availability, water tower storage capacities, pump performance, and water age under current demand conditions and under projected demands through year 2030.

According to Phase 1 of PEC's study of the existing distribution system, the following are summarized conclusions and recommendations stated in the draft report:

- Projected demands for the year 2030 are:
    - Average Day = 8.20 MGD
    - Maximum Day = 14.68 MGD
    - Peak Hour = 22.30 MGD
- System pressures are adequate during average day, maximum day, and peak hour demands.
- Available fire flows are currently inadequate for a majority of the City.
- Additional water storage is required for both present and 2030 projected conditions.
- Water age within the distribution system is adequate.
- There are areas of the distribution system which are experiencing taste and odor problems and/or low chlorine residuals believed to be caused by iron bacteria depleting oxygen in the water.

The City has recently initiated Phase 2 of this project which includes completion of a study to determine appropriate solutions to the deficiencies identified.

7.4.3 Systems Deficiencies

The City's existing water supply facilities, which includes the raw water supply sources, raw water pumping, raw water piping, water treatment facility, and water distribution system does have deficiencies which are listed below.

Raw Water Supply Sources

Surface Water – Smoky Hill River

- The supply from the Smoky Hill River is impacted by the minimum release schedule for Kanopolis Reservoir. During drought conditions when the minimum of 50 cfs is released, supply available for the City is reduced.
- Water supplied from the Smoky Hill River is directly connected to the existing groundwater source (Smoky Hill Alluvium Aquifer) and is negatively impacted during drought conditions.
- There are existing water rights upstream from the City's river intake that are senior to the City's appropriated surface water right and could impact the City's ability to withdraw water from the river during drought conditions if those rights are exercised.

Groundwater - Downtown Wellfield and South Wellfield

- The wellfield aquifer is directly connected to the existing surface water source (Smoky Hill Alluvium Aquifer) and is negatively impacted during drought conditions.
- Aquifer recharge is not sufficient to keep up with pumping demand during drought conditions.
- There is currently no regulatory control over private wells; therefore during drought periods when domestic pumping occurs, there is a substantial amount of water use by private wells (KGS, 2008). This can have a negative effect on the levels in the aquifer from which the Downtown Wellfield draws from.
- Water from the South Wellfield is high in iron, manganese, and hardness. Since no treatment is currently provided this wellfield is limited in use.

Raw Water Pumping

Groundwater - Downtown Wellfield and South Wellfield

- The pumping capabilities of the wells have been reduced due to fouling of the well screens, a drop in static water levels since the wells were installed, and past operation at too high a pumping rate.
- Pump capacity must be reduced when groundwater levels are low to prevent possible cavitation and pulling of water from below well screens.
- Use of Wells 11, 12, 15, and 16 at the Downtown Wellfield has been curtailed due to high levels of contamination. The curtailment of these wells reduces the overall capacity of the wellfield.
- Well withdrawals of other wells may need to be reduced to avoid pulling the contamination plume into the cone of influence of the wells.

Raw Water Piping

Groundwater - Downtown Wellfield

- The Downtown Wellfield raw water supply is not run through a water treatment plant and can currently only be chlorinated; as a result the wellfield is rarely used due to water quality issues.

Groundwater - South Wellfield

- The South Wellfield raw water piping is not connected to the water treatment facility; as a result the wellfield is rarely used due to water quality issues.

Water Treatment Facilities

- The River Settling Basin which is for surface water only has a reliable capacity less than 10 MGD.
- The reliable capacity of the air stripping towers (10 MGD) does not maximize use of the Downtown Wellfield (15.2 MGD water rights).
- Operational changes (i.e. chemical dosages, etc.) are necessary as the raw water supply proportion of surface water and groundwater varies.
- There are miscellaneous maintenance/replacement items as the facilities and equipment age.
- Additional treatment may be necessary to treat the contamination near the Downtown Wellfield.
- Additional treatment is necessary to treat the periodic taste and odor issues when utilizing the Smoky Hill River supply.
- The current river settling basin is unable to treat surface water that has turbidity greater than 800 NTU; as a result the City temporarily discontinues the use of the Smoky Hill River when the turbidity is greater than 800 NTU.
- Additional treatment may be necessary if a new source of water supply is proposed which has different water quality than that of the existing surface water and ground water supply.
- Additional treatment may be necessary as water regulations become stricter.
- There is no additional land available at the existing site if additional capacity or advanced treatment is required.

Water Distribution System

A detailed review of the distribution system was not completed as part of this study, therefore the following is a list of deficiencies provided in the Phase 1 of the PEC study:

- Available fire flows are currently inadequate for a majority of the City.
- Additional water storage is required for fire protection and flow equalization.
- There are areas of the distribution system which are experiencing taste and odor problems and/or low chlorine residuals believed to be caused by iron bacteria depleting oxygen in the water.

In addition to the deficiencies above, there may be some areas of aged pipe or pipe of inadequate size that may need replacement.

7.4.4 Water Treatment Recommendations

Based on the evaluation of the water treatment facility, several improvements can be made. The nominal capacity of the air stripping towers is 10.0 MGD. If it is desired to maximize the water right of 15.2 MGD (maximum diversion rate) from the Downtown Wellfield, it is recommended that additional capacity of 5.2 MGD be added. There is currently no additional land available at the water treatment plant for expansion of any facilities; therefore, it is desired that the air stripping towers be upgraded within the existing footprint if possible. If the air flow rate is increased to provide a higher air-to-water ratio, the required constituent removals can be achieved within the existing footprint. Preliminary calculations indicate that the air flow rate should be increased from 25,560 cfm to 27,520 cfm. This upgrade would require new air blowers that meet the required air flow, new pumps capable of pumping the new flow (5278 gpm), and possibly some hydraulic changes at the distributor and redistributor. With the increased air flow to the air strippers, there may be more head losses through the packing media, distributor, redistributor, and mist eliminator which will likely result in increased pumping costs.

As discussed previously, the City has had to discontinue use of the Smoky Hill River if turbidities are greater than 800 NTU. The turbidities are normally increased during high flow periods. Having to discontinue use of the river forces the City to be fully dependent on the Downtown Wellfield during a time when there is adequate flow in the river for withdrawal. In addition, the river settling basin that is used as pretreatment of the surface water is limited to a reliable capacity of 8.2 MGD based on KDHE design criteria. It is recommended that the river settling basin be increased in capacity by adding additional weir length in order to reduce the basin overflow rate to 600 gpm/ft^2, which is the maximum overflow rate recommended by KDHE. This would allow the full 10.0 MGD from the Smoky Hill River based on KDHE minimum design requirements. In addition, it is recommended that additional coagulant (higher dose of current coagulant) be added during flash mix to remove higher turbidity levels.

Improvements should be made to provide adequate capacity in the Downtown Wellfield raw water piping. The piping between Well Nos. 11, 12, 8, 3 and the equalization basin at the water treatment plant should be upsized (Wilson & Company (b), 2008). In addition, with the recommended well re-drilling at the Downtown Wellfield, a small segment of piping downstream of Well No. 4 should be upsized. Figure 7-9 shows the reaches of piping that should be upsized and the preliminary recommended sizing.

Improvements should be made to the distribution system to improve fire flow availability, water storage, taste and odor problems, and low chlorine residuals. Improvements should be identified through hydraulic modeling of the distribution system which is currently underway by PEC. Also, continued replacement and upsizing of aged distribution piping should be completed as necessary.

City of Salina

Raw Water Supply Study

Figure 7-9: Downtown Wellfield Piping Improvements

HDR

WILSON & COMPANY
ENGINEERS & ARCHITECTS

Layne

7.5 ARTIFICIAL RECHARGE POTENTIAL

Aquifers are typically recharged by natural precipitation, which infiltrates through the ground to the aquifer, or results in high stream levels, which induce flow from the stream into the aquifer. During drought periods such as 2000 through 2006, the amount of precipitation is not enough to recharge the aquifer through infiltration or through high stream levels. This can result in declining aquifer levels over a drought period as the aquifer is pumped but not fully recharged.

The objective of a groundwater recharge project is to maintain elevated water levels within the aquifer so that water is available for pumping during times of need. There are two recharge methods available to achieve this objective, as described below:

- Passive recharge – maximize the use of surface water to meet the water supply demand. This indirectly allows the water levels within the wellfield to stay as elevated as possible and ensures the maximum aquifer storage is available to meet demands during periods of low streamflow when surface water cannot be used.
- Active recharge – Infiltrate or directly inject water into the aquifer to cause water level elevations within the aquifer to rise.

As shown on Figure 7-3, there have been extended periods of time (1984 through 1990 and 1996 through 1999) where the wellfield has been over pumped, resulting in significant water level declines. However, except for those two periods of time, a review of the Oakdale well hydrograph indicates that the wellfield is generally operated in a manner that allows sufficient time for water levels in the aquifer to recover from one pumping period to the next. An aquifer recharge project could maximize the storage in the aquifer and ensure that maximum storage is available during the peak demand months.

The following sections present an evaluation of several options to directly or indirectly recharge the aquifer near the Downtown Wellfield. The following options are considered:

- Near-Term Maximization of the Existing Surface Water Right
- New Surface Water Diversion
- Direct Recharge Using Ponds
- Direct Recharge Using Wells
- Direct Recharge Using Oxbow
- Aquifer Storage and Recovery System

7.5.1 Near-Term Maximization of Existing Surface Water Right

A passive form of aquifer recharge is available to the City by maximizing use of the existing surface water right and decreasing the use of the wellfield during periods of high flow in the Smoky Hill River. The City currently maintains a surface water right of 10 MGD (instantaneous flow) or 1,638 million gallons per year (mgy). Table 7-10 shows the City's usage of surface water over the last ten years (1998 – 2007). Over the last three years, the City has used approximately 80% of its annual volume allotment, leaving approximately 300 million gallons per year available on average. Increasing the use of surface water during periods of high river flows allows the wellfield more time to recover, returning water levels to near static conditions. This can be seen on the wellfield hydrograph, presented as Figure 7-3 where, during periods of less intensive pumping the Oakdale well returns to the general groundwater trend of the other observation wells.

This option is considered a near-term passive recharge option. As demands increase, the usage on an annual basis will approach the 1,638 mgy water right limit unless another water source is identified or water rights are increased from the Smoky Hill River.

Table 7-10
Historical Smoky Hill River Usage Analysis

Year	Historical River Usage (gal)	Water Right Limit (gal)	Remaining Annual Volume (gal)
1998	785,296,380	1,638,267,206	852,970,826
1999	1,030,580,420	1,638,267,206	607,686,786
2000	840,424,800	1,638,267,206	797,842,406
2001	1,049,489,240	1,638,267,206	588,777,966
2002	1,438,460,100	1,638,267,206	199,807,106
2003	1,406,564,720	1,638,267,206	231,702,486
2004	1,243,442,400	1,638,267,206	394,824,806
2005	1,366,941,470	1,638,267,206	271,325,736
2006	1,283,821,100	1,638,267,206	354,446,106
2007	1,327,274,980	1,638,267,206	310,992,226

7.5.2 New Surface Water Diversion

The Smoky Hill River is not closed to new surface water diversions, however, it is restricted. Generally, the DWR permits surface water diversions on the Smoky Hill River near Salina on the basis of "in-season" (July to September) or "off-season" (October-June). The City could obtain a new “off-season” surface water right and use that new water right to meet water supply demands during the fall, winter, and spring, when flows in the river are typically plentiful and water demands are low. Using this approach would allow for preserving as much of the saturated thickness of the aquifer as possible in both the Downtown and South Wellfields, which could then be used to meet peak summer demands. This seasonal water right is discussed in detail in Section 8.0.

Surface water flow in the Smoky Hill River can occasionally be somewhat low during winter months. If low stream flow conditions are encountered during winter, then the groundwater wellfields could be used to help meet water demands as needed. Typically, water demands are much lower in the winter, which should help minimize water level declines in the wellfields.

7.5.3 Direct Recharge Using Ponds

One option that could be used to directly recharge the aquifer is to construct infiltration ponds, which involves keeping water at the surface in areas where the water can percolate down to the shallow, unconfined aquifer. This is a relatively simple concept; however surface spreading techniques are prone to siltation problems and also lose significant volumes of water to evaporation.

A potential negative with construction of an infiltration pond is the water deficit for surface waters in central Kansas. Near Salina, the mean annual precipitation is approximately 30 inches and the mean annual lake evaporation is approximately 52 inches, which is a water deficit of approximately 22 inches per year.

Several former sand pits, located south of the City, were identified in previous studies as potential locations for direct recharge of the alluvial aquifer. These existing sand pits could potentially be used as infiltration ponds. Using infiltration ponds as recharge sources will increase the water levels in the immediate vicinity of the infiltration pond but will have a limited impact on the overall potentiometric surface of the aquifer in the wellfields. Therefore, to provide maximum benefit to the water supply wells, any new infiltration ponds should be located near, and up-gradient of, the wellfields.

No sand pits are located near the Downtown Wellfield; however, one sand pit is located near the South Wellfield. Assuming the sand pit has not silted in over time, this location could be used to directly recharge the aquifer in the vicinity of the South Wellfield. Using sand pits that are not located near existing wellfields would have a very minimal impact of the water levels of the alluvial aquifer at the wellfields.

To implement this concept, a new “off-season” surface water diversion is required to provide the water source.

7.5.4 Direct Recharge Using Wells

Another option that could be used to directly recharge the aquifer is to take excess surface water flows from the Smoky Hill River, treat the water, and pump (or gravity feed) the treated water into the aquifer through recharge wells. Like the previous recharge options, this option would require a new “off-season” surface water diversion to provide the water source.

Alternatively, river bank filtration wells could be installed near the wellfield to provide the water source necessary for aquifer recharge. A river bank filtration well is essentially a “regular” pumping well that is located 50 to 100 feet from the edge of the stream. The wells would pump water out of the alluvial aquifer during periods of high stream flow in the Smoky Hill River. As the stage in the Smoky Hill River rises, water levels in the alluvium also rise. This “extra” water in storage could be pumped from the alluvium, conveyed by pipeline to a recharge well, and pumped or gravity fed into the alluvial aquifer near the wellfield. The filtration process that occurs with river bank filtration wells would likely mean that the water would not have to be treated further prior to injection into the aquifer. Unlike the previous recharge options, this option would not require a new surface water permit. However, a DWR permit for river bank filtration wells, which would be operated based on streamflow triggers, would be required for this option. Additionally, a KDHE Underground Injection Control Class V Permit would be required for recharge wells.

7.5.5 Direct Recharge Using River Oxbox

The old river oxbow, located near the Downtown Wellfield could be used to provide direct recharge to the alluvial aquifer. This concept is similar to using infiltration ponds in that surface water will be used to create a hydraulic head that will result in water percolating into the shallow, unconfined aquifer. In addition to potentially increasing the head in the aquifer, recharge using the oxbow also could provide aesthetic improvements to the City. The non-profit organization Friends of the River is interested in restoring the oxbow area in order to improve Salina's character and quality of life

To implement this concept, a new "off-season" surface water diversion is required to provide the water source. The surface water diversion could be routed directly into the oxbow channel, or it could be routed into a pond located in Lakewood Park, north of the Downtown Wellfield. Because the surface water permit required for this option is seasonal, the surface water that is extracted from the river could be routed to the pond, which allows for water storage. The stored water could be pumped into the oxbow, as needed, to ensure that water continues to flow into the oxbow during times when the temporary surface water diversion is unavailable.

The overall impact of this option on the head conditions within the alluvial will be limited, as recharge will occur only through infiltration of water through the channel bottom of the oxbow. Based on conversations with City staff, the channel bottom is a low permeability silt or clay which will likely keep infiltration rates during non-pumping times to a minimum. During periods of high pumping from the Downtown Wellfield, the cone of depression of the Downtown Wellfield will intersect the oxbow. This creates the potential that pumping the Downtown Wellfield could deplete the flow in the oxbow during periods of high volume pumping.

7.5.6 Aquifer Storage and Recovery (ASR) System

Another option is to store water in an aquifer storage and recovery system (ASR) for future withdrawal during peak demand periods. Most artificial ASR projects store water in an aquifer that is not directly connected to the source of recharge water. For example, the City of Wichita ASR project extracts water from the Little Arkansas River during high streamflow conditions, treats the extracted water, and places the treated water in infiltration ponds. This procedure is similar to the process described in Section 8.3.

The City of Wichita also uses the concept of river bank filtration wells to inject water into the Equus Beds Aquifer. As the stage in the Little Arkansas River rises, water levels in the alluvium also rise. This water is pumped from the alluvium, conveyed by pipeline to a recharge well and pumped or gravity fed into the Equus Beds aquifer. Typically, the water is injected into confined units of the Equus Beds that are 100 to 200 feet below ground surface and are not directly connected to the Little Arkansas River.

A primary concern of applying direct recharge to the Smoky Hill alluvial aquifer is its' direct connection to the Smoky Hill River. To increase the benefit to the City's wellfields, any direct recharge applied to raise the water levels in the aquifer would need to be applied very close to, and upgradient of, the wellfields. Due to the proximity of the Downtown and South Wellfields to the river, there is concern that water injected into the aquifer through direct recharge would be returned to the river in a short period of time.

A quantitative evaluation of the ability of the alluvial aquifer to store water can be performed by reviewing the flood pulse generated by winter 1973 flood of the Smoky Hill River, presented as Figure 7-10. This figure illustrates the water level response observed at the KWU and Ohio monitoring wells and the streamflow observed in the Smoky Hill River at the Mentor gage. As shown on Figure 7-10, this flood event caused an approximate 4-foot water level rise in the KWU monitoring well, beginning in December 1973. This 4-foot water level rise completely dissipated from the aquifer by December of the following year (1974). The relatively rapid dissipation of water from storage illustrates the limited potential for ASR in the Smoky Hill alluvial aquifer. The direct connection of the alluvial aquifer to the river significantly impacts the ability of the aquifer to store water. This limitation exists whether the direct recharge is applied through use of infiltration ponds, direct recharge wells, or the oxbow channel.

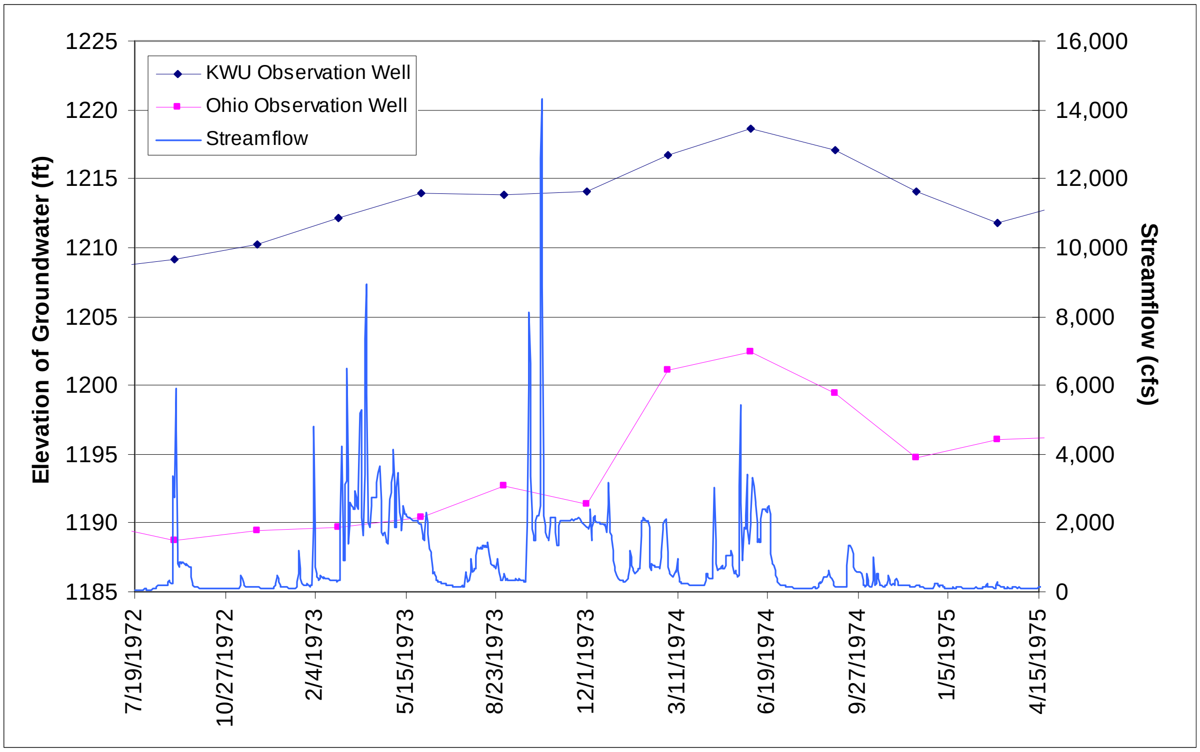


Figure 7-10
Smoky Hill River Flood Pulse
Near Downtown Wellfield

7.5.7 Aquifer Recharge Recommendations

Based on the review presented, the new seasonal surface water right is recommended as the most effective means to ensure that the water levels within the aquifer remain as elevated as possible. If implemented, this option will require obtaining and perfecting a new "off-season" surface water diversion. Water obtained from the new surface water diversion should be used to meet "off season" water supply demands. Development of a new surface water source will allow groundwater near the wellfield to remain in storage for use during periods of low streamflow in the Smoky Hill River.

As a means to increase water supply during high stream flow conditions river bank filtration wells could be installed near the Smoky Hill River. These wells could allow the City to capture more water than could be obtained through a surface water diversion alone. The use of bank storage diversion wells would have a secondary benefit of improved water quality, as the water has been pre-treated through the river bank filtration process.

Directly recharging the aquifer through injection wells is also a viable option to implement. This option allows placement of the wells to directly benefit the wellfield. The advantages and disadvantages of each direct recharge method is summarized in Table 7-11. Regardless of recharge method, the direct connection between the aquifer and the river will limit the long-term ability of the alluvial aquifer to store water that is directly recharged; the water injected into the aquifer through direct recharge would be returned to the river in a short period of time. The artificial recharge methods considered in this section will be considered further in Chapter 11 for inclusion in the City's future water supply plan.

Table 7-11
Summary of Active Recharge Methods

Active Recharge Methods	Advantages	Disadvantages
Infiltration Ponds	• Relatively simple • Do not need to treat source water	• Prone to siltation • Water deficit due to evaporation • No existing features near wellfield • Space intensive
Infiltration through Oxbow	• Good location to benefit wellfield	• Limited infiltration through channel bottom • Flow in channel may be depleted during high pumping times • Water deficit due to evaporation
Direct Recharge Wells	• Likely do not need to treat water source if using bank storage diversion wells • Do not need a lot of space • Can place wells to directly benefit wellfield	• Expensive • Permitting with DWR for Underground Injection Control Class V Permit • Periodic maintenance for well screens

7.6 CONJUNCTIVE USE

The Downtown Wellfield and the Smoky Hill River will continue to be important sources in the City's future water supply system. This section summarizes the conjunctive use of the existing water supply system and evaluates options for the optimization of the two water supply sources when they operate together. The South Wellfield is considered a separate source as it needs the addition of water treatment to become a reliable water source.

7.6.1 Current Operation Procedures

In general, the current conjunctive use of the City's sources of supply is 60% surface water from the Smoky Hill River and 40% groundwater from the Downtown Wellfield. Use of surface water is dependent on turbidity, temperature, and the presence of algal blooms in the river. As discussed previously, use of surface water is discontinued if possible when turbidity in the river is above 800 NTU and then all supply is from the Downtown Wellfield. During the presence of algal blooms in the river, operators typically limit the withdrawal to 1,500 to 2,000 gpm (2.16 to 2.88 MGD) to increase treatment efficiencies. Indicators for an algal bloom include a visual inspection of the color of the water in the solids contact clarifiers and secondary clarifiers, heavy foam around the river settling basin influent and effluent, and a drop in the free chlorine residual in the flocculator with no rise in influent turbidity and odor. If a particularly bad algal bloom occurs, which is rare, use of surface water is discontinued in favor of groundwater. Overall, the surface water source is used 99% of the time according to the City staff.

In the winter months (November through February and occasionally into March) the City typically uses 1,000 gpm (1.44 MGD) of water from the Downtown Wellfield with surface water making up the remaining. The water from the wellfield (downstream of the air strippers) is mixed with the colder surface water in the river settling basin to keep the water temperatures above freezing. A minimum of 1,000 gpm is needed to run the tempering pump on low in order to pump water from the effluent of the air strippers to the river settling basin.

In the summer months (June through August) the split is closer to 50% surface water and 50% groundwater, with groundwater supply just over half. This may be due to a combination of the presence of algal blooms and reduced surface water flow due to drought conditions. Table 7-12 shows the distribution of ground water and surface water on average for the period 2003-2007.

Table 7-12
Historical Average Conjunctive Use
2003-2007

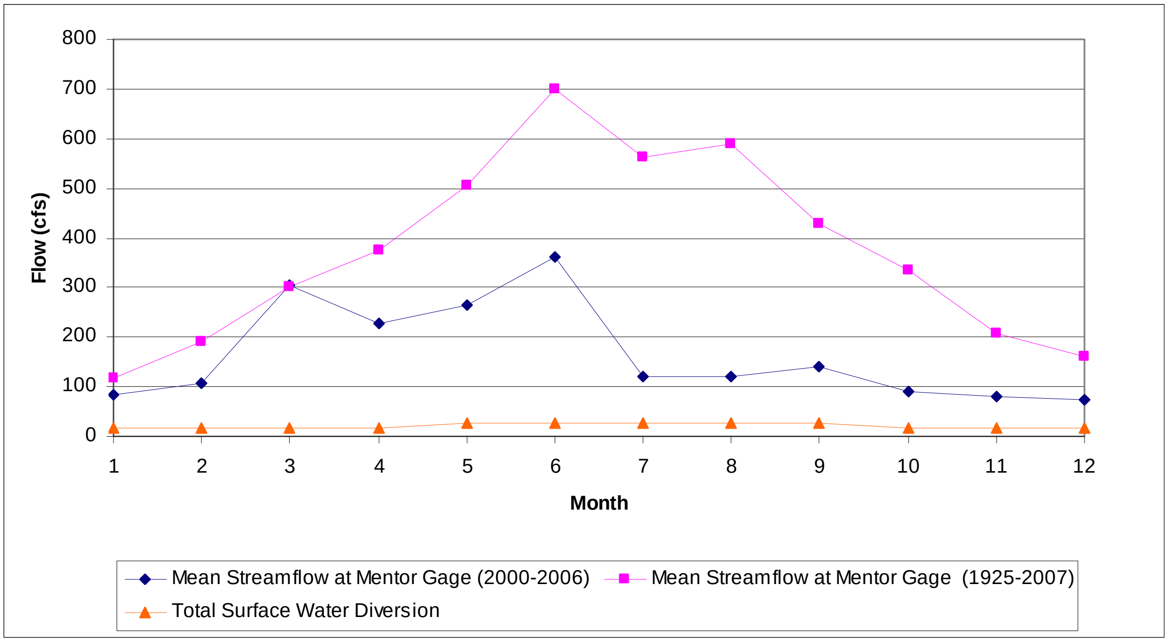
Month	Ground Water	Surface Water
Jan	35%	65%
Feb	36%	64%
Mar	39%	61%
Apr	41%	59%
May	47%	53%
Jun	52%	48%
Jul	44%	56%
Aug	56%	44%
Sep	47%	53%
Oct	44%	56%
Nov	37%	63%
Dec	35%	65%
Avg	43%	57%

7.6.2 Proposed Operation Procedures

Several considerations must be taken into account when analyzing alternative operations of the current sources of supply. The contamination plume near the Downtown Wellfield is a major factor in how the wellfield should be operated in the future. As discussed previously, KDHE is considering adding a capture well in the vicinity of the Downtown Wellfield to intercept contamination prior to reaching the wellfield. This well would be equipped with a Granular Activated Carbon (GAC) system to treat the high levels of contamination. While the City will receive this additional water, it is likely that the wellfield as a whole will experience reduced pumping capabilities due to the increased stress to the aquifer by pumping the capture well (Burns & McDonnell, 2008). It is unknown what the reduced pumping capabilities of the wellfield would be from pumping the capture well during peak demand times as a transient model would be required to evaluate this.

The City should maximize the use of its existing surface water right whenever surface water is available. The Smoky Hill River represents a water source that is less expensive for the City to treat when compared with the existing groundwater source. Beyond the existing surface water right, a seasonal (off-season) water right could be obtained. This seasonal water right could serve the following purposes: 1) immediate consumption to lessen the off-peak demand use of the Downtown Wellfield; 2) direct artificial recharge of the alluvial aquifer, by the use of recharge wells, ponds, or trenches (as discussed in Section 7.5); or 3) treatment and diversion to an aquifer storage and recovery system for later use during peak demand periods (as discussed in Section 7.5).

Streamflow from October through June during normal years and drought years is typically plentiful on average to support increased surface water diversions. Any increase in surface water diversions would require additional water rights in the form of the seasonal water right. Most upstream withdrawals are for irrigation; assuming they withdraw water for irrigation May through September, the maximum upstream withdrawal rate (between the USGS streamflow gage at Mentor and the City of Salina) is approximately 12.1 cfs. If the City is allowed to withdraw their projected average day demand in 2060 of 10.3 MGD or 16.5 cfs during the off-season months of October through June (average demands are assumed in off-season months) there is still at least 50 cfs in the river on average for withdrawal. This analysis does not account for interaction between the river and the alluvial aquifer; however, during off-season times of the year when the City would likely be withdrawing, the stream is likely to be a gaining stream (receives flow from the aquifer). Figure 7-11 shows the streamflow at the USGS gage at Mentor for the historical period of record and the drought of 2000-2006 compared to surface water diversions.



Note: Total surface water diversions include the maximum diversion rate for upstream irrigators (May through September only) and the City's 2060 average demand

Figure 7-11
Monthly Stream Flow Trends
Smoky Hill River at Mentor, KS

DWR would consider and likely allow a new water right for the City on the Smoky Hill River to withdraw water at off-season times. The DWR considers off-season times to be October 1 through June 30. The DWR has done similar water rights in the past two different ways: 1) the water right can be conditioned based on a minimum river flow or gage height (i.e. no withdrawals if the river flow or gage height is below a certain value); 2) the water right can be conditioned such that written authorization from the DWR must be obtained prior to pumping. Based on discussions with DWR, a seasonal water right for the City could be conditioned with a minimum river flow at the USGS streamflow gage at Mentor.

It is our opinion that a seasonal water right conditioned with a minimum flow of 50 cfs would be sufficient to meet the needs of the City while providing enough flow in the river. The DWR would determine the minimum flow condition upon application for the water right. If the City were to obtain such a water right, this right could be utilized during off-season times to meet demands which would save the more senior appropriated surface water right (Certificate 3043) and the water rights at the Downtown Wellfield and the South Wellfield for the peak demand times in the summer. This option also has the added benefit that the aquifer levels at the wellfields are preserved since they haven't been pumped significantly during times when they aren't needed. The wellfields may need to be pumped at a minimum of 1,000 gpm, however, in order to temper the surface water during the winter months. This pumpage would be minimal (approximately 2 wells) and would still conserve the water in the aquifer.

A seasonal water right does not guarantee that the City can withdraw from the river everyday during the off-season and there may be periods of time during drought periods when the City cannot use this water right and must either use their senior surface water right, which is not conditioned for flow, or the wellfield rights. Table 7-13 shows the number of days per year (during the off-season) in which the flow in the Smoky Hill River at the Mentor gage was above 50 cfs during the drought of 2000 through 2006. During the period 2000-2004 the City would have been able to use the seasonal water right the majority of the time. Although there would have been some times when the Smoky Hill River could not have been used, it could have kept aquifer levels higher than those experienced. Therefore, by 2006 the aquifer levels would have been higher and the Downtown Wellfield more effectively utilized even though the seasonal water right was not available. The amount of time the seasonal water right can be used per year will decrease each year in a prolonged drought.

Table 7-13
Off-Season River Flow Analysis
2000-2006

Year	# of Days in Off-Season	# Days above 50 cfs	% of Time Available
2000	274	255	93%
2001	273	266	97%
2002	273	247	90%
2003	273	205	75%
2004	274	190	69%
2005	273	135	49%
2006	273	6	2%

In order to implement a seasonal surface water right on the Smoky Hill River for the City of Salina, a new surface water intake would need to be constructed. If the existing intake were to be used for the seasonal surface water right, the DWR would consider the more senior water right to be pumped first, which would defeat the purpose of the seasonal water right, which is to save the more senior water right for peak demand periods. The DWR does not have requirements on how far apart the new intake would have to be constructed; the only requirement is that the two intakes must be consecutive and there cannot be other water users between the City's two diversion points. Therefore, a new intake could be located next to the existing intake and the existing raw water pump station and piping could be utilized for conveyance to the water treatment plant.

Generally any increase in surface water use will likely require additional treatment for eliminating taste and odor problems and TTHM and HAA5 formation. A recent study completed by Wilson & Company recommended the use of ozone treatment at the river intake site to treat for taste and odor while controlling or reducing the potential for TTHM and HAA5 formation (Wilson & Company, 2008). Such a treatment system could be utilized for both intakes.

If the City were to obtain a seasonal water right, the proposed conjunctive use of the Smoky Hill River and the Downtown Wellfield is as follows:

<u>October 1 though June 30</u> – the seasonal water right should be used first on all days in which the flow in the river at the Mentor gage is above the minimum flow requirement. This withdrawal should be supplemented by 1,000 gpm of groundwater as required for tempering the surface water. If the river flow at the Mentor gage is below the minimum flow requirement of the seasonal water right, the remaining surface water right (Certificate 3043) should be pumped to meet demands as the river flows allow with 1,000 gpm of groundwater as required for tempering. If the surface water source cannot fully meet demands, the use of groundwater should be increased until demands are met.

<u>July 1 through September 30</u> – the senior surface water right (Certificate 3043) should be pumped to meet demands as the river flows allow. If the surface water source cannot fully meet demands, the use of groundwater should be increased until demands are met.

In the absence of a seasonal water right, the proposed conjunctive use of the Smoky Hill River and the Downtown Wellfield is as follows:

<u>All year</u> - the senior surface water right (Certificate 3043) should be pumped to meet demands as the river flows and water rights allow. If the surface water source cannot fully meet demands, the use of groundwater should be increased until demands are met.

The future conjunctive use will depend on any new sources of supply that are recommended as part of the alternatives evaluation and capital improvements plan that results from the Raw Water Supply Study. New water sources, including the seasonal surface water right, will be further evaluated as a water supply alternative in Chapter 11.

7.7 WATER BALANCE MODEL

Development of a water balance model for the City of Salina to be used to identify water supply conditions based on weather fluctuations, operational considerations, and impacts of future demands involved many steps. The initial concept of the water balance model was that it would identify future water supply conditions for the Smoky Hill River and its alluvial aquifer based on projected weather patterns and other operational considerations such as upstream water users and Kanopolis Reservoir.

The intent of the model was to use it as a predictive tool for the following:

- Predict general streamflow conditions for water supply based on weather impacts
- Determine general recharge of groundwater supply based on weather impacts
- Test proposed operational procedures
- Determine when alternative sources of supply need to come online
- Assist in the prediction of the need to implement the Drought/Emergency Response Plan (discussed in Chapter 8)

The water balance model was not completed to its full potential as described above due to the correlation of data that prevent the model from being reliable as a predictive tool. The following sections describe the steps that were taken to create the model, the reasoning for the data limitations, and the overall results that may help the City in future water supply planning.

7.7.1 Precipitation Outlook

The initial source of water for the Smoky Hill River and the alluvial aquifer is highly dependent on precipitation that falls in the area. The groundwater component of the system is tied to precipitation that falls over and in the immediate vicinity of Salina. The component of water supply drawn from the Smoky Hill River is largely dependent on the volume of water flowing through the river at the City intake which is directly controlled by releases from Kanapolis Reservoir. The water balance model requires knowledge of potential future precipitation patterns as an input to determine future streamflow and groundwater conditions. The HDR Atmospheric Science Group examined the potential impacts of natural climate variability on precipitation on both of these areas. This section will briefly describe the analysis and present the results.

The analysis reviews quarterly periods of precipitation in these areas and how the amount of precipitation can be affected by longer-term natural cycles of variability that have been documented by the atmospheric and oceanic science community. Long-term cycles are also referred to in other bodies of work as Climate Indices, Hydro-Climate Indices, tele-connections and/or seasonal cycles. For the purposes of this section, we will refer to these factors as Hydro-Climate Indices (HCI) as they potentially affect the precipitation of the region. HCIs are large-scale oscillations of atmospheric and/or oceanic values across relatively large areas compared to, for example, the area of the State of Kansas. The link between these factors and the precipitation in the area is that these factors can affect the jet stream and the resultant track of large-scale weather features that ultimately result in the production of weather features in the area.

These variables were segmented into quarterly periods of time that are concurrent with the quarterly periods of analysis to examine their potential impacts. In addition, effort was undertaken to examine the impacts of these indices as measured during the wintertime period (defined as November-March).

An analysis comparing the values of the HCI variables in the basin and precipitation variables necessitated the definition of two precipitation values to use:

- **Monthly (and subsequently summated quarterly) precipitation values for Salina itself.** Monthly precipitation data for Salina was readily available from the National Atmospheric and Oceanic Administration (NOAA) National Weather Service (NWS) via the High Plains Climate Center located at the University of Nebraska-Lincoln. The period of record where precipitation was readily available was from 1951-April 2004 at the Salina Regional Airport. There was a notable break in the precipitation data from November 1995 to February 1999; data from the Lindsborg precipitation station was used to 'fill in' for this period as well as for calendar year 2007. For the period of May 2004 - December 2006 precipitation was acquired from Smolan 1 SE which is a relatively short distance away from the station as well.

- **A "basket" of precipitation stations were assembled as a reasonable proxy of precipitation in the Smoky Hill River basin where a majority of the resulting inflows to Kanapolis Reservoir occur.** The stations are relatively evenly spaced in an east-west manner across this stretch of the Smoky Hill basin and are Ellis, Hays 1S, Russell, Ellsworth and Kanapolis Reservoir. The period of record from these stations were largely intact in terms of their period of record with only minor use of nearby stations to assist in completing a monthly record for the period of 1950-2007.

This limited study should be considered to be an initial evaluation of potential HCI factors and their impacts on the water supply system of the City. As such, the information presented below will draw connection that City staff maybe able to use in long-term and potentially annual planning.

To derive the potential connections between the HCI variables and precipitation, the information between these two areas was conducted by comparing the following:

1) Direct comparison of quarterly average HCI variables and concurrent values of quarterly precipitation.
2) Direct comparison of April-September average HCI variables and concurrent values of April-September precipitation.

3) Comparison of the wintertime (Nov.-March) HCI average values to the values of April-June and July-Sept. precipitation values.

The analysis identified some longer-term trends present in some of the useful HCIs in order to identify windows over the next 40 years where the threat of extremely dry years may develop that affect the City's water supply system. The precipitation outlook for the Salina area is presented in Table 7-14.

Table 7-14
Long-Range Precipitation Outlook
Smoky Hill River Basin Downstream of Kanopolis Reservoir

	Annual Precipitation as a Percent of Average (29 inches)		
Years	Above Normal	+/- 20% Average	Below Normal
2009-2010		Average	
2011-2015			60% of Average
2015-2019	130% of Average		
2020-2028			70% of Average
2029-2031	140% of Average		
2032-2036			40% of Average
2037-2040		Average	
2040-2045	140% of Average		
2045-2050		Average	

7.7.2 Regression Analysis of Historical Streamflow

Several different regression analyses were completed in an attempt to find a strong correlation or relationship that could be used to determine future streamflow conditions based on the predicted precipitation outlook defined in the previous section. It is desired to have a correlation at least greater than 50% in order to for the relationship to be useful; it is preferable to have a correlation of 75% or higher to obtain a reasonable prediction of future conditions. Streamflow data from the USGS streamflow gage at Mentor, Kansas, precipitation data from the Kansas State Research and Extension for the Salina Municipal Airport, and City records of river water pumped were collected for the past 20 years (1988 through 2008). These data were compared to determine what correlation, if any, existed on a quarterly or annual basis. Table 7-15 shows the analyses that were completed and the resultant correlation factor, R^2.

Table 7-15
Regression Analyses of Smoky Hill River
USGS Stream Flow Gage at Mentor, KS

Regression Analysis Description	Data Sample Period	Correlation (R^2)
Streamflow vs. Precipitation	1988 - 2007	25.00%
River Yield vs. Streamflow	1988 - 2007	0.50%
River Yield vs. Precipitation	1988 - 2007	8.40%
Streamflow vs. Precipitation	1988 - 2007	11.30%
Minimum Streamflow vs. Precipitation	1988 - 2007	0.10%
River Yield vs. Streamflow	1988 - 2007	1.00%
Runoff vs. Precipitation	1951 - 2007	34.70%
Runoff vs. Precipitation (by Precip Amount)	1951 - 2007	
Above-Average Precipitation Years		60.80%
Below-Average Precipitation Years		6.40%
Runoff vs. Precipitation (by Season)	1951 - 2007	
Irrigation Season (Jun - Sep)		41.50%
Non-Irrigation Season (Oct - May)		38.70%
Runoff vs. Precipitation (by Precip Amount and Season)	1951 - 2007	
Above-Average Precipitation Years		
Irrigation Season (Jun - Sep)		70.40%
Non-Irrigation Season (Oct - May)		58.30%
Below-Average Precipitation Years		
Irrigation Season (Jun - Sep)		13.60%
Non-Irrigation Season (Oct- May)		17.90%

Notes:

1. Runoff calculated between the USGS Langley gage and the USGS Mentor gage.
2. Average precipitation assumed to be 29 inches per year.

Based on these analyses no strong correlation was found that could be used in a model for predictive purposes. Overall the best correlation was the “Runoff vs. Precipitation (by Season).” However, the correlation for both the seasons is less than 50% (41.50% during the irrigation season and 38.70% for the non-irrigation season). The “Runoff vs. Precipitation (by Precip Amount)” comparison appears good for the above-average precipitation years (60.80%), however the correlation is not desirable for the below-average precipitation years (6.40%), which are the most critical for the City. Predicting streamflow from a predicted precipitation amount for the purpose of the water balance model is not recommended based on the above regression analyses.

There are various factors that contribute to the inability to determine an adequate relationship between streamflow and precipitation. Rainfall intensities and antecedant soil moisture conditions prior to a storm event can affect the amount of runoff in the watershed and resulting streamflow. Short periods of high intensity rainfall (such as a thunderstorm) can produce more runoff compared to slow and steady rains. Thunderstorm activity with high intensity rainfall is common in Kansas, especially during the spring and summer months when most of the annual precipitation occurs. In addition, if periods of rainfall occur back to back-to-back, more runoff will occur if the soil does not have a chance to dry out.

Another potential factor is that runoff characteristics within the watershed have changed over time although long-term patterns of precipitation have not (precipitation tends to be normally distributed since it is a natural process). Development that has occurred over the period of record used for the regression analyses (1951 through 2007) contributes to more runoff for the same amount of precipitation as the pre-development period.

7.7.3 Water Balance Model Conclusions

As demonstrated in the previous section, no adequate correlation exists to create a water balance model that will include prediction of future streamflow conditions. However, the City can take actions to identify critical drought periods that may affect the water supply conditions. The following actions are recommended for future water supply planning and drought identification:

- The precipitation outlook outlined in Table 7-14 may be used for predicting when future drought periods are likely to occur. It should be noted that this outlook is an initial evaluation based on long-term natural cycles of variability documented by the atmospheric and science community and should be used as a guide only. This precipitation outlook may identify periods where increased monitoring should occur as described below.
- The City should monitor the "U.S. Seasonal Drought Outlook published by the National Oceanic and Atmospheric Administration (NOAA) National Weather Service (found at http://www.cpc.noaa.gov/products/expert_assessment/seasonal_drought.html) and the short-term "U.S. Drought Monitor" published by the National Integrated Drought Information System (found at www.drought.gov).
- The City should monitor USGS data of Kanopolis Lake levels and Smoky Hill River flows at the Mentor gage on a monthly basis at a minimum (and more frequently during a known drought period) to determine long-term trends. Long-term monitoring of lake levels and river flows will identify when drought conditions are getting critical and will signal to City staff that actions should be taken.

During a drought period the City should ensure that the Drought/Emergency Response plan (contained within the City's Water Conservation Plan and outlined in Chapter 8) is implemented as outlined.

8 CONSERVATION PLAN

Prior to considering alternative sources it is important to consider conservation of the existing water sources. Water conservation can be defined as any beneficial reduction in water losses, water waste, or water use. Conserving water can be beneficial in many ways, such as addressing short-term or long-term water supply shortages, providing environmental protection, and avoiding or postponing the high costs of new water and wastewater system improvements. The objective of this Chapter is to evaluate the City's existing Water Conservation Plan, make recommendations for modifying this existing plan, assess the impact of existing private wells within the City, and review potential water conservation measures. Also included within this Chapter is the review of the existing water rate structure and completion of a water loss analysis.

8.1 WATER CONSERVATION PLAN

A Water Conservation Plan is required under the following Kansas Statutes:

- As required by the Chief Engineer of the Division of Water Resources (K.S.A. 82a-733) if applying for or already own an appropriated water right
- Anyone purchasing water from the State Water Marketing Program (K.S.A. 82a-1311a)
- Anyone participating in the Water Assurance District Program (K.S.A. 82a-1348)
- Anyone sponsoring or purchasing the public water supply portion of a Multipurpose Small Lakes Program project (K.S.A. 82a-1608)
- Anyone transferring water under the Water Transfers Act (K.S.A. 82a-1502)
- Anyone applying for a loan from the State Revolving Fund (K.S.A. 65-163g)

All public water suppliers on the drought vulnerable list (which is a list maintained by the Kansas Department of Health and Environment and the Kansas Water Office) are *encouraged* to develop and implement a municipal water conservation plan and to resolve the limitations underlying their vulnerability. The City of Salina is on this list due to the Basic Source Limitation. The Basic Source Limitation is defined as the water supplier having a primary water source that is particularly sensitive to drought as evidenced by depleted streamflow, depleted reservoir inflow and storage, or by declining water levels in wells. Restrictions imposed due to the inability to use a well(s) due to water quality problems are also considered as being indicative of a basic source limitation.

8.1.1 Existing Plan

In October 1997, the City of Salina adopted the current Municipal Water Conservation Plan (by Wilson and Company) when the City applied for a loan from the State Revolving Fund for water treatment plant improvements. The existing plan was completed in accordance with the "Municipal Water Conservation Plan Guidelines" published by the KWO in November 1990.

The existing Water Conservation Plan lists current and proposed future water conservation practices which are separated into three different categories: Education, Management, and Regulation. The Plan also includes a drought/emergency contingency plan that has three stages: Water Watch (voluntary), Water Warning (restriction), and Water Emergency (prohibition). Each of these stages are triggered by one of the following conditions: water treatment plant operating capacity, groundwater levels in well field observation wells, or Smoky Hill River levels at the USGS stream gage in Mentor, Kansas. The following is a description of the stages that are outlined in the existing plan:

Stage 1: Water Watch

Triggers:

- Treatment plant operations are at 75 percent capacity or more for three consecutive days, or
- Groundwater levels have fallen 5 feet below the normal seasonal level, or
- Smoky Hill River levels are below 45 cfs at the Mentor Gage

Goal: Heighten awareness of the public on water conditions and maintain the integrity of the water supply system.

Stage 2: Water Warning

Triggers:

- Treatment plant operations are at 90 percent capacity or more for three consecutive days, or
- Groundwater levels have fallen 10 feet below the normal seasonal level, or
- Smoky Hill River levels are below 30 cfs at the Mentor Gage

Goal: Reduce peak demands by 20% and reduce overall weekly consumption by 10%.

Stage 3: Water Emergency

Triggers:

- Treatment plant operations are at 100 percent capacity or more for three consecutive days, or
- Groundwater levels have fallen 15 feet below the normal seasonal level, or
- Smoky Hill River levels are below 15 cfs at the Mentor Gage

Goal: Reduce peak demands by 50% and reduce overall weekly consumption by 25%.

8.1.2 Current Requirements

In August 2007, the KWO updated the 1990 Guidelines and published the “2007 Municipal Water Conservation Plan Guidelines.” These current guidelines include the following main updates:

- State Approval Process - The KWO reviews and recommends the need for and the approval of plans and the DWR approves all plans.
- All highly recommended water use efficiency practices must be included, or a substantiated reason must be given for exclusion.
- A highly recommended water use efficiency education practice includes that water bills will show the amount of water used in gallons and the cost of the water.

- A highly recommended water use efficiency management practice includes that source meters and service connection meters will be repaired or replaced if test measurements are not within industry standards (such as AWWA standards).
- County drought declarations, in and of themselves, do not trigger a public water supplier's drought response.
- Private wells may be included in drought response if approved by the Chief Engineer.
- There are new drought stage triggers for Water Marketing and Water Assurance Districts.

8.1.3 Water Use Efficiency

All municipal Water Conservation Plans should include a water use efficiency goal. Water use efficiency is measured in gallons per capita per day (gpcd). In 2007 the City used 116 gpcd. The 2007 average for other similar sized municipalities in the same region (Arkansas City, Coffeyville, Derby, El Dorado, Emporia, Independence, Junction City, Manhattan, McPherson, Newton, Salina, Shawnee County Rural Water District #4C, Topeka, Wichita, and Winfield) was 135 gpcd. Over the five year period of 2003-2007 the City used an average of 124 gpcd. The 2003-2007 average for other similar sized water suppliers in the same region was 142 gpcd. The City is currently below the average water use efficiency but should still set a goal of maintaining this below average water use.

8.1.4 Drought/Emergency Response Plan

The existing conservation plan includes a drought/emergency response plan that has three stages: Water Watch (voluntary), Water Warning (restriction), and Water Emergency (prohibition). In 2006 the City did not implement the existing drought reponse plan until the recorded streamflow of the Smoky Hill River was 7.7 cfs (at the USGS Mentor streamflow gage). The City has indicated that the existing plan has flaws and is hard to implement as it is written. For this study the trigger points for entering into a Water Watch, Water Warning, and Water Emergency were reviewed in order to develop a drought/emergency response plan that is more detailed and easier for the City to implement. The problems with the old response plan and the proposed solutions are described below.

Problems with Old Drought Response Plan

- No documented method for determining the streamflow triggers
- Streamflow triggers may not be accurate based on the most recent drought conditions
- No differentiation between winter and summer conditions for streamflow triggers
- No reliable way of getting in and out of a stage results in changing stages frequently as river flows change quickly
- Data analysis required for groundwater triggers

Solutions for New Drought Response Plan

- Select the streamflow triggers based on sound methods, such as considering upstream water rights and losses to the aquifer during a losing stream situation, which is common in a drought scenario
- Differentiate between summer and winter times for the various streamflow triggers

- Include a provision for getting into and out of each stage (i.e. must see a declining streamflow trend for 7 days before getting into a Water Watch)
- Set a procedure for getting into and out of each stage of the plan.
- Provide specific groundwater levels based on the Oakdale monitoring well

The surface water flow trigger conditions should be based on recent data only and account for the total surface water diversion rates in the Smoky Hill River between the USGS streamflow gage at Mentor and Salina. The following assumptions are taken into consideration for the streamflow triggers:

- There is 12.5 cfs of senior water rights upstream of the City of Salina
- There is 25% water loss to the aquifer between the Mentor gage and Salina's river intake during the summer period
- There is no water loss to the aquifer during the winter, and to be conservative water added to the stream is not considered
- The City's water right is 15.5 cfs (10 MGD)

The data utilized should be flow duration curves based on the streamflow data of the drought of 2000 to 2006, divided into summer (June through September) and winter (October through May) conditions. A flow duration curve is a plot of the percentage of time a particular streamflow is likely to be equaled or exceeded; the flow duration curves for the Smoky Hill River at the Mentor gage are shown in Figures 8-1 and 8-2.

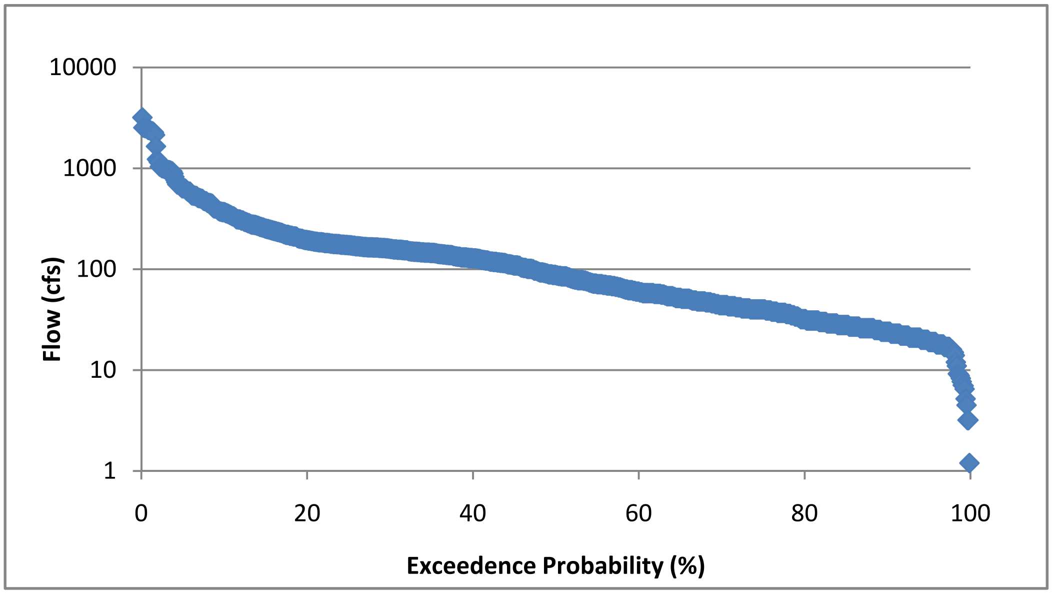


Figure 8-1
Smoky Hill River Flow Duration Curve
Summer 2000 - 2006

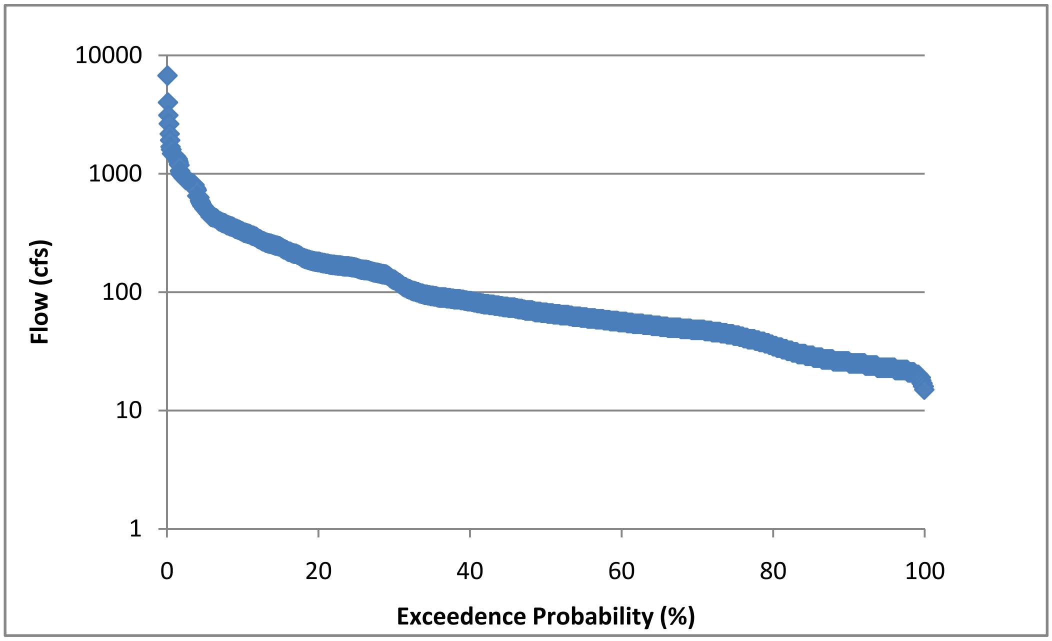


Figure 8-2
Smoky Hill River Flow Duration Curve
Winter 2000 - 2006

The following are definitions from the original Conservation Plan for a Water Watch, Warning, and Emergency:

- Watch: heighten awareness and voluntary reduction in usage. (Flows in the river are declining to low levels and may reach the point where reduction of demand is needed.)
- Warning: reduce peak demands by 20%. (Flows in the river are just enough to meet demands but are continually declining.)
- Emergency: reduce peak demands by 50%. (The flow in the river is not sufficient to meet demands.)

The previous method of determining the response plan triggers for the groundwater source were based on determining a “normal seasonal level” based on the five year average of the three monitoring wells at specific times of the year. The City requested more direct groundwater level numbers to be used for the drought response plan; therefore, the new trigger points are based on the saturated thickness of the aquifer (measured monthly at the Oakdale monitoring well) during the worst groundwater drought of record at the Oakdale monitoring well which occurred in 1988. Figure 8-3 shows the historical saturated thickness of the aquifer measured at the Oakdale monitoring well and associated recommended trigger point levels.

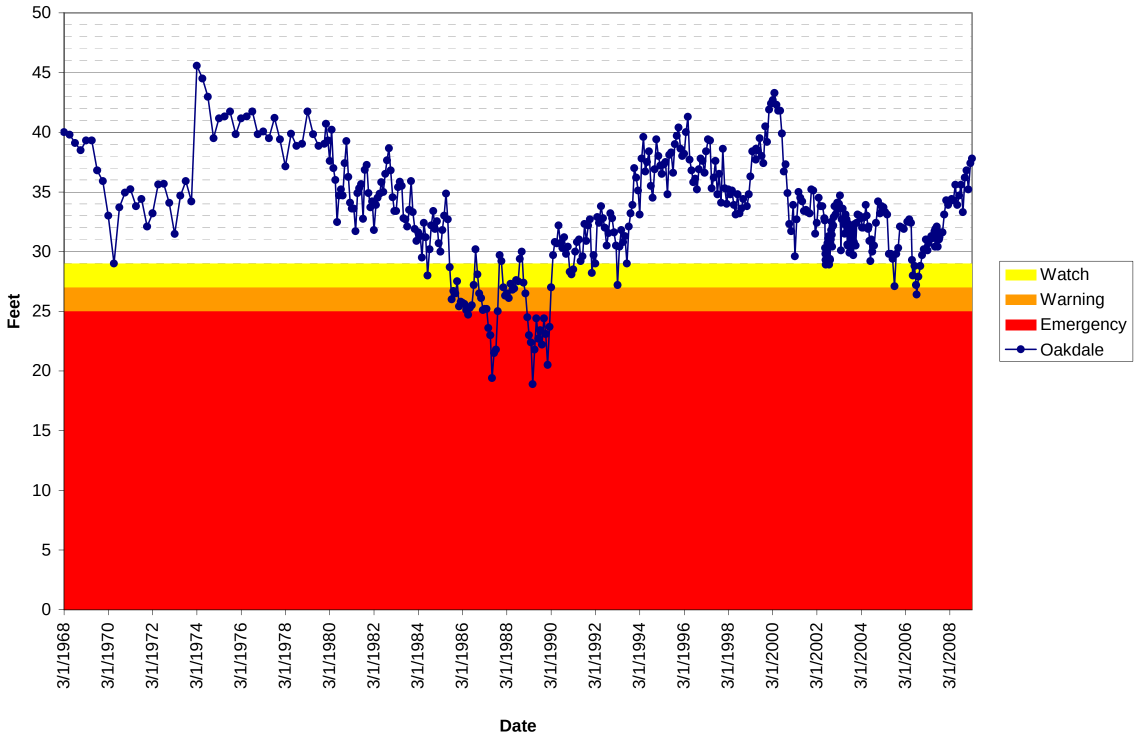


Figure 8-3
Saturated Thickness of Alluvial Aquifer
At Oakdale Monitoring Well
1968 - 2008

Based on the above assumptions, new trigger points were calculated for the Smoky Hill River (summer and winter conditions) and the alluvial aquifer. Table 8-1 shows a comparison of the current and proposed trigger levels. Calculations for the surface water and groundwater trigger points are presented in Appendix E.

Table 8-1
Recommended Modifications to Drought/Emergency Response Plan

		Watch	Warning	Emergency
Plant	Current/Proposed	Operations are at 75 of operating capacity or more for 3 consecutive days.	Operations are at 90 of operating capacity or more for 3 consecutive days.	Operations are at 100 of operating capacity or more for 3 consecutive days.
River	Current	Discharge at Mentor Gage is less than 45 cfs	Discharge at Mentor Gage is less than 30 cfs	Discharge at Mentor Gage is less than 15 cfs
	Proposed (June - September)	Discharge at Mentor Gage is less than 40 cfs and in a generally declining trend for at least 7 consecutive days	Discharge at Mentor Gage is less than 30 cfs and in a generally declining trend for at least 5 consecutive days	Discharge at Mentor Gage is less than 20 cfs and in a generally declining trend for at least 3 consecutive days
	Proposed (October - May)	Discharge at Mentor Gage is less than 30 cfs and in a generally declining trend for at least 7 consecutive days	Discharge at Mentor Gage is less than 20 cfs and in a generally declining trend for at least 5 consecutive days	Discharge at Mentor Gage is less than 15 cfs and in a generally declining trend for at least 3 consecutive days
Groundwater	Current	Depth of water at Oakdale Monitoring well is at least 5 ft below seasonal average	Depth of water at Oakdale Monitoring well is at least 10 ft below seasonal average	Depth of water at Oakdale Monitoring well is at least 15 ft below seasonal average
	Proposed	When groundwater is the only source and the depth of water at Oakdale Monitoring Well is less than 29 ft	When groundwater is the only source and the depth of water at Oakdale Monitoring Well is less than 27 ft	When groundwater is the only source and the depth of water at Oakdale Monitoring Well is less than 25 ft

The drought response plan must also address how the City will terminate each stage of the plan. The following are the items to consider for termination of the Water Watch/Warning/Emergency stages:

- Are water treatment plant operations below 75%/90%/100% of operating capacity?
- Are the Smoky Hill River flows above 40 cfs/30 cfs/20 cfs and in a generally increasing trend for 7/5/3 consecutive days during the months of June through September?

- Are the Smoky Hill River flows above 30 cfs/20 cfs/15 cfs and in a generally increasing trend for 7/5/3 consecutive days during the months of October through May?
- Is the depth of water at the Oakdale monitoring well greater than 29 feet/27 feet/25 feet?
- Are there any emergency conditions related to repairs or water quality.
- What is the current and projected length of the drought?
- What is the short and long range precipitation forecast?
- What are the current and future releases from the Kanopolis Reservoir?

8.1.5 Recommended Modifications

Based on the current requirements, the City's current Water Conservation Plan needs to be modified in order to meet the new 2007 requirements. There are various modifications to the existing plan that are recommended in order to bring it up to date including reducing the water use efficiency goal, inclusion of private wells into the Water Conservation Plan, and updating the drought response plan.

It is recommended that the water use efficiency goal be reduced from 140 gpcd to 116 gpcd. The 116 gpcd is recommended as it is believed to be sustainable based on water usage during the drought of 2000 through 2006 and implementation of conservation practices outlined in this plan. Historical water usage was determined in Chapter 4. Based on the historical per capita water usage, the City has averaged 126 gpcd between the years 1998 through 2007; however, there are four years where the City exceeded 126 gpcd. Utilizing a water use efficiency goal of 116 gpcd will push the City to decrease their per capita water usage so that they consistently meet this goal, even during years with low annual precipitation. This goal of 116 gpcd will be an achievable goal by implementing the necessary measures outlined in the revised Water Conservation Plan.

It is also recommended that the City include regulation of private wells in the drought response of the Water Conservation Plan. The City's existing Water Conservation Plan only regulates the water users that are customers of the City's water distribution system and does not regulate users of private wells. Under K.S.A. 82a-733a the Chief Engineer of the Division of Water Resources (DWR) has the authority to require the owner of a water right to adopt and implement conservation plans and practices. Private well owners do not hold an appropriated water right but are allowed to use the water as long as the domestic use for watering is less than two acres of land. The Chief Engineer of DWR can allow municipal water utilities to address the use of private wells within the city limits by including them in their Water Drought/Emergency Ordinance which references the City's Water Conservation Plan. Regulating private wells usage during times when the City is not in a Water Watch, Warning, or Emergency can also be addressed in the City's Water Conservation Plan.

In addition to the above recommendations, it is recommended that the City amend their drought/emergency response plan that is contained within the Conservation Plan. The following conditions are recommended for declaring and terminating each stage of the plan:

Stage 1: Declaring a Water Watch

  - Treatment plant operations are at 75 percent operating capacity or more for three consecutive days, or
  - When groundwater is the only source and the groundwater level at Oakdale Monitoring Well has fallen below a saturated aquifer thickness of 29 feet, or
  - Smoky Hill River levels are below 40 cfs at the Mentor Gage during the months of June through September and the river flow has been in a declining trend for at least seven consecutive days, or
  - Smoky Hill River levels are below 30 cfs at the Mentor Gage during the months of October through May and the river flow has been in a declining trend for at least seven consecutive days, or
  - Emergency conditions related to repairs or water quality.
- Stage 2: Declaring a Water Warning
  - Treatment plant operations are at 90 percent capacity or more for three consecutive days, or
  - When groundwater is the only source and the groundwater level at Oakdale Monitoring Well has fallen below a saturated aquifer thickness of 27 feet, or
  - Smoky Hill River levels are below 30 cfs at the Mentor Gage during the months of June through September and the river flow has been in a declining trend for at least five consecutive days, or
  - Smoky Hill River levels are below 20 cfs at the Mentor Gage during the months of October through May and the river flow has been in a declining trend for at least five consecutive days, or
  - Emergency conditions related to repairs or water quality.
- Stage 3: Declaring a Water Emergency
  - Treatment plant operations are at 100 percent capacity or more for three consecutive days, or
  - When groundwater is the only source and the groundwater level at the Oakdale Monitoring Well has fallen below a saturated aquifer thickness of 25 feet, or
  - Smoky Hill River levels are below 20 cfs at the Mentor Gage during the months of June through September and the river flow has been in a declining trend for at least three consecutive days, or
  - Smoky Hill River levels are below 15 cfs at the Mentor Gage during the months of October through May and the river flow has been in a declining trend for at least three consecutive days, or
  - Emergency conditions related to repairs or water quality.

The WATER WATCH will be terminated following consideration of the following information:

- Have Treatment Plant operations been below 75 percent operating capacity for three consecutive days?
- When groundwater is the only source, have groundwater levels at the Oakdale Monitoring Well risen above a saturated aquifer thickness of 29 feet?
- Are the Smoky Hill River levels above 40 cfs at the Mentor Gage during the months of June through September and the river flow has not declined for seven consecutive days?
- Are the Smoky Hill River levels above 30 cfs at the Mentor Gage during the months of October through May and the river flow has not declined for seven consecutive days?
- Are there any emergency conditions related to repairs or water quality?
- What is the current and projected length of the drought?

- What is the short and long range precipitation forecast?
- What are the current and future releases from the Kanopolis Reservoir?

The City will continue to promote wise outdoor watering throughout the summer months.

The WATER WARNING will be terminated following consideration of the following information:

- Have Treatment Plant operations been below 90 percent operating capacity for three consecutive days?
- When groundwater is the only source, have groundwater levels at the Oakdale Monitoring Well risen above a saturated aquifer thickness of 27 feet?
- Are the Smoky Hill River levels above 30 cfs at the Mentor Gage during the months of June through September and the river flow has not declined for five consecutive days?
- Are the Smoky Hill River levels above 20 cfs at the Mentor Gage during the months of October through May and the river flow has not declined for five consecutive days?
- Are there any emergency conditions related to repairs or water quality?
- What is the current and projected length of the drought?
- What is the short and long range precipitation forecast?
- What are the current and future releases from the Kanopolis Reservoir?

Upon termination of a WATER WARNING, a WATER WATCH becomes operative.

The WATER EMERGENCY will be terminated following consideration of the following information:

- Have Treatment Plant operations been below 100 percent operating capacity for three consecutive days?
- When groundwater is the only source, have groundwater levels at the Oakdale Monitoring Well risen above a saturated aquifer thickness of 25 feet?
- Are the Smoky Hill River levels above 20 cfs at the Mentor Gage during the months of June through September and the river flow has not declined for three consecutive days?
- Are the Smoky Hill River levels above 15 cfs at the Mentor Gage during the months of October through May and the river flow has not declined for three consecutive days?
- Are there any emergency conditions related to repairs or water quality?
- What is the current and projected length of the drought?
- What is the short and long range precipitation forecast?
- What are the current and future releases from the Kanopolis Reservoir?

Upon termination of a WATER EMERGENCY, a WATER WARNING becomes operative.

Appendix F contains the recommended revised Water Conservation Plan. The City should draft an ordinance to implement the revised Water Conservation Plan and then submit the ordinance and revised Water Conservation Plan to the Kansas Water Office and the Division of Water Resources for review and approval. Once approved by the Chief Engineer of DWR, the City can move forward with passing the ordinance and implementing the revised Water Conservation Plan. The City should also revise their current Emergency Water Supply Plan to include the revised and approved Water Conservation Plan.

8.2 IMPACT OF PRIVATE WELLS

Private well owners hold a water right and are allowed to use the water as long as the domestic use for watering is less than two acres of land. The City does not currently have the authority to restrict water use from private wells. The 2007 Municipal Water Conservation Guidelines include a provision to allow the Chief Engineer of the DWR to restrict private well users under certain conditions. Per information from the Kansas Geological Survey (KGS) it is estimated that since 1974 approximately 1,400 private wells for lawn and garden or domestic use have been drilled in and around the City of Salina. Figure 8-4 shows the increase in the number of private wells since 1974 and that the major increase is in private lawn and garden wells.

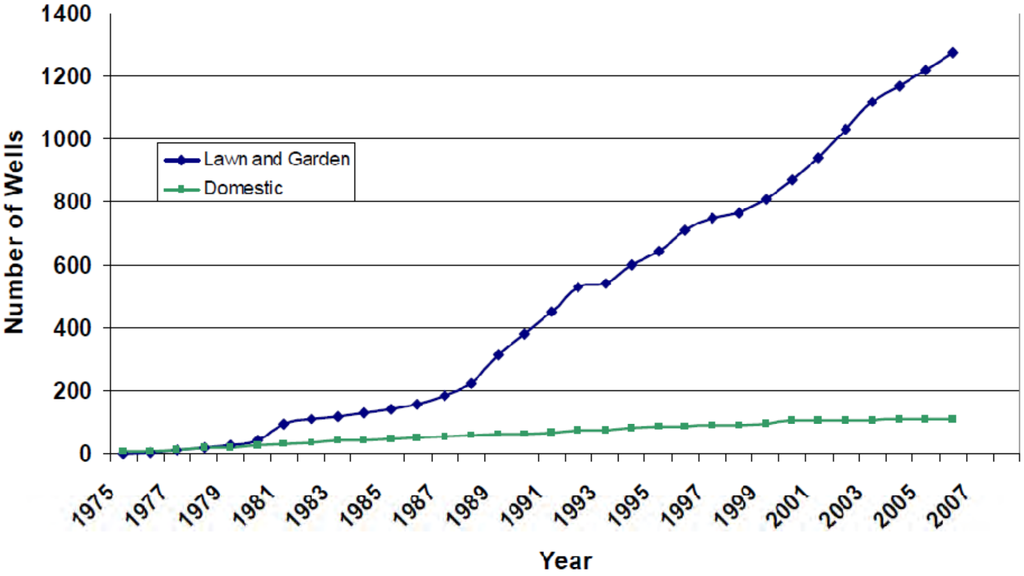


Figure 8-4
Domestic and Lawn/Garden Well Development In and Around the City of Salina
(Source: Kansas Geological Survey)

To verify this approximation of 1,400 private wells an internet search on the Kansas Geological Survey's water well database was completed. According to that database there are approximately 2,600 private wells used for domestic, lawn and garden, or irrigation purposes that are currently in use within Saline County. Therefore, it is assumed that the approximation of 1,400 private wells in and around the immediate area of the City of Salina is fairly accurate. However, there may be more wells if they weren't properly recorded to the state by the owner or driller.

A majority of these private wells are utilized for lawn and garden irrigation purposes. These private wells are pumping water from the same water supply source that the City of Salina utilizes for water supply for their customers. Per information from the KGS, Figure 8-5 shows the estimated increased water use from private wells since 1974 with the majority of the water use coming from private lawn and garden wells.

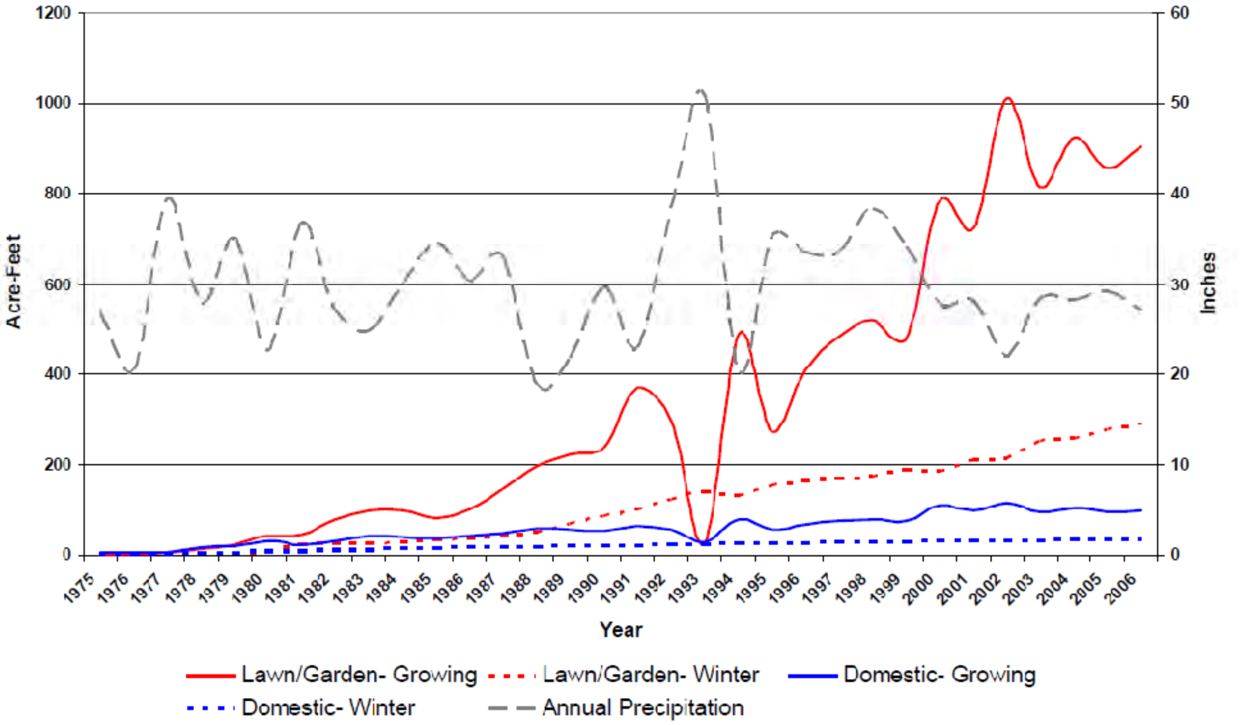


Figure 8-5
Estimated Private Well Water Use
(Source: Kansas Geological Survey)

As previously mentioned, regulating private wells during times when the City is not in a Water Watch, Warning, or Emergency can also be addressed in the City's Water Conservation Plan. Per the 2007 Municipal Water Conservation Plan Guidelines, the conditions under which domestic well owners may be required to implement water conservation measures include:

(1) when impairment to senior water rights is occurring,
(2) when a municipality with a common source of supply is experiencing a period of drought, and water watches, warnings or emergencies are in place, and
(3) when the waste of water is occurring.

The City of Salina could regulate the private wells based on the waste of water condition. According to a publication by the Kansas State University Extension Service, the morning is the most efficient time to water lawns and gardens because it is cooler and less evaporation loss occurs. Wind that can increase evaporation rates is also less likely to be a problem during the early morning hours. Watering during the afternoon hours when high evaporation, low humidity, and high winds occur is considered waste of water.

During these times the water applied has a higher percentage of loss than that actually put to beneficial use. The City currently has an ordinance prohibiting customers of the City's water distribution system from outdoor watering with potable water between the hours of 10:00 am and 6:00 pm, effective between June 1 and September 30.

On the basis of waste of water and per state statutes and the 2007 Municipal Water Conservation Plan Guidelines, the City can revise their current Water Conservation Plan and ordinance to indicate that watering during 10:00 am and 6:00 pm between June 1 and September 30 is considered a waste of water, which applies to all outdoor watering (including private wells) and shall be subject to watering regulations. Refer to Appendix F for a copy of the recommended revised Water Conservation Plan. As previously mentioned, the City should draft an ordinance to implement the revised Water Conservation Plan and then submit the ordinance and revised Water Conservation Plan to the Kansas Water Office and the Division of Water Resources for review and approval. Then the City can move forward with passing the ordinance and implementation of the revised Water Conservation Plan. It is highly recommended, but not required, that the City conduct a public meeting to explain the state statutes and proposed ordinance regarding regulation of private wells to the citizens and allow for public comment prior to any ordinance being passed.

8.3 WATER CONSERVATION MEASURES

As previously mentioned, water conservation can provide many benefits for the municipal water and wastewater utility, environment, and community. Some of these benefits include reduced energy and chemical use for water treatment, downsized or postponed expansions of water treatment facilities, and reduced costs and impacts on wastewater collection and treatment facilities. Common water conservation measures include customer education, water-efficient fixtures, water-efficient landscaping, economic incentives, and water-use restriction ordinances.

8.3.1 Existing Conservation Measures

Passive water conservation occurs with current regulations, natural replacement of fixtures, and new technologies. For example, current federal regulations (1992 Energy Policy Act) mandate that by 1994 new toilets sold in the U.S. must use no more than 1.6 gallons per flush and new showerheads sold in the U.S. must not exceed 2.5 gallons per minute.

The City has historically taken steps for water conservation through ordinances and other regulations. The City has in place the following water conservation measures:

- A water waste ordinance which defines waste of water
- An irrigation ordinance which prohibits outdoor watering during times of high evaporation (June – September)
- A water conservation rate structure which charges for the amount of water used and charges a higher rate for consumption above a certain level
- Informative inserts are included with water bills on a regular basis
- The City's website contains water conservation information
- Annual water festival for area grade school kids

- Periodic water conservation articles published by the local newspaper

8.3.2 Potential Conservation Measures

Additional conservation measures can delay the need for new sources of supply and associated infrastructure. One of the first steps in selecting potential conservation measures to be implemented is to identify criteria for evaluating the conservation measures. The criteria that were used in selecting conservation measures include:

- Program costs, cost-effectiveness, budgetary considerations
- Ease of implementation
- Staff resources and capability
- Legal issues or constraints
- Regulatory approvals
- Public acceptance
- Environmental impacts (reduced use of water and energy)
- Timeliness of water savings
- Ratepayer impacts
- Environmental and social justice
- Consistency with other programs

After reviewing information from numerous municipalities, a wide selection of potential water conservation measures was evaluated based upon the above criteria. These measures include system measures to reduce non-revenue water, outreach and education activities, distribution of plumbing hardware targeting specific customer categories, rebate programs, landscaping ordinances, conservation rate structures, and commercial and industrial incentive programs. Refer to Appendix G for a brief overview of each of the measures, including a description with pros and cons of each measure.

Outreach and education activities are critical to the success of any conservation program. These types of water conservation measures can directly produce water savings when customers change their water use habits, although these savings are often difficult to estimate. Public outreach and education alone may not produce the same amount of sustained water savings as other more direct approaches, but educational and informative measures can enhance the effectiveness of other conservation measures. There needs to be a balance between soft conservation efforts (outreach and education activities) and the hard, goal-based programs targeted to save gallons (reduction in non-revenue water, plumbing hardware distribution, rebate programs, etc.). More generally, customers that are informed and involved are more likely to support the City’s water conservation goals.

8.3.3 Recommended Conservation Measures

On December 18, 2008, the Citizen Advisory Board, which is a board made of up thirteen citizens at large specifically formed for the Raw Water Supply Study, was asked to fill out a simple rating worksheet on the potential water conservation measures listed. Based on the rating worksheets completed by the Citizen Advisory Board, Table 8-2 lists the top twenty specific water conservation measures in order of importance of implementation with the most important measures first. The rating worksheet included all the water conservation measures listed in Appendix G which includes water conservation measures that the City currently has in place. Including these allows for additional feedback on the measures to determine if continued implementation of these existing conservation measures is necessary.

Table 8-2
Top 20 Water Conservation Measures from Citizen Advisory Board

Order of Importance of Implementation	Type of Measure	Potential Water Conservation Measure	Total Points Received During Rating
1	Outreach and Education	Understandable and Informative Water Bill	33
2	Outreach and Education	Water Conservation Classes	32
3	Outreach and Education	Teaching Water Conservation in Schools	32
4*	Rate Structure	Water Emergency Water Rates	32
5*	Rate Structure	Conservation Based Water Rate Structure	31
6*	Outreach and Education	Conservation packets, brochures, newsletter articles, etc.	30
7*	System	Water Loss Control Program	29
8*	Outreach and Education	High Use Notifications	29
9*	Outreach and Education	Bill Inserts – Monthly Water Saving Tips	29
10	Commercial & Industrial Incentive Program	Commercial High-Efficiency Toilets	29
11	Outreach and Education	Public Awareness for Commercial & Industrial (placards, stickers, etc.)	29
12*	Outreach and Education	Water Conservation Website	28
13	Rebate Program	High Efficiency or Low Flow Toilets Rebate	28
14	Commercial & Industrial Incentive Program	Water Savings Project Program	28
15*	System	Water Meter Maintenance Program	27
16*	Outreach and Education	Local Newspaper Ads	27
17	Rebate Program	Rain Sensors Rebate	27
18*	Landscaping Ordinance	Water Waste Ordinance	27
19	Outreach and Education	Water Conservation Garden	26
20	Commercial & Industrial Incentive Program	Commercial Low Flow Toilets	26

* Currently being implemented by the City and should be continued

The top twenty water conservation measures from the Citizens Advisory Board include nine water conservation measures that are currently being implemented by the City. It is recommended that the City continue with these nine measures. Taking into consideration the ratings from the Citizen Advisory Board and our technical evaluation, it is recommended that the ten water conservation measures (not currently being implemented by the City) listed in Table 8-3 be implemented within the next five years as City staffing availability allows. These ten water conservation measures include a majority of the top twenty measures from the Citizen Advisory Board but also include a couple different measures recommended by technical staff in order to gain a good mix of different types of measures. These ten measures were chosen over the others because of the relative costs to implement the measures were minimal with regards to the potential water savings.

Table 8-3
Recommended Top Ten Water Conservation Measures

Order of Importance of Implementation	Type of Measure	Potential Water Conservation Measure	Approximate Annual Cost To Implement
1	Outreach and Education	Understandable and Informative Water Bill	Software Updates and Staffing
2	Outreach and Education	Water Conservation Classes	$5,000
3	Outreach and Education	Teaching Water Conservation in Schools	N/A
4	Outreach and Education	Public Awareness for Commercial & Industrial (placards, stickers, etc.)	$5,000
5	Commercial & Industrial Incentive Program	Commercial High-Efficiency Toilets	$100 x # of rebates + Staffing
6	Rebate Program	High Efficiency or Low Flow Toilets Rebate	$50 x # of rebates + Staffing
7	Rebate Program	High Efficiency Clothes Washer Rebate	$100 x # of rebates + Staffing
8	Outreach and Education	Water Conservation Garden	Include in all future public works projects
9	Ordinance	Xeriscape Ordinance	N/A
10	Rebate Program	Rain Sensors Rebate	$75 x # of rebates + Staffing

* The City should continue to implement all their current water conservation measures

The following are more specific details on the recommended water conservation measures:

1. Understandable and Informative Water Bill: This means going above and beyond the basic water bill and making sure customers are able to easily read and understand their water bill by identifying volume of usage (in gallons preferably), rates and charges, and other relevant information. For example, a bar graph showing the entire last years monthly consumption would allow customers to easily see their seasonal water usage habits. The main advantage of this is that it is provided to all customers and may reduce questions pertaining to water bills, water rates, etc. The main disadvantage of this is the cost involved with improving the water accounting software and training City staff on the improved software.

2. Water Conservation Classes: Water conservation classes could be offered to teach customers about water conservation. Classes could be held on different water conservation subjects such as how to irrigate efficiently, to inform customers on low water use plants, indoor water conservation, performing your own water audit, to discuss the City's water situation, etc. Two-hour classes could be held every three months with one class during the daytime hours and one at night to accommodate customers' different work schedules. As an incentive customers who participate in the class could be given a free rain barrel, a coupon to purchase low water use plants, free water conservation irrigation products, etc. The advantage of this is that the City can control the size of the program by limiting the number and size of classes and therefore it can be easily budgeted for. The main disadvantage of this is the cost involved to pay a qualified person to conduct the classes. The City could potentially team with local irrigation specialists, expert gardeners, etc. to conduct the classes rather than utilizing City staff only.

3. Teaching Water Conservation in Schools: Coordinating with the local board of education and providing simple and quick water conservation lessons that can be taught by teachers in classes. The EPA has WaterSense example lessons that could be utilized. The main advantage of this is that it helps the new generation become water conservation oriented and then the kids help to change water use practices at the family level.

4. Public Awareness for Commercial & Industrial: Offering free "Water Conservation" placards, decals, stickers, posters, etc. for commercial and industrial customers to display at their businesses. For example "Please Use Wisely" stickers could be given to commercial and industrial customers to be affixed to the mirrors above all sinks. The main disadvantage is the cost to provide the public awareness items but this could be minimized by purchasing the items in bulk.

5. Commercial High-Efficiency Toilets: A high efficiency toilet is defined as a toilet that flushes at 20 percent or better below the standard 1.6 gallons per flush which is required by federal law. There are three categories of high efficiency toilets: dual flush, gravity flush, or pressure-assist models. The City could offer a rebate per toilet to commercial customers who replace old high-water using toilets with high-efficiency toilets that use an average of 1.28 gallons per flush or less. The City would have to make sure that the old high-water using toilet was rendered inoperable and was not available to be sold for reuse. The

City would also need to schedule an inspection of the installed high-efficiency toilet prior to issuing a rebate. The main advantage is that this would target high-traffic, high-use toilets (i.e. restaurant toilets). The disadvantage of this is the cost of providing the rebates and staffing to administer a rebate program and perform the inspections. The cost of providing the rebates could be minimized by the City controlling the size of the rebate program by limiting the number and amount of the rebates. For example if the City chose to provide 1,000 rebates in the amount of $100 each for one year (limit 3 per customer) then the cost of the rebates could not exceed $100,000 plus the cost of staffing. The City could possibly do this rebate the first year followed by the residential rebates the subsequent years to limit the cost of the rebate program each year.

6. <u>High Efficiency or Low Flow Toilets Rebate (Residential):</u> Toilets account for approximately 30 percent of indoor residential water use. Toilets also happen to be a major source of wasted water due to leaks and/or inefficiency. Provide a rebate on high-efficiency or low flow toilets. The main advantage is that this would be available to all customers—all homes have a toilet. The disadvantage of this is the cost of providing the rebates and staffing to administer a rebate program and perform the inspections. The cost of providing the rebates could be minimized by the City controlling the size of the rebate program by limiting the number and amount of the rebates. For example if the City chose to provide 2,000 rebates in the amount of $50 each for one year (limit 1 per customer) then the cost of the rebates could not exceed $100,000 plus the cost of staffing. The City could possibly do this rebate one year and the clothes washer rebate the next year and the rain sensors rebate the following year to limit the cost of the rebate program each year.

7. <u>High Efficiency Clothes Washer Rebate:</u> Washing clothes accounts for approximately 15 percent of indoor residential water use. High efficiency clothes washers can save approximately 14 gallons of water a day or more than 75,000 gallons over the washer’s lifetime. Clothes washers also require less energy to heat water for warm wash cycles which lowers your energy use. By installing a high efficiency washer one can reduce energy costs by approximately 50% and lower water and sewer costs by approximately 35-50%. Provide a rebate on ENERGY STAR labeled clothes washers with a maximum water factor of 7.0 or lower. The main advantage is that this would be available to a majority of the customers—a majority of all homes have a clothes washer. The disadvantage of this is the cost of providing the rebates and staffing to administer a rebate program and perform the inspections. The cost of providing the rebates could be minimized by the City controlling the size of the rebate program by limiting the number and amount of the rebates. For example if the City chose to provide 1,000 rebates in the amount of $100 each for one year (limit 1 per customer) then the cost of the rebates could not exceed $100,000 plus the cost of staffing. The City could possibly do this rebate one year and the rain sensors rebate the following year to limit the cost of the rebate program each year. The City could also look into asking Westar Energy to team with the City to provide these rebates as this is a water saver and energy saver measure.

8. <u>Water Conservation Garden:</u> A water conservation garden would be a City owned and maintained garden/landscaping area that shows citizens an example of how to landscape utilizing water conservation measures such as xeriscaping. The advantage of this is that the City would lead by example by providing a

visible example to the customers. The only disadvantage is the cost to install which could be minimized by incorporating a water conservation garden into a future City project (i.e. new aquatic park with a water conservation garden near the entrance).

9. Xeriscape Ordinance: Xeriscaping is a systematic approach to landscaping that uses plants selected for their water efficiency. Basically it means planting native and low-water-use grasses, trees, shrubs, flowers, and groundcovers to minimize the amount of irrigation that is necessary. Also, plants are grouped in the landscape area according to their different water needs so they can be irrigated separately and efficiently. The ordinance could just encourage xeriscape landscaping or could actually put a limitation on the amount of water intensive landscape/turf area for certain customer classes. The main advantage of this is there could potentially be a substantial amount of irrigation cost savings to the customers to do this. The main disadvantage of this is that it is a totally different way to landscape. People aren't generally accustomed to the look of a xeriscape and there's the cost of replacing existing landscaping. Potentially the ordinance could be for all new construction.

10. Wireless Rain Sensors Wireless rain sensor devices automatically shut off automatic sprinkler systems during and after rain events and then allow the system to go back to normal cycle operation mode when the sensor dries out. This provides an advantage by controlling the use of automatic sprinklers and reduces irrigation demand which is the largest use. The City could control the rebate program by limiting the time period or number of rebates given. The disadvantage it is only targets customers with existing in ground irrigation systems

It is hard to determine which measures will be successful and which will not, therefore it is recommended that all the water conservation measures be re-evaluated on a regular basis (i.e. annually). Each measure will need to be evaluated in a different way. For example the water meter maintenance program and water loss control program can be evaluated by analyzing the percent water loss each year. The City must be willing to change direction as necessary, based on the regular evaluations, to continue to do more of what is working and less of what is not. The City should utilize the information in Appendix F to implement additional or different water conservation measures in the future, as necessary.

8.4 WATER CONSERVATION RATE STRUCTURES

To promote water conservation and water efficiency, water rate structures must communicate the true cost of water. Only if the price of water reflects the economic value of water will customers know whether it is "worth it" to conserve water. The true cost of water includes: (1) operation, maintenance, and replacement costs; (2) the costs to procure and develop additional water supplies to meet growing demands; and (3) the social and environmental "opportunity costs" of losing other benefits of the water in order to develop and consume the water (i.e. ecological and recreation values of river basins, local economies, values of river flows for diluting pollutants, etc.). Failing to integrate all of these true costs into a water rate structure is equivalent to the City subsidizing the cost of water. Furthermore, if the retail cost of water is lower than its value, customers lack an incentive to conserve water.

8.4.1 Existing Water Rate Structure

Generally, customers respond to price, therefore higher water rates lead to lower water consumption/use. Because some types of water use are necessary in daily life, basic water use will not change significantly with price whereas other non-essential water use, such as lawn watering, should be reduced in response to higher rates. By structuring water rates to be more expensive at certain usage levels or during certain time periods, customers will be encouraged to consume less water during peak water use periods and generally less water overall.

The City's proposed water rate structure for 2009 is an excess use rate structure in which customers are charged for the water used with a higher rate for consumption/use above a certain level. The excess use rate structure is a type of water conservation rate structure that is fair to all customer types and effectively encourages efficient water use year round. The following page describes the City's water rate structure for 2009.

8.4.2 Recommendation Modifications

It is recommended that the City evaluate the effectiveness of the existing excess use rate structure after it is in place for an entire year. If the existing water rate structure does not appear to yield water efficiency and water conservation by decreasing the annual gpcd and reducing the seasonal peaks in water usage, then the City should continue with the excess use rate structure but consider implementing one of the following modifications:

- Eliminate the Excess Use Baseline and the Minimum Winter Quarter Average (MWQA) and then base the excess use charge on 120% of the Winter Quarter Average (WQA) in order to promote further water conservation
- If possible, utilize a portion of the revenue from the excess use rate to fund the previously recommended water conservation measures
- Raise rates to fund any proposed improvements for future raw water supply or distribution system improvements
- Implement emergency water rates during a water emergency by doubling the excess use charge.

Customer Charge (O.F.C)

5/8” Meter	$4.44
3/4" Meter	$7.07
1” Meter	$9.60
1-1/2” Meter	$14.89
2” Meter	$24.06
3” Meter	$63.15
4” Meter	$63.15
6” Meter	$167.82
8” Meter and above	$353.14

Consumption Charge per 100 C.F.

Unit Block Rate – Metered Consumption above Excess Use Baseline	$2.34
Excess Use Charge – Metered Consumption above Excess Use Baseline	$4.68
Metered Consumption for All Irrigation Meters	$4.68

Rate Outside City

Customer Charge	Double Inside Rate
Consumption Charge	125% Inside Rate

Winter Quarter Average (WQA) shall be defined by adding the metered water consumption on bills rendered during the months of January, February, and March and then dividing the sum by the number of billings (three). Each customer’s WQA shall be recalculated in April of each year. This WQA shall be utilized for the following months of May through April.

Minimum Winter Quarter Average (MWQA) shall be defined as 800 cubic feet.

In those instances where no water consumption data exists for the calculation of a WQA for a customer, the Director of Utilities or designated representative shall determine the most appropriate method of establishing the WQA.

Excess Use Baseline shall equal the greater of 120% of the WQA or 120% of the WMQA.

Excess Use Charge shall apply to: (1) all commercial and industrial irrigation meters (2) any use in excess of the Excess Use Baseline.

A customer with metered water consumption greater than three million cubic feet (3,000,000 CF) per year shall be charged at the Unit Block Rate for all consumption. This customer must have a Water Conservation Plan and the plan must be approved by the Director of Utilities.

8.5 WATER LOSS ANALYSIS

As water supplies become strained, the control of water loss within a water system becomes more important. All raw water that is diverted and treated is intended to be sold to customers and not lost.

Confusing terms and definitions make it difficult to address water loss issues. The terms 'water loss' and 'unaccounted for water' are used somewhat interchangeably. For purposes of this study and per the Kansas Water Office and Division of Water Resources, unaccounted for water is defined as the amount of water that is diverted minus the metered amount of water that is sold to customers, other public water suppliers, and water that is distributed as free water.

Unaccounted for water consists of two basic components: water lost from the distribution system (real losses) and water used but not documented and paid for (apparent losses). In most municipal water distribution systems the following are the main potential sources of unaccounted for water:

- <u>Water main breaks and leakage</u> - The largest portion of unaccounted for water is typically lost through water main leaks because they often go undetected for long periods of time. Water main breaks and leaks can be attributed to a number of factors including, poor design, improper installation, poor thrust restraints, joint failure or aged pipe.
- <u>System pressure</u> - Water pressure within the distribution system can affect unaccounted for water in many ways. High pressure can lead to higher break rates. High pressure can also lead to higher leakage rates once a leak or break has occurred. Once the distribution system has been laid out and pressure zones have been established, it is difficult to reduce pressure in an area.
- <u>Fire fighting</u> - Water used for fire fighting is typically over short periods of time and usually accounts for less than 1 or 2 percent of total production. Water used for occasional fire-hydrant flow testing also does not account for a significant portion of unaccounted for water.
- <u>Water main flushing</u> - Water main flushing through fire hydrants results in a significant volume of water because virtually all water mains in the distribution system are flushed.
- <u>Meter under registration</u> - Most water meters tend to register less water than is actually used as they become older.
- <u>Theft of water</u> - Water can be stolen from hydrants. Water can also be stolen at services by removing the meter or tapping into a service line upstream of the meter.

8.5.1 Existing Water Loss

Water loss from public water suppliers is tracked by the Kansas Water Office through the annual municipal water use reports that public water suppliers must submit to the DWR. The annual DWR reports divide the municipal raw water diverted into five categories:

- Water Sold to Other Public Water Suppliers
- Water Sold to Industrial, Stock, and Bulk Customers
- Water Sold to Residential and Commercial Customers
- Metered Water Provided Free (water used for treatment processes, etc.)
- Unaccounted for Water (losses within the system that are not metered—i.e. water main leak and breaks, fire fighting, hydrant flushing, etc.)

The Kansas Water Office has an objective by 2010 to reduce the number of public water suppliers with excessive "unaccounted for" water by first targeting those with 30 percent or more "unaccounted for" water. Table 8-4 shows water loss data from the City's DWR reports for the last seven years (2001-2007). As shown the unaccounted for water has averaged 12.3% which is well below the targeted 30%.

Table 8-4
Water Loss Data from DWR Municipal Use Reports (2001 – 2007)

Year	Raw Water Diverted (MG)	Water Sold to Other Public Water Suppliers (MG)	Water Sold to Industrial, Stock, and Bulk Customers (MG)	Water Sold to Residential and Commercial Customers (MG)	Metered Water Provided Free (MG)	Unaccounted for Water (MG)	% Water Loss (%)
2001	2,445	27	285	1,830	52	252	10.3
2002	2,708	28	278	1,971	61	370	13.7
2003	2,460	27	245	1,830	51	306	12.4
2004	2,363	27	273	1,711	51	301	12.7
2005	2,406	29	265	1,894	48	269	11.2
2006	2,422	28	271	1,720	55	347	14.3
2007	2,288	24	300	1,652	54	259	11.3
						MINIMUM	10.3
						AVERAGE	12.3
						MAXIMUM	14.3

The City's percent water loss has been fairly consistent over the last five years and within reasonable water loss percentages for typical communities. This means the City's current water loss measures have aided in good control of their system's water loss. Current water loss measures implemented by the City are quick response to water main breaks, system pressure management, and a meter maintenance program.

8.5.2 Recommended Modifications

In order to further decrease the percent water loss the City should implement additional measures. These additional measures could consist of one or more of the following:

- Scheduled replacement of aged or deteriorated water mains – The City should be proactive and replace aged and deteriorated water mains annually via capital improvement projects.
- Improved system pressure management – The City should continue to monitor and manage system pressure in order to decrease the amount of pressure-related water main breaks that occur. Based upon the recently completed hydraulic model of the City's distribution system, the City could determine which areas have the highest probability of excessive pressure due to the location of storage tanks,

pumping stations, and changes in elevation. If the pressure at these locations cannot be reduced without adversely affecting other areas of the distribution system, then the age and condition of those water mains should be noted and evaluated to determine if water main replacement is necessary. The City should also try to eliminate any excessive water hammer conditions.

- Directional water main flushing – Traditional flushing consists of opening of a fire hydrant until the water clears up or disinfectant residuals increase. Directional flushing consists of closing valves within the distribution system and then opening a fire hydrant to maximize the velocity in the pipes being flushed. This type of water main flushing does require additional labor hours to close/open valves but it uses approximately 40% less water than traditional flushing methods by creating higher velocities for more efficient pipe cleaning thereby decreasing amount of time necessary to flush the mains. Other benefits of directional water main flushing include: immediate water quality improvement, allowing for simultaneous preventative maintenance activities such as valve and hydrant exercise, and minimal rusty water disturbance to surrounding areas. With the recent completion of a computerized hydraulic model by others, the City may want to utilize this hydraulic model to develop a directional flushing program to enhance the current operations.
- Improved meter maintenance program – The City should continue to improve their existing meter maintenance program. To reduce the amount of meter under registration it is recommended that the City implement a meter replacement program so that all service meters are replaced based on their age approximately every 15 to 20 years.

8.6 DEMAND IMPACTS FROM WATER CONSERVATION

If any of the water conservation measures within this report are implemented it is assumed that there will be a reduction in the water demand projections that were discussed in Chapter 4. These water demand projections will not be recalculated based on the fact that this reduction in water demand will vary. It is estimated that water conservation, in general, could yield up to a 5% reduction in average daily per capita water usage (gpcd). This reduction in the water demand will only delay the need for additional water supply therefore water reuse and supply source alternatives should still be evaluated.

9 WATER REUSE EVALUATION

The direct reuse of treated wastewater effluent for potable uses may or may not be publicly acceptable, but reductions in potable water demands by watering public parks, athletic fields, golf courses, and commercial or municipal properties by utilizing treated wastewater effluent can stretch the water supply during periods when it is the most valuable. The objective of this Chapter is to define and evaluate potential water reuse options such as irrigation, industrial use, and groundwater recharge, and examine water reuse regulatory requirements and the impacts water reuse has on water rights in terms of reduced discharges to the Smoky Hill River.

Under the broad definition of water reclamation and water reuse, sources of reclaimed water may range from industrial process waters to the tail waters of agricultural irrigation systems. For the purpose of this study, the source of reclaimed water will be focused on the treated effluent discharged from the City's municipal wastewater treatment facility.

9.1 REGULATORY REQUIREMENTS

Currently there are no federal regulations governing water reuse practices in the United States, although there are published federal guidelines. Therefore, state regulatory agencies develop water reuse regulations to reduce threats to public health and the environment. Before examining the state regulations and federal guidelines it is important to first understand the difference between regulations and guidelines. Regulations are legally adopted, enforceable, and mandatory whereas guidelines are advisory, voluntary, and non-enforceable. However, guidelines can be incorporated into permits and thus become enforceable requirements.

9.1.1 State Regulations

The KDHE Bureau of Water is responsible for regulations pertaining to water reuse in the State of Kansas. Current published requirements only address use of treated wastewater effluent for irrigation purposes. Table 9-1 summarizes KDHE's current minimum design requirements for land application of treated municipal wastewater effluent. These design standards are for irrigation-oriented systems which are defined as municipal wastewater treatment systems that can meet National Pollutant Discharge Elimination System (NPDES) effluent limitations for discharge to surface waters and therefore the treated effluent is utilized as needed for supplemental water and is not an integral component of the overall wastewater treatment process (i.e. non-discharging wastewater treatment lagoon facilities). There are no wastewater effluent storage requirements for irrigation-oriented systems.

Suitability of reclaimed water for industrial uses would likely be dependant on the type of process the industry uses. Industries that require a high quality of water, such as food manufacturing facilities, would likely not allow reclaimed water and KDHE would likely not permit water reuse for such purposes. However, industries that use water for manufacturing processes, cooling systems, or other similar purposes may allow reclaimed water for their water source. KDHE does not currently have any specific requirements for industrial applications.

Table 9-1
Summary of KDHE Minimum Design Requirements for Effluent Reuse
(KDHE, 1978)

Projected Use of Effluent	Minimum Required Treatment Level for Irrigation Oriented (Periodic Discharge to Surface Waters)	Site Protection Requirements	Loading Rates for All Uses
Athletic fields, highway rest areas, or public parks with a high probability of body contact	Secondary Treatment[(1)] Filtration Disinfection	No separation, buffer zone and tail water control requirements. Public use prohibited during irrigation and 8 hours thereafter	• Maximum daily application rate of 3 inches per day per acre • Maximum annual application rate of 40 inches per acre • Based on soil and crop moisture and/or nutrient requirements
Golf courses or public parks with a low probability of body contact	Secondary Treatment[(1)] Disinfection	No separation, buffer zone and tail water control requirements. [(2)]	
Airfields, farmland, and other properties owned or leased by the municipality	Secondary Treatment[(1)]	Irrigation to be conducted by employees of the permittee. Crops suitable for direct human consumption without processing shall not be irrigated. Tail water control practices or provisions are to be provided. [(3)]	
Farmland and properties not owned or leased by the municipality	Secondary Treatment[(1)]	Irrigation to be conducted by individual(s) under contract with municipality. Crops suitable for direct human consumption without processing shall not be irrigated. Tail water control practices or provisions are to be provided. [(3)]	

(1) Secondary treatment includes effluent from approved lagoon systems when withdrawn from the final cell above the two foot operational level.

(2) Use of treated effluent to cool golf greens during playing hours is prohibited. Consideration should be given to using a potable water connection to the golf course irrigation system for green cooling purposes or use of a portable watering tank. Suitable backflow prevention measures must be incorporated into the design to prevent backflow or siphonage into the potable water system. The effluent irrigation system must be drained prior to connection with any potable water source.

(3) Irrigation oriented systems shall provide tail water management or facilities unless applied runoff meets permit effluent limitations and would directly enter a defined water course.

9.1.2 Federal Guidelines

The EPA published *Guidelines for Water Reuse* in 1992 in order to present and summarize water reuse guidelines for the benefit of water utilities and state regulatory agencies. The EPA took the position that federal water reuse regulations were not necessary and that their guidelines, in conjunction with state regulations, would be adequate. The EPA's guidelines were updated in 2004 to include technological advances, research data, and other information gathered in the last decade (EPA, 2004).

KDHE's current minimum design criteria do not address using treated wastewater effluent for groundwater recharge of aquifers that are used for municipal water supply. As a result, the federal guidelines will be used as a basis for discussion. The federal guidelines describe suggested treatment, water quality standards, monitoring, and setback distances from potable water sources. KDHE could adopt similar guidelines into a permit if groundwater recharge using treated wastewater effluent were pursued.

Guidelines for groundwater recharge depend on the type of recharge implemented. Methods of groundwater recharge were discussed in Chapter 7 and include recharge by infiltration ponds or direct injection wells. Groundwater recharge by infiltration into the aquifer would likely require water that meets drinking water standards after percolation through the vadose zone to the unconfined aquifer. This may be as simple as secondary treatment and disinfection at the wastewater treatment plant if enough treatment is provided by percolation through the soil profile to meet drinking water standards. A pilot study is needed to determine if percolation through the soil profile will treat the water to drinking water standards. If not, advanced wastewater treatment or water treatment processes may be required and are dependent on the soil profile characteristics. The guidelines recommend that the water be retained in the aquifer for a minimum of six months prior to withdrawal for adequate mixing and additional treatment in the aquifer system. A recharge pond that uses treated wastewater effluent should be located a minimum of 500 feet from the public water supply wells to minimize negative impacts (EPA, 2004).

Groundwater recharge by direct injection wells into the aquifer likely requires water of drinking water quality standards prior to injection per the guidelines. This may include the addition of advanced wastewater treatment or water treatment processes. The federal guidelines recommend that the water be retained in the aquifer for a minimum of nine months prior to withdrawal for adequate mixing and additional treatment in the aquifer system. An injection well that uses treated wastewater effluent should be located a minimum of 2,000 feet from the public water supply wells to minimize negative impacts (EPA, 2004).

9.1.3 Approval Process

KDHE must be involved in the planning and design phases of a water reuse project from the beginning. Prior to the permitting of a water reuse project, the City would be required to submit a preliminary report to KDHE describing the scope of work for the reuse project. From this report KDHE will determine the potential risks to public health and environment that may exist with implementation of the project and if approvable, draft a new NPDES permit. The preliminary report should include the following information:

- Nature of reuse proposed
- Description of the existing wastewater treatment plant
- Significant industrial contributors to the wastewater treatment plant
- Volume of treated wastewater to be used for reuse versus what is normally discharged to the river
- Proposed reuse sites and intended use
- Estimated groundwater depth and site flooding potential
- Soil types and permeability

- Anticipated water management scheme
- Location of facilities for the water reuse system

The process described above could take as long as 90 days for irrigation requests to achieve an approvable reuse proposal with KDHE. Water reuse for purposes other than irrigation could take longer than 90 days as KDHE has not typically permitted these projects in the past. Once preliminary approval is obtained from KDHE, the NPDES permit for the existing wastewater treatment plant would be updated to include the new discharge locations (irrigation and/or industrial sites that are allowed to reuse the effluent). If the reuse program includes irrigation, special condition requirements would likely be added to the City's existing NPDES permit. The following are special conditions for irrigation that KDHE has recently imposed on other Kansas municipalities:

1. Irrigation shall occur only at times when public access to the irrigated area is restricted.
2. Irrigation of crops produced for direct human consumption shall be prohibited.
3. Irrigation shall be limited in such a manner as to avoid runoff of effluent to adjacent landowners.
4. Irrigation shall be conducted in such a manner as to prevent ponding of treated wastewater on the ground surface.
5. Irrigation spray shall not be allowed to fall or drift on areas used for picnicking, public drinking fountains, potable water hose bibbs, private residences or any other areas where food and drink is routinely prepared or served.
6. Signs bearing the following warning must be posted around any treated wastewater holding pond: RECLAIMED WASTEWATER. DO NOT DRINK OR SWIM.
7. Signs bearing the following warning must be posted at any hose bibb which can discharge treated wastewater: RECLAIMED WASTEWATER. DO NOT DRINK.
8. Cross-connections between treated wastewater water lines and potable water supply lines shall be prohibited.
9. For Golf Course Treated Wastewater Holding Ponds:
   A notice shall be placed on the golf course score cards indicating the holding ponds and irrigation system contain treated wastewater.
10. For Parks, Ball Fields, Cemeteries, Recreational Areas, etc.:
    Signs shall be placed at the entrance or other suitable conspicuous places indicating the area is irrigated with treated wastewater.
11. All monitoring of the treated wastewater shall be conducted using EPA approved methods and KDHE certified laboratories if applicable.
12. The results of the analyses shall be reported in conjunction with the monthly discharge monitoring reports. If the irrigated facility conducting the sampling and receiving the test results is not the permittee or controlled by the permittee, the irrigated facility is expected to report the results to the permittee within five days of receiving the results so permittee can transmit the result to KDHE with the monthly discharge monitoring report.
13. Maintenance repairs to the system may be tested at any time provided public access to the irrigated

area is restricted and the system operator (or maintenance personnel) is present at the irrigated site during the entire test.

Additional monitoring and water quality limitations of the effluent for irrigation may be added to the NPDES permit for any calendar months in which the effluent is reused for the new outfalls that are added (irrigation/industrial sites). The additional requirements are dependant on the type of water reuse. For example, reuse for irrigation purposes may require sampling of chlorine residual, fecal coliform, BOD, and other water quality parameters at each outfall site (industrial/irrigation site) with associated limitations. KDHE determines on a site-by-site basis if groundwater monitoring for a particular irrigation site is required.

After the NPDES permit is revised the draft permit is placed on public notice for comment. The public comment period and final approval can take up to 90 days. Final approval by KDHE is the issuance of the new NPDES permit. Once the final NPDES permit is issued, the City may be required to maintain records describing the date, location, and quantity of effluent applied to the land for submittal to KDHE along with the remaining NPDES monitoring requirements.

9.2 EXISTING CONDITIONS

The first step in determining if the City's treated wastewater effluent can be utilized for various water reuse applications is evaluating the quantity and quality of the effluent.

9.2.1 Wastewater Effluent Quantity

All wastewater treatment systems have hourly, daily, and seasonal flow rate variations. These flow rate variations will have a direct effect on the potential for water reuse. Figure 9-1 and Table 9-2 show daily influent flow rates at the wastewater treatment plant for years 2005 through 2007. As shown in Figure 9-1 the influent flow to the wastewater treatment plant is fairly stable and does not decrease during drought periods (such as the summer of 2006) but does increase in conjunction with heavy rain events. The low influent flows shown in Figure 9-1 are likely dry weather periods where the flow is mostly domestic usage.

Table 9-2
WWTP Daily Average Influent Flow Statistics
2005 – 2007

Year	Average Flow (MGD)
Minimum	3.04
Average	4.65
Maximum	16.10 (1)

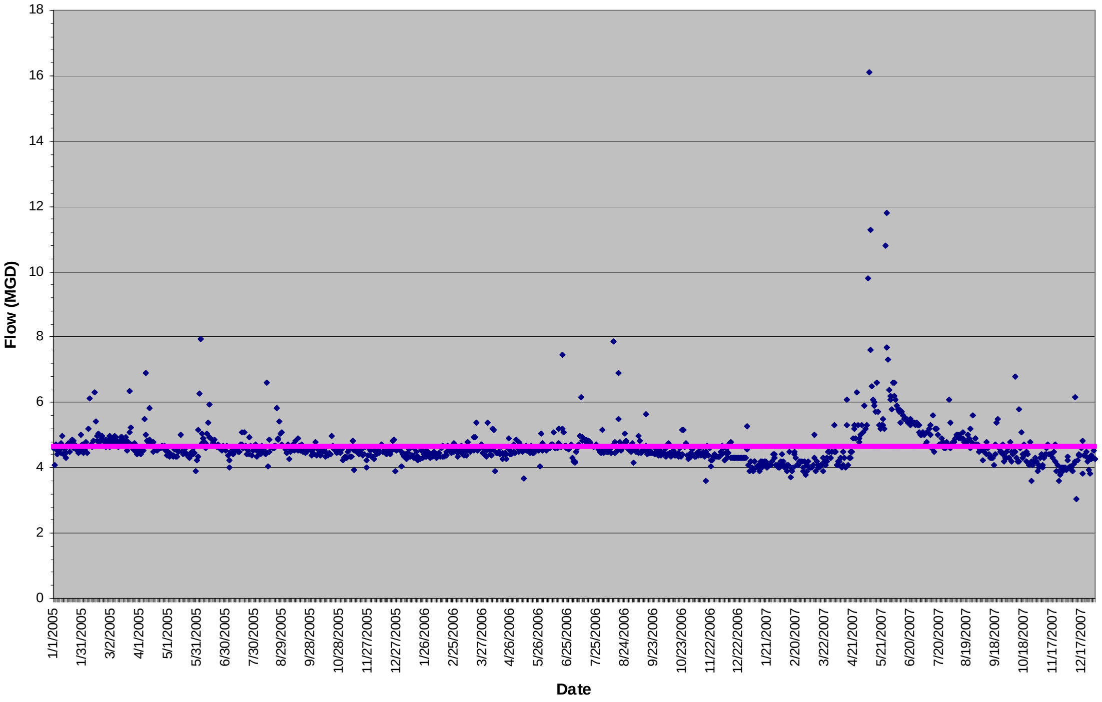


Figure 9-1
WWTP Daily Influent Flow
2005 - 2007

It is assumed that wastewater influent flow is approximately equal to effluent flow. As a conservative approach, the minimum average influent flow is considered as being available for water reuse purposes. Therefore, even during dry weather periods when influent flow is at the minimum there is still an adequate amount of effluent for reuse when irrigation demand is high. Based on the influent flow data, the minimum amount of reliable wastewater effluent available for reuse is approximately 3.0 MGD. Water conservation could decrease the minimum amount of flow into the wastewater plant; however, the minimum will also likely increase in the future with increasing population.

9.2.2 Wastewater Effluent Quality

The quality of the wastewater effluent discharged from the City's existing wastewater treatment facility is monitored and must meet the effluent limitations set forth in their current NPDES permit. Table 9-3 summarizes the City's current NPDES permit effluent limitations. The City's current permit will expire on December 31, 2009, when a new permit will be issued with possibly new permit effluent limitations. For the purposes of this study it will be assumed that all future issued NPDES permits will impose stricter effluent limitations.

Table 9-3
Current NPDES Permit Limits
Kansas Permit No. M-SH33-IO01
Federal Permit No. KS0038474
(PEC, 2007)

Parameter	Current NPDES Permit Limit
BOD_5 (Monthly Average)	30 mg/l (Jan – May & Sept – Dec)
	25 mg/l (Jun – Aug)
BOD_5 (Weekly Average)	45 mg/l (Jan – May & Sept – Dec)
	40 mg/l (Jun – Aug)
TSS (Monthly Average)	30 mg/l
TSS (Weekly Average)	45 mg/l
Ammonia (Monthly Average)	10.0 mg/l (Nov – Feb)
	6.7 mg/l (Mar, Apr, Oct)
	5.5 mg/l (May)
	3.8 mg/l (Jun)
	3.1 mg/l (Jul)
	3.2 mg/l (Aug)
	4.5 mg/l (Sep)
Ammonia (Daily Maximum)	10.0 mg/l
E. Coli (Monthly Geometric Mean) (1)	160 colonies/100ml (Apr – Oct)
	2,358 colonies/100ml (Nov – March)
pH	6.0 – 9.0
Dissolved Oxygen	6.0 mg/l
Chlorides	Monitor
Sulfates	Monitor
Total Phosphorus	Monitor
Total Kjeldahl Nitrogen	Monitor
Nitrate	Monitor
Nitrite	Monitor

(1) Parameter changed from fecal coliform to E. Coli as of July 1, 2008

As discussed previously, KDHE would likely issue a new NPDES permit with water quality limitations for the irrigation sites. In the past KDHE has added limitations for irrigation sites for chlorine residual and fecal coliform (now E. Coli). For example, KDHE requires a limit of 20 colonies/100 mL (monthly geometric average) for fecal coliform in Park City, Kansas for each irrigation site. Park City uses treated wastewater effluent for the irrigation of several properties including golf courses and some private use areas (KDHE, 2002). The E. Coli limit would most likely be decreased from the typical NPDES requirement for irrigation sites if irrigation is to occur in areas with a high probability of body contact. In addition, in most cases of irrigation with treated wastewater effluent KDHE applies a minimum chlorine residual at the irrigation site; if the City were to treat the reuse water with chlorine, this minimum chlorine residual would apply. However, if the City uses ultraviolet (UV) disinfection for the reuse water as they currently do for the wastewater that is discharged to the river, a minimum chlorine residual would not apply.

For this study the City provided water quality data from the treated wastewater effluent for years 2005 – 2007 for cBOD, TSS, ammonia, pH, phosphorus, nitrogen, sulfates, chlorides, and nitrates. Table 9-4 presents a summary of this water quality data.

Table 9-4
Summary of Wastewater Quality Data
2005-2007

Parameter	Average Concentration (mg/L)	Maximum Concentration (mg/L)	Minimum Concentration (mg/L)
Ammonia-N	0.48	20.1	0.10
CBOD	4.29	17.6	0.00
pH	6.71	7.35	5.51
TSS	9.00	42.7	1.40
Phosphorus-P	4.50	6.05	1.20
Total Nitrogen-N	23.7	33.0	13.0
Nitrate-N	19.8	32.0	1.90
Sulfates	208.8	262.0	164.0
Chlorides	262.5	357.0	194.0

As discussed previously, the suitability of the treated wastewater for industrial purposes is dependent on the particular industry; therefore, the discussion of wastewater quality will be focused on it’s suitability for irrigation purposes. The effects of physical parameters such as pH and chemical constituents such as chlorides, sodium, heavy metals, and trace organics, on turf and other vegetation, soil, and groundwater are well known, and recommended limits have been established for many constituents. Most irrigation in Salina will be for turf grass on athletic fields, golf courses, and other urban areas. The quality of the water used for irrigation can have an impact on the soil quality and the performance of the turf grass. Of special importance are salinity, pH, and nutrients.

Salinity is the most important parameter in determining suitability of reclaimed water for irrigation. It is generally expressed as a measure of electrical conductivity or TDS. The salinity of the irrigation water can impact the plant’s ability to uptake water (osmotic potential of the soil), toxicity of particular ions, and degradation of the soil’s physical conditions. The data provided by the City did not include TDS as it is not currently required to be monitored by the NPDES permit. For the purposes of this study, it is assumed that the TDS is approximately 1,100 to 1,200 mg/L, which is a typical value for trickling filter plants in Kansas (KDHE, 1978).

Excess salts can affect turf and other landscape vegetation production and quality as well as soil quality. Salt has the following effects on crop yield and quality:

- Soluble salts damage plants through an osmotic effect. Water moves from areas of low salt concentration (plant roots) to an area of high salt concentration (soil). Therefore, soils with high salt content causes plants to stress from water moving out of the roots into the soil and causes the plant to wilt even when the soil is wet.
- Soluble salts in irrigation water can desiccate (burn) leaf tissue when applied to foliage.

Irrigation water can be classified by its salt hazard, as shown in Table 9-5.

Table 9-5
Salinity Hazard and Effect on Vegetation
(Ayers, 1977)

Total Dissolved Solids (mg/L)	Salinity Hazard and Effects on Management
Below 160	Very low hazard. No detrimental effects on plants and no soil buildup expected.
160 to 480	Low hazard. Sensitive plants may show stress; moderate leaching prevents salt accumulation in soil.
480 to 1,280	Medium hazard. Salinity may adversely affect plants. Requires selection of salt tolerant plants, careful irrigation, good drainage, and leaching.
1,280 to 1,920	Medium-high hazard. Will require careful management to raise most crops.
Above 1,920	High hazard. Generally unacceptable for irrigation, except for very salt-tolerant plants where there is excellent drainage, frequent leaching, and intensive management

In addition to Table 9-5, KDHE minimum design criteria suggest that wastewater containing more than 1,250 mg/L of TDS may cause salt injury to sensitive vegetation (KDHE, 1978). The level of TDS potentially experienced at Salina's wastewater treatment plant could be described as a medium hazard to some vegetation. The level of potential injury to vegetation depends on the type of vegetation and characteristics of the soil. Soils that are poorly drained, such as clay and loam soils that are common in

Salina and throughout Kansas, may contribute to degradation of the turf when irrigated with water high in salinity.

Irrigation water with a high sodium to calcium + magnesium ratio (expressed as the sodium absorption ratio, SAR) could limit water movement into the soil and through the soil. The continued use of a water source with a high SAR can lead to a breakdown in the physical structure of the soil. The SAR is also dependent upon the total salt concentration in the water. Consequently, the potential for developing an impermeable soil is dependent on the salinity and SAR. Table 9-6 provides an evaluation of risk of sodium in irrigation water causing a water infiltration problem in soils. Sodium at very high levels can also be directly toxic to sensitive plants. Turfgrass is not particulary sensitive to high levels of sodium.

Table 9-6
SAR/Salinity Hazard of Irrigation Water
(Ayers, 1985)

Sodium Absorption Ratio (SAR)	Risk of Water Infiltration Problem in Soils		
	Low	Moderate	High
	Electric Conductivity of water (dS/m or mmhos/cm)		
0-3	Above 0.7	0.7-0.2	Below 0.2
3-6	Above 1.2	1.2-0.3	Below 0.3
6-12	Above 1.9	1.9-0.5	Below 0.5
12-20	Above 2.9	2.9-1.3	Below 1.3
20-40	Above 5.0	5.0-2.9	Below 2.9

KDHE minimum design standards suggest that wastewater with an SAR greater than 15 should not be applied to land due to potential adverse effects to the soil and reduction in infiltration rates (KDHE, 1978). The SAR for Salina's treated effluent cannot be determined at this time due to lack of sodium, calcium, and magnesium concentration data. Concentrations of these parameters do not require monitoring under the current NPDES permit.

Chloride is another ion that contributes to salinity and can be harmful to vegetation. Water softeners often contribute to the increased chloride content of the wastewater. Excess chloride deposited on leaves can cause foliar burn. Some plants are more susceptible to chloride than others. Turf grass, for example, is not particularly sensitive to high levels of chloride; however many ornamental plants such as rhododendron and azaleas are sensitive to chlorides. Salina's treated effluent is generally in the range of 190 to 360 mg/L, indicating there may be some negative effects on some vegetation types, especially ornamentals (Ayers, 1985).

The pH of the treated wastewater may not directly affect the performance of the vegetation, but can indicate other water quality problems. The pH should generally be between 6.0 and 8.2 for irrigation; a pH outside of this range can indicate other chemical constituents that should be evaluated. As shown in Table 9-4 the average pH of treated effluent from Salina's wastewater treatment plant is within this acceptable range.

It is possible that irrigation users may experience a benefit of lowering their fertilizer costs because of added nutrients in the treated wastewater effluent. Salina's treated effluent has on average 23.7 mg/L of nitrogen and 4.50 mg/L of phosphorus. Nitrogen is the nutrient required in greatest quantities by turf grass and is necessary for healthy growth and color. On average, assuming an average irrigation application rate of 20 inches per acre per year, the treated wastewater effluent can supply approximately 107 pounds of nitrogen per acre per year. Typical total annual nitrogen requirements for turf grass range from 1 to 5 pounds of nitrogen per 1,000 square feet (KSU, 1998); this equates to between 40 and 220 pounds of nitrogen per acre per year. Irrigation with the treated wastewater effluent has the potential to significantly reduce fertilizer requirements and costs, but is dependant on the application rate of the treated wastewater and the type and expected quality of the turf grass.

Prior to consideration of a water reuse program, the City should perform a comprehensive analysis of the effluent wastewater, as required by KDHE's minimum design criteria. This evaluation should include pH, total Kjeldahl nitrogen, ammonia-N, nitrate-N, total phosphorus, potassium, TDS, electrical conductivity, total suspended solids, chloride, sodium, magnesium, calcium, boron, carbonate, bicarbonate, sulfates, and trace metals. Samples used for the analysis should be taken at extreme flows to the wastewater treatment plant (including high flows and low flows) to capture the water quality at various instances.

9.3 APPLICATION OPTIONS

There are various potential water reuse applications. The principal categories and applications for water reuse from treated municipal wastewater are shown in Table 9-7. For purposes of this study, the reuse evaluation will focus on landscape irrigation uses for municipal, recreational or industrial purposes near the City's wastewater treatment plant; industrial process uses; and the potential for indirect groundwater recharge. Reuse options for these three categories will be discussed in the following subsections.

Table 9-7
Water Reuse Categories and Typical Applications

Category	Typical Application
Agricultural Irrigation	Crop irrigation
	Commercial nurseries
Landscape Irrigation	Parks
	School yards
	Street medians
	Golf courses
	Cemeteries
	Residential

Category	Typical Application
Industrial Recycling and Reuse	Cooling water Boiler feed Process water Heavy construction
Groundwater Recharge	Groundwater replenishment
Recreational/Environmental Uses	Lakes and ponds Streamflow augmentation
Non-potable Urban Uses	Fire protection Air conditioning Dust control Gray Water Systems
Potable Reuse	Blending in water supply reservoirs Blending in groundwater Direct pipe to pipe water supply

9.3.1 Municipal Recreational Irrigation

The use of treated wastewater effluent for crops and turf irrigation is well-established in the State of Kansas. Communities currently using treated wastewater for irrigation include the cities of McPherson, Newton, Hays, and Park City among others. Municipal and/or recreational irrigation uses for water reuse can include irrigation of public parks, playgrounds, athletic fields, school yards, street medians, golf courses, and cemeteries. The possible locations for this type of use that are near the wastewater treatment plant and their average annual water use are shown in Table 9-8.

Application of treated wastewater effluent at these sites is limited to a maximum annual application rate of 40 inches per acre under KDHE's regulations. Each site is also limited to a daily maximum application rate of 3 inches per acre (KDHE, 1978).

Table 9-8
Potential Municipal and Recreational Irrigation Water Reuse Applications

Water User	Body Contact Class	2006 Irrigation Water Usage		Irrigated Area (ac) (4)	Max Water Usage (gallons) (5)
		Water Right Usage (gallons) (1)	Municipal Usage (gallons) (2)		
Bill Burke Park (City)	Low	1,030,000	13,120,000	40	43,444,000
Soccer Complex (City)	High	-	6,118,000 (3)	23	24,980,000
Salina Municipal Golf Course (City)	Low	122,615,000	(4)	110	119,471,000
Salina Country Club	Low	52,436,000	(4)	75	81,457,000
Elks Country Club	Low	56,864,000	(4)	80	81,457,000
E. Crawford Rec. Area (City)	High	-	1,171,000	40	43,444,000
Annual Total		232,945,000	20,409,000		399,683,000
Allowance for Water Losses (10%)		23,294,500	2,040,900		39,968,333
Daily Avg (over 120 days per year)		2.14 MGD	0.19 MGD		3.67 MGD
Daily Avg (over 120 days per year)		2.33 MGD			

(1) Water right usage obtained from DWR for those rights that are owned by the water user (DWR/KGS, 2009).
(2) Assumes minimal domestic usage; data obtained from water sales records.
(3) Usage high in 2006 due to new turf. Typical irrigation for established turf assumed to be 2007 usage; 2007 usage shown in the table.
(4) Potable municipal usage is for domestic purposes and not included in water reuse calculations
(5) Irrigated area determined from total site area defined from parcel data on City of Salina mapping website multiplied by the percentage (estimated visually) of land irrigated.
(6) Based on annual maximum of 40 inches per acre multiplied by the irrigated area (KDHE, 1978).

Many of the irrigation sites identified currently have their own groundwater or surface water rights that are used for irrigation; any water used at these sites from the potable municipal water system is assumed to be used for domestic purposes only and is therefore not considered in the total quantity available for irrigation with reclaimed water. Salina Country Club, Elks Country Club, and the Salina Municipal Golf Course (City-owned) irrigate with private water rights and wells. Bill Burke Park (City-owned) has a water right which they use for dust control and is not a significant use.

The total amount of irrigation water saved from the municipal water system is 0.19 MGD according to Table 9-8. Private water right holders at the sites indicated in Table 9-8 could replace their current groundwater and surface water withdrawals with reclaimed water. This could result in an opportunity for the City to purchase these water rights to supplement existing municipal water rights if the owners are willing to sell their water rights. For example, water rights for Bill Burke Park and Salina Municipal Golf Course are already owned by the City; the City could then convert these water rights to municipal use.

There are two alternatives relating to water reuse for irrigation. The first alternative is to provide reclaimed water for irrigation for all of the sites listed in Table 9-8. If existing water rights usage is included, the total average usage per day during the irrigation season for the sites identified in Table 9-8 will be approximately

2.3 MGD with a maximum day of 3.7 MGD. The second alternative would be to irrigate only the sites that are currently owned by the City (such as Bill Burke Park, Salina Municipal Golf Course, and East Crawford Recreational Area). The Soccer Complex could be included as well; however an additional 11,600 feet of pipeline is needed to serve its relatively small flow. If Bill Burke Park, Salina Municipal Golf Course, and East Crawford Recreational Area are served with the reclaimed water, the average day usage is approximately 1.1 MGD and the maximum day usage is 1.9 MGD based on the data shown in Table 9-8. The minimum flow of 3.0 MGD at the wastewater treatment plant would be capable of meeting these flow requirements.

9.3.2 Industrial Uses

There were no known industrial irrigation uses for reclaimed water identified in this study that are located near the wastewater treatment plant. Locations of potential industrial non-irrigation uses for water reuse include those shown in Table 9-9. These users represent the largest current water users in the City that use manufacturing processes that could potentially use treated wastewater effluent. Some of these facilities currently provide additional treatment onsite to the City's potable water prior to use in their manufacturing process; therefore further evaluation would be needed to determine if these industries could effectively utilize treated wastewater effluent for process water. Industrial users may have to add chemical treatment to reclaimed water. Other large current water users that use water for domestic consumption (truck stops, hotels, etc.) or for food manufacturing are not considered.

Table 9-9
Potential Industrial Water Reuse Applications

Location	Industry	2006 Water Usage (1) (gallons)
Exide Corporation	Automotive Batteries	44,270,000
Philips Lighting Co.	Fluorescent Lighting	42,416,000
Metlcast Products	Gray/Ductile Iron Foundry	4,652,000
Great Plains Manufacturing	Agricultural Equipment	4,452,000
El Dorado National	Motor Vehicle Bodies	3,150,000
Annual Total		98,940,000
Allowance for Water Losses (10%)		9,894,000
Daily Average (over 260 days per year) (2)		0.42 MGD
Daily Maximum (over 260 days per year) (3)		1.14 MGD

(1) Includes minimal potable water use unless otherwise specified
(2) Assumes 5 working days per week
(3) Based on a max day peaking factor of 2.72 which is typical for the water distribution system (PEC, 2007)

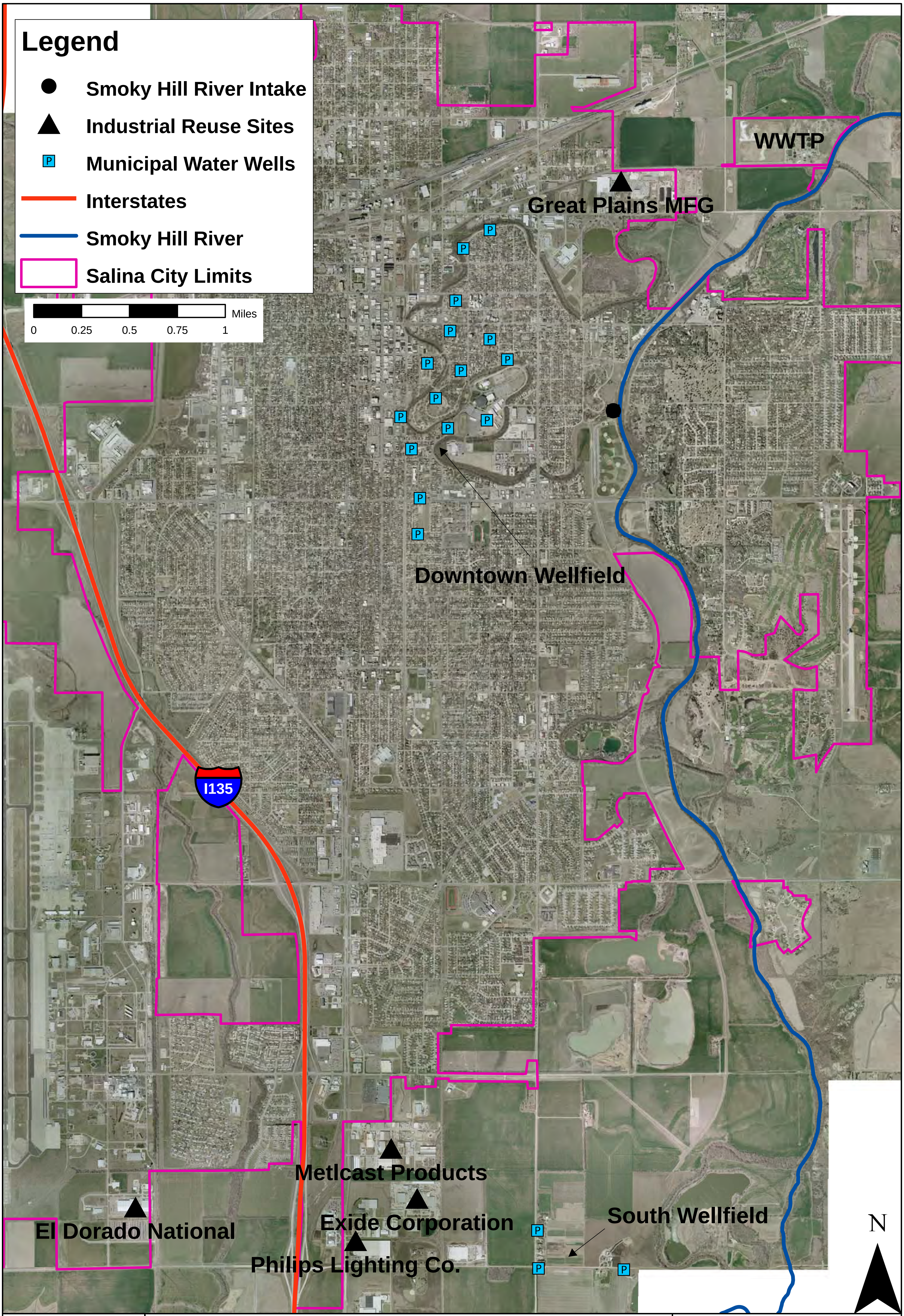
Of these industrial application sites, Great Plains Manufacturing is the only industry located in proximity to the wastewater treatment plant. The other industries are located in the southern part of town near South Wellfield; however, a pipeline constructed for the irrigation purposes discussed in Section 4.1 could be extended to serve these industries as they are fairly close together. El Dorado National, which is located on the opposite side of I-135 from the wastewater treatment plant may require relatively costly construction techniques to serve a small amount of demand. In addition to the two irrigation water reuse alternatives, a third alternative is that the irrigation pipeline could be extended to serve these industries. Figure 9-2 shows the locations of the industries in relation to the wastewater treatment plant.

9.3.3 Groundwater Recharge

This alternative includes using treated wastewater effluent as a source of water for artificial recharge as described in Chapter 7. The methods previously described include recharge using ponds or the old river oxbow to infiltrate the water into the aquifer or by direct injection by wells. Treatment requirements for using wastewater effluent for a source of groundwater recharge are not directly addressed by current KDHE regulations and would therefore need to be considered on an individual basis.

There are a number of technical and administrative considerations to groundwater recharge using treated wastewater effluent in Salina. The City of Hays, Kansas studied the potential for groundwater recharge using treated wastewater effluent, though was met by opposition of the public and was stopped from further consideration (HDR, Regulatory Meeting, October 31, 2008). Based on experience with similar potential recharge projects across the country, public perception is the most significant consideration. A strong public outreach program that presents the various technical and public health issues is needed to present the information in as objective a manner as possible, and to gain the needed public acceptance. Public health considerations are related to pathogenic and other water quality characteristics. For example, there is the potential for chlorides to become concentrated in the aquifer which could eventually impact the existing wellfield. These affects would likely require advanced water treatment processes, such as reverse osmosis to remove chlorides upon withdrawal, and high-level disinfection prior to consumption.

The most significant issue for applying groundwater recharge in Salina was discussed in Chapter 7 and is the hydraulic characteristics of the alluvial aquifer, which is interconnected with the Smoky Hill River. Retention time for treated effluent in the aquifer and the setback distances may be applied as suggested by EPA (EPA, 2004). The retention time requirements of six months or more would likely mean that most water recharged to the aquifer would likely have been discharged back into the river and the purpose of the recharge project would been defeated.



City of Salina

Raw Water Supply Study

Figure 9-2: Industrial Reuse Opportunities

HDR

WILSON & COMPANY ENGINEERS & ARCHITECTS

Layne

9.3.4 Direct Reuse

KDHE's current minimum design criteria for using treated wastewater effluent do not address direct potable reuse. Although this report does not recommend direct reuse be implemented in Salina, there is some interest within the community about direct reuse and its perceived potential cost savings for the City. KDHE stated that direct reuse of treated wastewater for potable water purposes would only be considered if there were no other water supply options available (e.g., land irrigation, agricultural uses, industrial uses, etc.); these options must be considered before direct reuse will be considered (HDR, Regulatory Meeting, October 31, 2008). Significant public perception issues would be expected. In addition, required epidemiological human health studies are inconclusive as to potential effects. Direct water reuse for potable water purposes has been studied in several places in the United States including Colorado, Florida, and California but is not currently practiced in the United States (EPA, 2004). Many cities withdraw drinking water from rivers or surface water reservoirs that contain varying amounts of treated wastewater discharge from cities and wastewater discharges from industries and agricultural areas that are upstream, therefore practicing unplanned (de facto) indirect potable reuse. However, once the treated wastewater is discharged to the water body, it becomes further mixed and receives natural attenuation as it flows downstream.

The perception is that there could potentially be cost savings to the City to reuse the wastewater effluent for potable uses rather than discharging it to the river. These cost savings are thought to be in the form of reduced treatment requirements if the treated effluent is of a better quality than the water currently obtained from the Smoky Hill River. Although the treated wastewater may have better water quality in terms of hardness and turbidity, there are other chemical and microbial constituents in the treated effluent that the existing water and wastewater treatment plants cannot currently treat that may have an impact on public health and would require additional treatment. Such constituents include nitrates, viruses, bacterial pathogens, pharmaceuticals, endocrine disruptors, personal care products, and other organic compounds that when combined with chlorine produce disinfection by-products. In addition, constituents that affect aesthetic conditions could be present, such as chlorides, high levels of nutrients (phosphorus and nitrogen), and certain metal species. It is also important to realize that the Safe Drinking Water Act drinking water regulations were developed for typical raw water sources such as rivers, lakes, and groundwater and not for the use of municipal wastewater as a source.

Additional water treatment at the existing water treatment plant would be required but would not necessarily remove all the constituents of concern, particularly pharmaceuticals and other endocrine disruptors (microconstituents). The removal of microconstituents is currently being studied from a regulatory perspective by the EPA and several state agencies. The effects of microconstituents on aquatic life are being studied, though little data exists to quantify potential effects on public health.

9.4 NECESSARY UPGRADES

The City's existing wastewater treatment plant process includes secondary treatment, nitrification, and disinfection by means of ultra-violet radiation (UV radiation) but does not include filtration. The following are the main components of the liquid train (not including solids handling) at the existing wastewater treatment plant:

- Bar screens
- Grit removal
- Primary clarifiers
- Trickling filters
- Intermediate clarifiers
- Aeration basins
- Final clarifiers
- UV disinfection
- Post-aeration

According to Table 9-1, if the City wanted to use treated effluent for irrigation of athletic fields or public parks with a high probability of body contact then filtration treatment would need to be added. Filtration could be added for only the flow that is being reused and not the entire flow. There are three types of filtration technologies for water reuse applications: (1) conventional filtration – passing the water through a filter bed comprised of a granular medium, (2) surface filtration – passing the water by mechanical sieving through a thin cloth filter, and (3) membrane filtration – passing the water through semi-permeable membranes. Each type of filtration has advantages and disadvantages relating to cost, footprint, loading rates, backwashing, and other operational considerations. The goal of adding filtration is to further reduce TSS and BOD to allow the water to be more suitable for human contact.

Irrigation applications that involve sites with a high probability of contact may have fecal coliform limitations written into the NPDES permit. As discussed previously, a limitation of 20 colonies/100 mL (monthly geometric mean) was imposed in Park City, Kansas. As of July 1, 2008 the bacteria tested was changed from fecal coliform to E. coli. A fecal coliform limitation of 20 colonies/100 mL corresponds to an approximate E. coli limitation of 16 colonies/100 mL. To achieve higher inactivation of pathogens (and lower E. coli) additional disinfection would be required.

The plant flow could be split downstream of the existing UV disinfection process to allow the desired amount of reuse water to be filtered without having to provide filtration for the entire plant flow since filtration is not required to meet current NPDES water quality limits. Additional disinfection would then be needed for the reuse flow after filtration to achieve the higher inactivation requirements based on the potential fecal coliform/E. coli limitations. The disinfection could be provided with additional UV radiation intensity or time of exposure or chlorination of the reclaimed water.

If the City wanted to limit irrigation with treated wastewater effluent to areas with a low probability of body contact such as golf courses or certain public parks, it is likely that no treatment improvements would be required as shown in Table 9-1.

In addition to any upgrades required at the wastewater treatment plant, a dedicated pipeline with pumping and storage facilities would be required to serve the sites listed in Table 9-6 with treated wastewater effluent. The potential sites listed in Table 9-6 would likely irrigate during off-peak (night) hours, which is the time of day when flow into the wastewater treatment plant is the lowest and may not be capable of meeting the full system demand. Therefore, storage facilities would be required to equalize the flow from the plant so that it can be used during the times when it is needed. Storage and pumping facilities could be located adjacent to the existing wastewater treatment plant. Either ground storage or elevated storage could be provided. A ground storage tank would require a pump station to pump reclaimed water into the irrigation distribution system. An elevated storage tank would require a pump station to pump to the tank and water would flow by gravity to the irrigation distribution system. Storage should be provided for the difference between the minimum nightly flow into the wastewater treatment plant and the maximum daily demand, assuming these occur during the hours of 9 PM to 5 AM.

A dedicated pipeline to convey the treated wastewater effluent could be constructed down the east side of the town and would serve most of the sites identified. Short branch lines from the main pipeline could be constructed to serve the sites that are not directly adjacent to the main transmission line. The pipeline should be sized to meet maximum day demands. Figure 9-3 presents a schematic of the existing treatment facility and potential facilities for water reuse. Figure 9-4 shows the location of the sites identified in Table 9-6 and the potential facilities that would be required to transmit the treated wastewater effluent.

As discussed previously, there are three alternatives for water reuse as described below:

- Alternative 1 – provide reclaimed water for all irrigation and industrial sites
- Alternative 2 – provide reclaimed water for all irrigation sites
- Alternative 3 - provide reclaimed water for City-owned irrigation sites, except for the Soccer Complex

Table 9-10 shows the flow and storage requirements for the three alternatives as well as estimated pipelines sizes.

Table 9-10

Water Reuse Alternative Requirements

Alternative	Average Day Demand (MGD)	Maximum Day Demand (MGD)	Approximate Storage Requirement (Gallons)	Approximate Pipeline Length (miles)	Estimated Pipe Size (in.)
1	2.12	5.00	1,000,000	12.8	16, 8
2	1.70	3.67	600,000	6.5	16
3	0.64	1.90	200,000	3.4	10

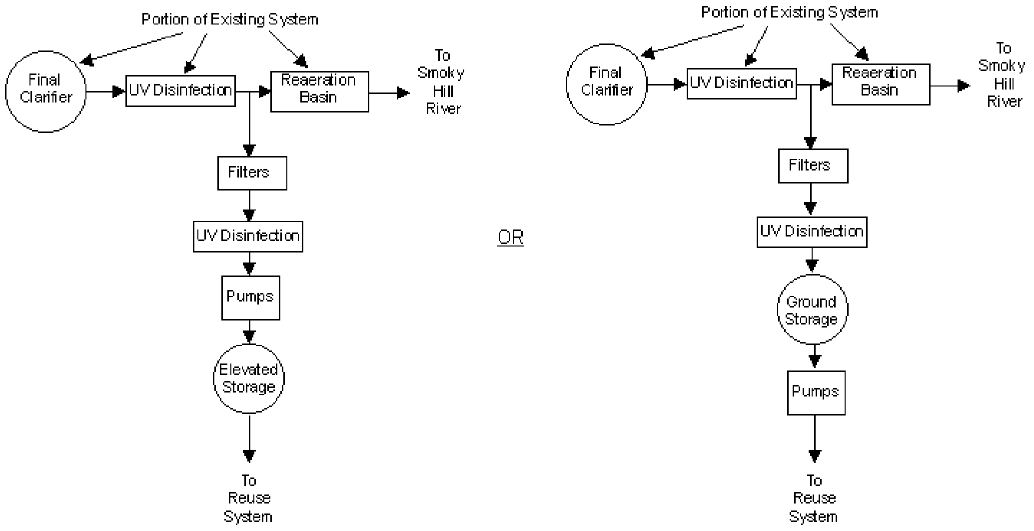
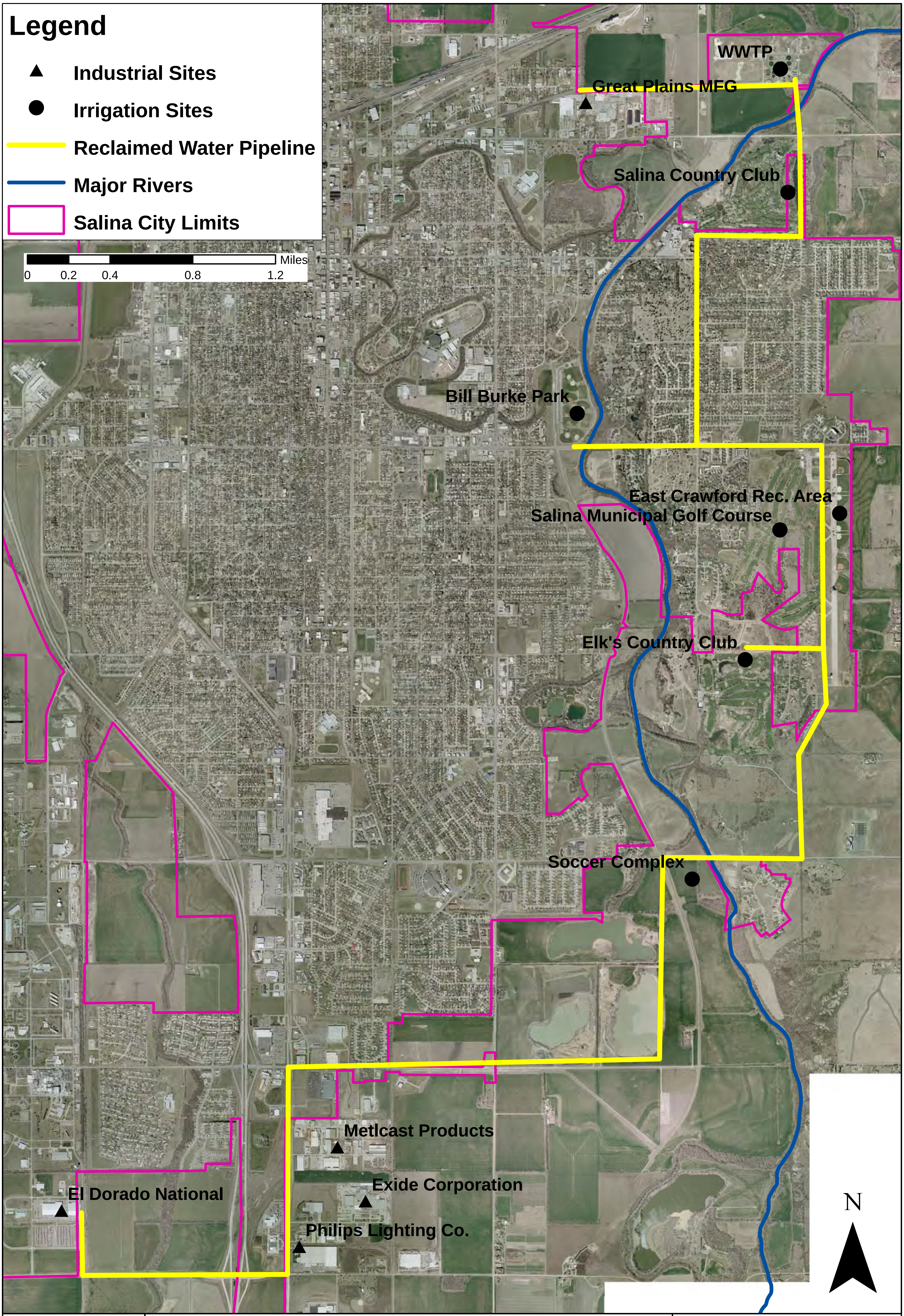


Figure 9-3
Potential Wastewater Treatment Schematics
With Water Reuse Upgrades



Raw Water Supply Study

Figure 9-4: Water Reuse Sites and Facilities

A preliminary cost estimate was completed for each of the alternatives to understand the potential cost of anticipated treatment upgrades, required infrastructure for conveyance to the application sites, and any additional costs that may be incurred with development of a water reuse program. The cost estimate includes two major cost categories: construction costs and other project costs. Construction costs are the direct costs, such as those for materials, labor, and equipment, incurred in constructing facilities. "Other project costs" include additional expenses not directly associated with construction activities of the project such as costs for engineering, land acquisition, studies, and interest during construction. Construction costs and other project costs comprise the total project cost.

Construction cost estimates for the elements that are part of a new study are determined from reliable cost information. Construction cost information can be obtained from a number of sources, such as vendor catalogs, construction periodicals, commercial cost reference materials, text books, and cost tables based upon historical data from actual projects. The cost for a project element can be determined by applying a unit cost from the cost tables to a specific unit quantity. For example pipeline costs can be determined by pipe diameter and linear feet of line.

Table 9-11 describes the potential construction costs and total project costs for the three water reuse alternatives. More detailed cost estimates for each alternative are presented in Appendix H.

Table 9-11

Water Reuse Alternative Cost Summary

Alternative	Maximum Demand (MGD)	Construction Costs (1)	Other Project Costs (2)	Total Project Costs
1	5.00	$13,863,000	$2,773,000	$16,636,000
2	3.67	$9,790,000	$1,958,000	$11,748,000
3	1.90	$5,051,000	$1,010,000	$6,061,000

(1) Includes a factor for contingencies of 30%
(2) Based on a factor of 20% of the construction costs

9.5 IMPACTS ON DOWNSTREAM WATER RIGHTS

Another important consideration in water reuse is who among the wastewater treatment effluent discharger, the water supplier, other appropriators, or environmental interests is entitled to the right to use the water that is normally discharged from the wastewater treatment plant into the river. As water becomes a scarce resource, especially during times of extended drought periods, legal disputes over water reuse and water rights are likely to arise. The disputes will come from conflict over who is entitled to the reused water and over ambiguities in contractual obligations. The main dispute over water that was previously returned to streams after use is not discharged and is instead withheld for reuse. Diminished flow downstream may deprive users of their accustomed water supply.

State regulations can either promote or constrain water reuse depending on how its system of water rights regard the use and return of reclaimed water. In general, the owner of the wastewater treatment plant that produces the effluent is generally considered to have first rights to effluent use and is not usually bound to continue its discharge. However, in general a wastewater treatment plant's right to reuse the effluent discharge could be restricted if one of the following occurs:

- Reduced Discharge: the use of reclaimed water reduces or eliminates the discharge of treated effluent to the receiving stream causing serious economic losses for downstream users or negative impacts on the environment
- Changes in Point-of-Discharge: appropriated water rights are designed to protect the origin of the water by limiting the point of discharge
- Hierarchy of Use: a hierarchy exists in appropriated water rights, and in times of water shortage, it is possible that a more important use could make claim to reclaimed water that, for example, is being used for irrigation purposes
- Reduced Withdrawal: when water rights are based on historic usage, reductions could jeopardize the amount of water the user is entitled to (this has a negative effect on water reuse and water conservation so, where possible, assurances should be made that historic water right allocations will not be reduced if demand is reduced)

The DWR is responsible for water rights in the State of Kansas. A portion of water diverted for beneficial uses under water rights is considered non-consumptive in that it is eventually returned to the natural system (i.e. discharged to the river from the wastewater treatment plant). Projects such as water reuse wouldn't be allowed by DWR if they resulted in an increase in the historic consumptive use. Preliminary discussions with DWR indicate that a water reuse program in the City of Salina would not increase the consumptive use as long as the water that is reused is kept under the City's control and is not discharged to the river. The DWR permits the initial diversion of water, but does not guarantee that it is discharged. Once water is returned to the water course it is returned to the State for appropriation. In addition, the site of application of the reused water must be within the authorized place of use specified in the water right. The authorized place of use for a municipality is defined as "within the City limits and the immediate vicinity." Immediate vicinity is defined as "within ½ mile of the City limits." Therefore, as long as the reuse water is under control of the City and is applied inside the authorized place of use, the DWR has no review of the process.

However, that does not mean that legal disputes with downstream users would not arise in the future. One example the DWR cites is the water reuse project in Hays, Kansas. Hays currently uses a portion of their treated wastewater effluent for irrigation of golf courses and other urban areas. Russell, Kansas is downstream of Hays and has relied on the wastewater discharge to meet their water rights for municipal water supply. Russell has not disputed the reuse project in Hays to date but could in the future claim injury to their water rights and take legal action. Legal disputes of this nature have not yet happened in Kansas but could in the future.

Salina is fortunate to be close to the confluence of the Saline and Solomon Rivers with the Smoky Hill River. Downstream of Salina prior to the confluence with the Saline River there is one surface water right for irrigation. This water right is for 47 acre-feet annually at a maximum withdrawal rate of 510 gpm. Any water rights on the Smoky Hill River downstream of the confluence of the Saline River or the Solomon River are likely more dependent on contributing water from the tributaries rather than effluent from Salina's wastewater treatment plant. Therefore, because of the City's location, the chances of legal disputes due to potential injury to water rights may be less than other municipalities.

10 NEW SOURCES OF SUPPLY

The City of Salina is fortunate to have a number of available alternatives for additional water supply. Such options include the Saline River, Solomon River, Dakota Aquifer, Kanopolis Reservoir, Wilson Reservoir, and Milford Reservoir. Alternatively, the City can construct its own reservoir for water supply purposes, join a water assurance district with other municipal and industrial users along the Smoky Hill River to purchase water in Kanopolis Reservoir, or acquire existing surface water or groundwater rights. Each of these options has advantages and disadvantages, which are described in the following sections. Figure 10-1 shows the locations of potential new sources of supply that are considered for this study and their relation to the City of Salina.

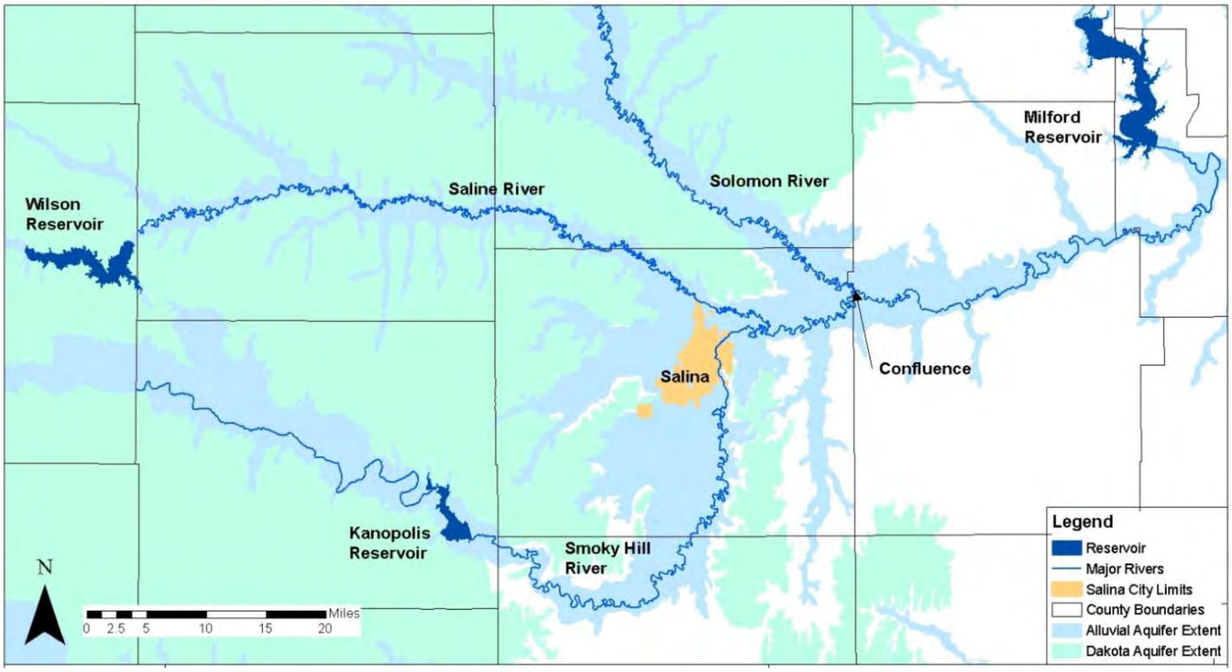


Figure 10-1
Potential New Sources of Supply

10.1 SALINE RIVER

The Saline River is formed in western Kansas and flows east to where it joins the Smoky Hill River approximately 5 miles northeast of Salina, as shown in Figure 10-1. One reservoir was constructed along the Saline River, the Wilson Reservoir.

There are currently three surface water rights on the Saline River in Saline County, as shown in Figure 10-2 (DWR, 2009). All three rights are for recreation and total to 1,200 gpm on a maximum diversion rate basis. The next water right is 33 miles upstream in Ottawa County where several water rights are clustered downstream of Wilson Reservoir. There are also a few groundwater rights along the Saline River in the vicinity of Salina. The Saline River provides an opportunity for the City to develop a senior water right. In addition, the ability to expand is good due to the low number of water rights and the generally higher expense of implementing advanced treatment for such purposes as irrigation and agricultural uses.

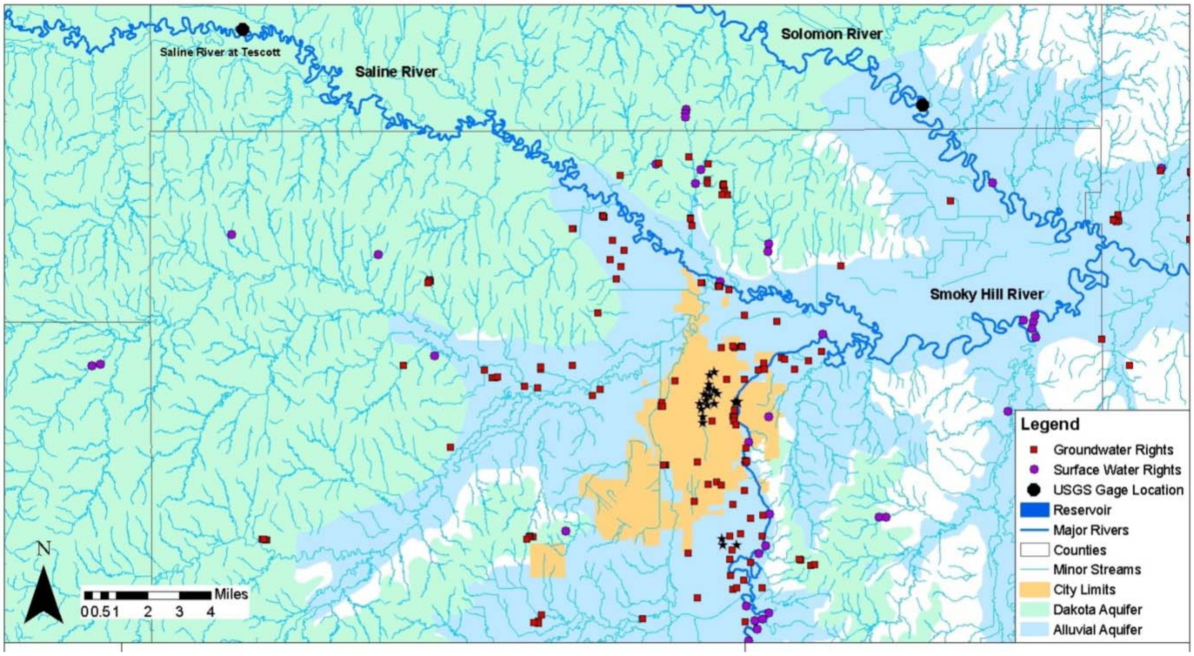


Figure 10-2
Water Rights Along Saline River

Similar to the Smoky Hill River, the Saline River is subject to low flow conditions during a drought. Flow data based on the USGS streamflow gage on the Saline River at Tescott, Kansas, approximately 22 miles upstream (straight-line distance) from the confluence with the Smoky Hill River, shows that the flow conditions are similar to the Smoky Hill River. During the period of 2000-2006, the flow in the river exceeded 12 cfs 90% of the time compared to the Smoky Hill River at Mentor, which exceeded 25 cfs 90% of the time.

There are two options for withdrawal of water from the Saline River. One option is a direct surface water intake. As of 1990, the DWR restricts withdrawal directly from certain rivers, including the Saline River, to between October 1 and June 30; this means that the City would not be able to withdraw between July 1 and September 30, the times when the demands are the greatest and the existing sources are most likely to be impacted by drought. Alternatively, water could be withdrawn from wells drilled into the alluvial aquifer along the river bank, termed river bank filtration wells. A river bank filtration well is essentially a well that is located 50 to 100 feet from the edge of the stream. As the stage in the Saline River rises, water levels in the alluvium also rise and water is stored in the river banks. Water in storage could be pumped from the alluvium and used as a water supply.

The main reason that many water rights have not been developed along the Saline River is due to its poor raw water quality. As the name suggests, this water source is high in salinity. The Saline River cuts through the Dakota Aquifer in its upstream reaches, which is known to be high in salinity due to saltwater intrusion from underlying Permian rocks. The Dakota Aquifer discharges some water to the Saline River in its upstream reaches. Water quality reports obtained from the Kansas Department of Health and Environment (KDHE) for 1990 through 2006 report that the TDS, a measure of salinity average approximately 1,150 ppm and have been measured as high as 2,000 ppm near New Cambria. The secondary drinking water standard for TDS is 500 ppm. The water is also above the secondary drinking water standard in chlorides and sulfates, which contribute to TDS. Dissolved solids such as chlorides and sulfates generally increase as the flow in the river decreases since discharge from the Dakota Aquifer constitutes the majority of the baseflow.

Use of water from the Saline River would require reverse osmosis treatment to remove the dissolved solids. Reverse osmosis is becoming more widely used and accepted in water resource management as fresh water supplies are decreasing and agencies are turning to widely available brackish or saline water sources. Reverse osmosis has been available for over fifty years and is a well-established practice for removing dissolved solids from brackish water.

The reverse osmosis process separates the water into two streams, the recovered water stream which is of potable quality (permeate) and a concentrate stream which contains the removed salts. The amount of water that is recovered for potable uses varies depending on the salinity of the feed water and the process design. The biggest design consideration when using the reverse osmosis process is disposal of the concentrate stream. Since this water is concentrated with salts, it can have toxic properties. Some options for disposal of the concentrate include:

- Discharge to surface water
- Deep-well injection
- Discharge to sanitary sewers
- Land application
- Evaporation ponds
- Recover for beneficial use (industrial uses, mineral salts, etc)

KDHE would likely require the concentrate be disposed of in double-lined evaporation ponds or through deep-well injection based on preliminary discussions. Deep-well injection would likely require Class I injection wells, which inject the concentrate into deep, isolated rock formations which are below the lowermost underground source of drinking water.

10.2 CONFLUENCE OF SMOKY HILL RIVER AND SOLOMON RIVER

The Solomon River is formed in western Kansas north of the Saline River and has two forks, North Fork and South Fork. The two forks combine at Waconda Reservoir. From the reservoir, the Solomon River flows south and east to where it joins the Smoky Hill River approximately 8 miles downstream of the confluence of the Smoky Hill and Saline Rivers. This is approximately 13 miles northeast of Salina near the border of Saline County and Dickinson County.

There are currently six surface water rights on the Smoky Hill River between Salina and the confluence with the Solomon River (DWR, 2009). All surface water rights are for irrigation and total to 1,150 gpm on a maximum diversion rate basis. There are approximately 15-20 groundwater rights between Salina and the confluence with the Solomon River; however, very few of these are located in the vicinity of the confluence. Figure 10-3 shows the locations of water rights along the Smoky Hill River near the confluence.

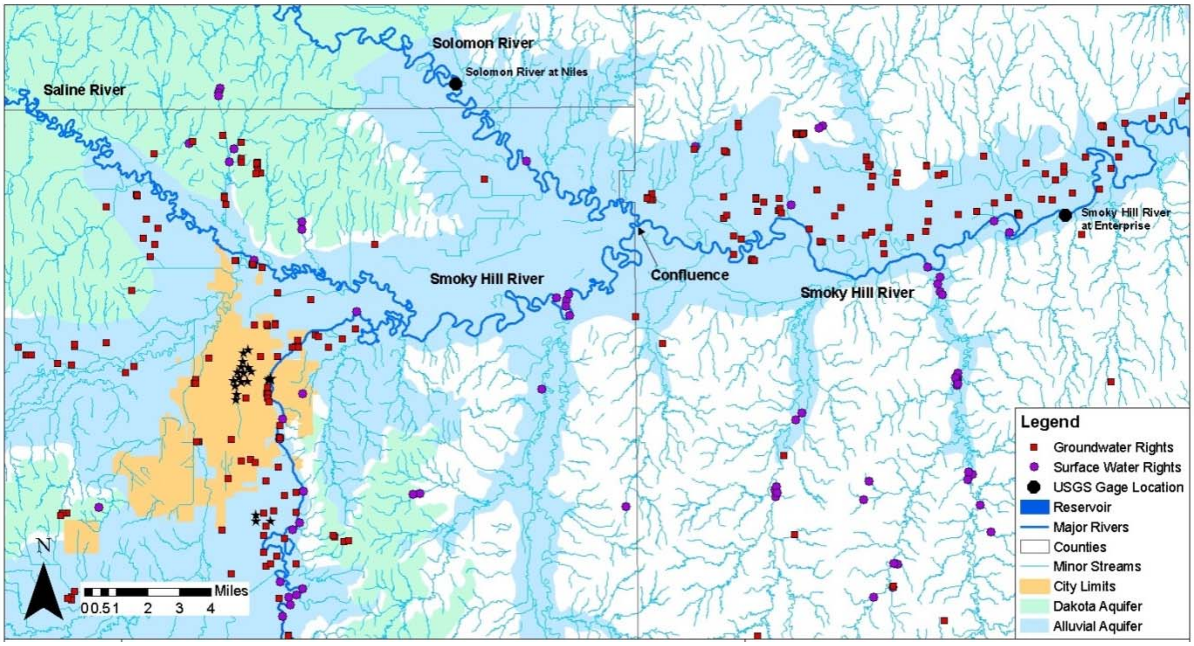


Figure 10-3
Water Rights Along Smoky Hill River Near Confluence

The Smoky Hill River downstream of the Solomon River is less affected by drought than the portion of the Smoky Hill River near Salina. This is due to the contribution of flow from the Saline and Solomon Rivers, two major tributaries. Flow data based on the USGS gage at Enterprise, Kansas, approximately 13.5 miles downstream (straight-line distance) from the confluence of the Smoky Hill River and the Solomon River, shows that the flow is plentiful in this part of the river. During the period of 2000-2006, the flow in the Smoky Hill River at Enterprise exceeded 127 cfs 90% of the time compared to the Smoky Hill River at Mentor, which exceeded 25 cfs 90% of the time. Between the confluence and the gage there is one large vested surface water right for Westar Energy and one smaller appropriated surface water right. The vested right is for 21,522 ac-ft annually, or 20,139 gpm (45 cfs).

There are two options for withdrawal of water from the Smoky Hill River downstream of the confluence with the Solomon River. One option is a direct surface water intake, in which withdrawal would be restricted to the period October 1 through June 30. Alternatively, water could be withdrawn year round from river bank filtration wells along the river bank as discussed previously.

Water quality reports near Enterprise obtained from KDHE for 1990 through 2006 report that the TDS levels in the Smoky Hill River downstream of the confluence with the Solomon River are similar to the Saline River and average 1,150 ppm and have been measured as high as 2,500 ppm. The secondary drinking water standard for TDS is 500 ppm. Similar to the Saline River, the Solomon River cuts into the Dakota Aquifer in its upper reaches and receives some flow from it. The water is also above the secondary drinking water standard in chlorides and sulfates, which contribute to TDS. This water source likely would also require a reverse osmosis treatment facility to remove TDS.

10.3 ACQUISITION OF EXISTING IRRIGATION WATER RIGHTS

The State of Kansas controls and regulates water use through the Kansas Water Appropriation Act, which is administered by the DWR as discussed previously. A detailed description of the water appropriation process was presented in Chapter 5.

Purchasing existing water rights is a common method for cities in western Kansas to increase their raw water supply volumes. As concerns regarding sustainability and diversification of supply sources have increased, the purchase of existing water rights has become part of the planning process for communities in central Kansas as well. New water supply sources could be obtained by the City of Salina through the purchase of existing water rights located near existing City infrastructure. The City should negotiate acquisition of water rights with willing sellers in order to maintain a good relationship with irrigators along the Smoky Hill River. Acquisition of existing water rights should be prioritized with consideration given to users with the largest volumes and/or oldest priority date. Figure 10-4 shows water rights in the area by volume and Figure 10-5 shows water rights in the area by priority date. At this point, willing sellers have not been identified, and all that is shown is general information on location, seniority, and volume.

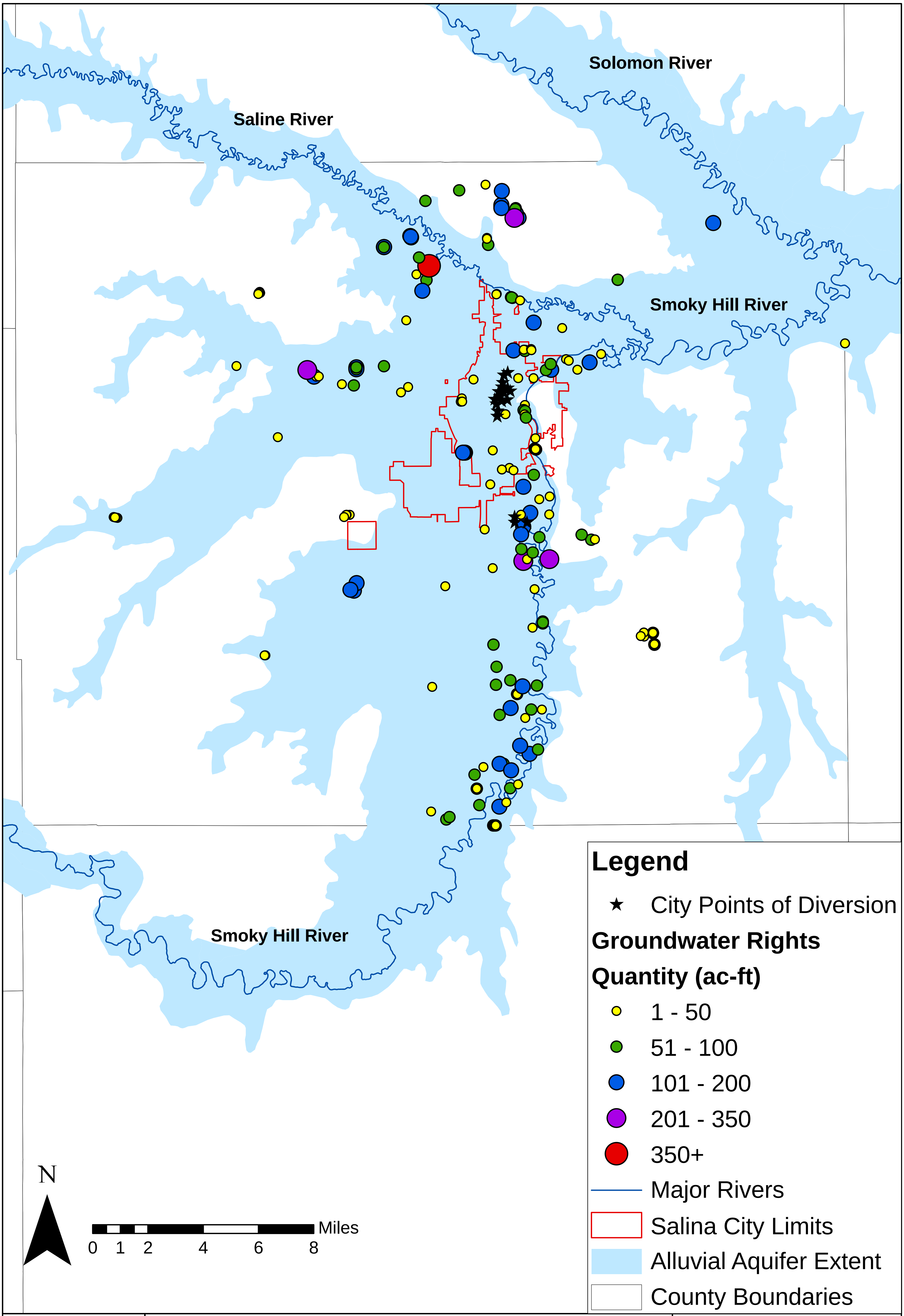
If sufficient volume is available, purchase of vested rights and appropriated rights that have a priority date senior to that of the City’s existing rights should be targeted first. A variety of issues should be considered with the acquisition of a water right, as summarized below:

- Well Replacement – Assuming the water right purchased is an irrigation water right, the existing well acquired likely will not meet the KDHE minimum design standards for a municipal water supply well. Therefore, installation of a new well would be required to comply with the KDHE minimum design standards for public water supply wells.
- Location – If a new well must be drilled, a Change in Point of Diversion must be approved by the DWR. The DWR does not allow the replacement well to be located further than one-half mile from the existing well it replaces. The location of the replacement well in relationship to the existing well can impact the time frame involved in the approval process for the transfer of ownership of the

acquired right. If the distance from the existing well to the replacement well is less than 1,320 feet, then the approval process could be as short as several weeks and can be completed by the regional DWR office. If the distance is between 1,320 to 2,640 feet, then the request has to be processed through the State Engineer in Topeka. This process may take up to six months to one year.

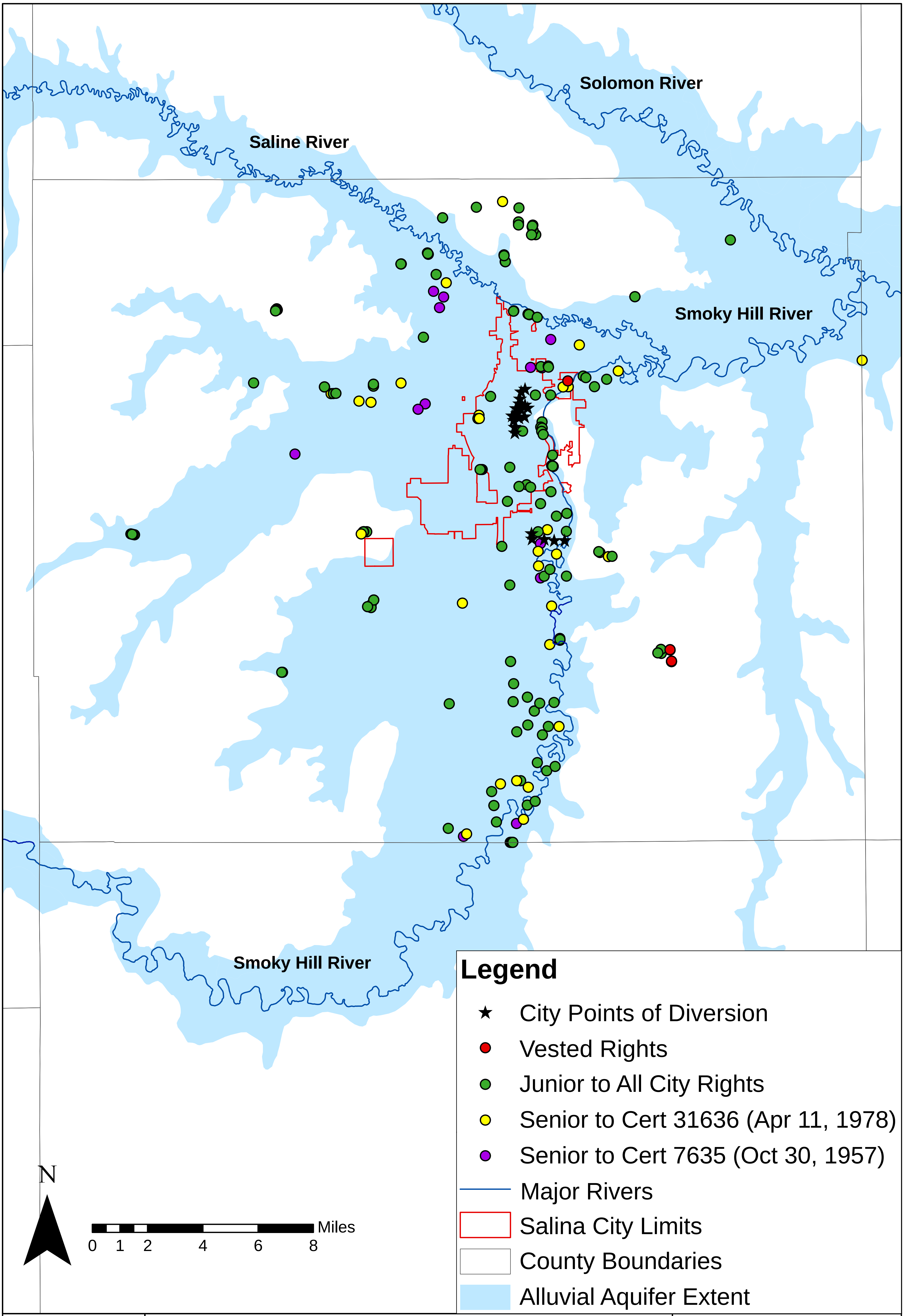
- Water Allocation – In addition to changing the point of diversion, the purchase of an irrigation water right for use as a municipal water source requires approval of two applications, a Change in the Use Made of Water and a Change in the Place of Use. Both applications must be approved by the DWR. Through the Change in the Use Made of Water process, it is likely that the DWR will modify the newly purchased right by reducing the original water right allocation. Irrigation wells are permitted with the understanding that they will operate only during the irrigation cycle. Permitted volumes for these wells are assigned based on: the irrigated crop type, the irrigation requirement for that crop, length of the irrigation season, and the irrigated acreage. Because the water use will change from irrigation to municipal, the DWR may decide to reduce the permitted volume to account for the fact that the municipal well could potentially operate everyday throughout the year, not just during the irrigation season, and that some of the water will not be returned to the aquifer through infiltration. These decisions, however, are typically made on a case-by-case basis.

The option of developing new water rights for the City of Salina was discussed with the regional water commissioner for the DWR. DWR has indicated that they would likely not approve any new water rights within a 2 mile radius of any existing supply well in the Downtown Wellfield. They have also indicated that any new water rights outside of that buffer would be approved on a case-by-case basis. As a result of this discussion with the DWR, it is our conclusion that any new points of diversion near the Downtown Wellfield will not be permitted. New points of diversion near the South Wellfield will be evaluated on a case-by-case basis by DWR, but may or may not be permissible due to the application of DWR's safe yield provision.



Raw Water Supply Study

Figure 10-4: Ground Water Right Diversion Points by Volume (Saline County)



Raw Water Supply Study

Figure 10-5: Ground Water Right Diversion Points by Priority Date (Saline County)

10.4 RESERVOIR CONSTRUCTION

A reservoir could be constructed in the vicinity of Salina for the purpose of storage for water supply for the City. Other likely benefits of a reservoir include flood control and recreation. Design, permitting, and construction of a reservoir would likely take a significant amount of time, requiring additional supply sources and associated permitting, optimization of existing sources, or conservation during the development period.

There are many items involved in construction of a reservoir which may impact the development of a reservoir for water supply purposes. These items include:

- Extensive permitting
- Property acquisition for the dam, any land inundated by the impoundment, and any land that will receive flow from the spillway
- Possible relocation of existing roads and utilities
- Impacts on natural resources and possible mitigation requirements
- Changes in the stream environment and characteristics downstream of the impoundment
- Development of recreation facilities
- Deposition of sediment in the reservoir which reduces the safe yield for water supply over time
- Reduction in inflows to the reservoir during drought years

The Kansas State agency responsible for permitting stream obstructions is DWR. A water right for the surface water for recreational use and a stream obstruction permit for construction of the dam must be obtained from DWR. In addition to the construction of the reservoir, a surface water intake, pump station, and pipeline would be required to transfer the water from the reservoir to the water treatment plant in Salina. The intake would require an additional water structures permit and surface water right for municipal use from the DWR. In addition to permits from DWR other permits that may be required include a Section 404 permit from the USACE, Stormwater Runoff permit from KDHE, and other local and county permits.

10.5 DAKOTA AQUIFER

Groundwater from the Dakota Aquifer is currently used for domestic, municipal, industrial, and agricultural water supply purposes in portions of central and southwestern Kansas. The Dakota Aquifer system consists of an upper and lower sandstone unit that is separated by the Kiowa Shale. These materials were deposited about 100 million years ago during the Cretaceous Period and are found at the surface and in the subsurface in most of the western two-thirds of Kansas (KGS, 1996). The upper unit of the Dakota Aquifer consists of the Dakota Formation and the lower unit consists of the Cheyenne Sandstone and the lower more permeable section of the Kiowa Formation. The sandstone layers within the Dakota Aquifer are the primary water producers and the proportion of sandstone to thickness of the unit averages around 30 percent statewide. A geologic map of the study area indicating the presence of these units is provided in Figure 10-6.

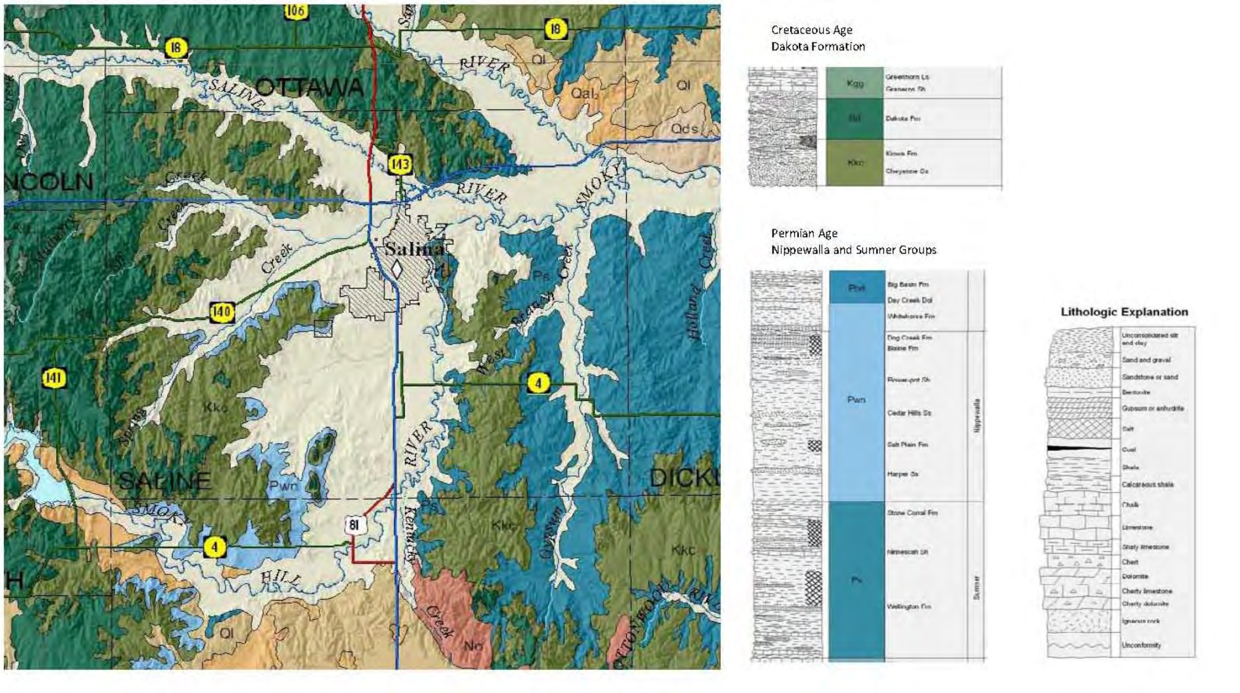


Figure 10-6
Dakota Aquifer Geological Map
(KGS, 2008)

The City of Salina lies within the juncture of the Smoky Hill and Saline River valleys. These valleys have eroded through both the upper and lower units of the Dakota Aquifer and into the underlying shale layers associated with the Wellington Formation. These rivers have left alluvial deposits considered the alluvial aquifer. The Wellington Formation is of Permian age and consists of thin alternating layers of shale and limestone and is regarded as a relatively impervious layer that is a poor source for water.

The lower unit of the Dakota Aquifer forms the valley walls of the Smoky Hill River near Salina. The Cheyenne Sandstone layer is missing in this part of Kansas thus the water producing zones of the Dakota Aquifer in the study area are from the interbedded sandstone lenses in the lower part of the Kiowa Formation. It has a maximum thickness of approximately 200 feet in this area (Latta, 1949). The City of Gypsum, located approximately 15 miles southeast of Salina, has wells located in this unit which produce 45-50 gpm. Domestic wells in the western part of Saline County yield 20 to 40 gpm from this lower unit.

The upper unit of the Dakota Aquifer terminates to the north of Salina around the Ottawa County line and to the west of Salina around the Ellsworth County line. The Dakota Aquifer thickens north and west of Salina. On a regional scale, the upper unit of the Dakota Aquifer is approximately 300 feet in thickness (KGS, 1996); however variations in thickness can occur over very short lateral distances. Well yields vary from 30 to 1,000 gpm depending upon thickness of sandstone encountered. Studies of well logs from the Kansas Geological Survey (KGS) water well database indicate well yields of from 50 to 300 gpm are possible near the study area.

Water quality within the Dakota Aquifer varies with location. The highest concentrations of dissolved solids occur in the northern and northwestern sections of the state. In general, salinity increases to the west. Figure 10-7 indicates TDS concentrations of Dakota Aquifer could range from 250 to 2,000 mg/L within the Salina study area.

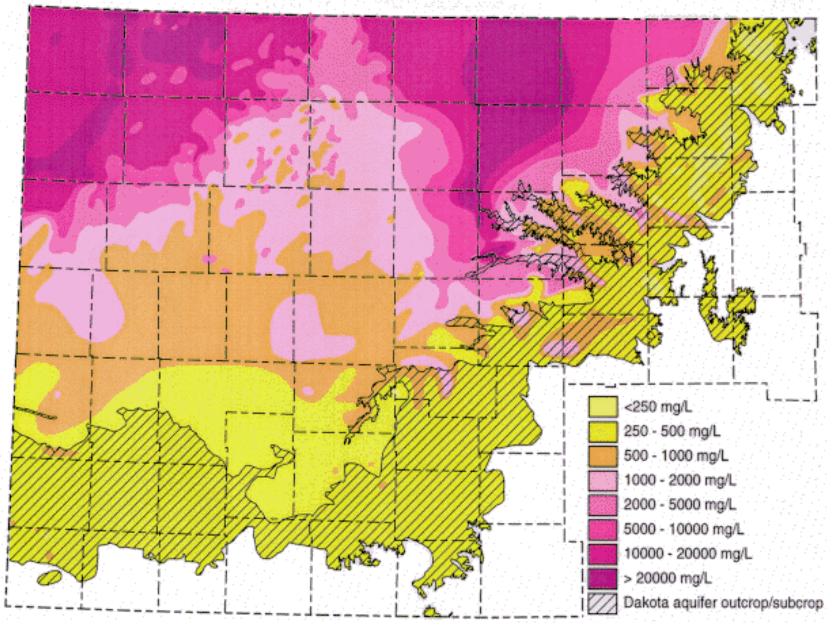


Figure 10-7
Contour Map of Total Dissolved Solids
Dakota Aquifer
(KGS, 1996)

The DWR has requirements on spacing for wells within the Dakota Aquifer. Wells in the unconfined aquifer are required to be spaced a minimum of one-half mile. Wells in the confined aquifer are required to be spaced a minimum of 4 miles. The Dakota Aquifer around Salina is mostly unconfined and the requirements would be one-half mile spacing between wells; the confined aquifer is found further west of Salina.

In summary, the Dakota Aquifer has been eroded near the Salina area by the Smoky Hill River, Saline River, and resulting alluvial deposits (aquifer). East of the City where the Dakota Aquifer is present, the absence of the Cheyenne Sandstone member limits the productivity of the Dakota Aquifer to wells that will likely produce less than 100 gpm. The Dakota Aquifer is also present to the north and west of the City in Lincoln and Ottawa Counties where the thickness of the aquifer increases. In these areas, well yields of 50 to 300 gpm are possible and the TDS concentrations range from 250 to 2,000 mg/L.

10.6 KANOPOLIS RESERVOIR

Kanopolis Reservoir is located on the Smoky Hill River approximately 27 miles (straight-line distance) upstream of Salina in Ellsworth County, as shown in Figure10-1. Kanopolis was constructed and placed in operation in May 1948 and is owned and operated by the USACE. The purpose of the reservoir is to provide flood protection, recreation opportunities, water supply and fish and wildlife benefits. Kanopolis operates in tandem with the upstream Cedar Bluff Reservoir to regulate flows in the Smoky Hill River.

Kanopolis Reservoir storage volume is divided into three separate pools: 1) the multi-purpose pool, which consists of water quality and water supply storage; 2) the flood control pool for flood water storage; and 3) the surcharge pool for additional flood water storage above the spillway. Table 10-1 describes the storage available in the reservoir.

Table 10-1
Kanopolis Reservoir Storage

Pool Space	Elevation (ft msl)	Usable Storage (Ac-Ft)
Surcharge	1508.0-1531.8	-
Flood Control	1463.0-1508.0	362,254
Multi-purpose	1431.0-1463.0	26,833
Water Supply		12,500
Water Quality		14,333
Total		389,087

After 25 years of negotiations, the KWO signed an agreement in 2002 to purchase 12,500 acre-feet (4,701 MGY) of water supply storage from the USACE for the Water Marketing Program. The purpose of the Water Marketing Program is to develop water supply storage for municipal and industrial water needs through the purchase of water supply in federal reservoirs in Kansas. The KWO then markets the water to municipal and industrial water users for a cost. Municipalities must file an application to purchase water from a specific reservoir. Contract negations begin at the applicant's request. The contract will include the length of the contract, the reservoir to be used, the amount of water to be withdrawn, the place of use, the billing and payment procedures, and the metering of water and withdrawal schedules. The price is set annually by a formula established by the state and cannot be negotiated. The purchaser must pay at least one half of the contracted amount, whether used or not, and there is an annual charge on the volume that is contracted but not used. Contracts can also be negotiated on a short-term basis (up to but not more than one year) when available. The price of water in a short term contract can be up to double the price in a long-term contract. All contracts are subject to the approval of the Kansas Water Authority and the Kansas Legislature. The KWO has purchased water supply storage in many of the federal reservoirs across the State, including Kanopolis Reservoir.

The KWO recently completed a study to determine the safe yield of Kanopolis Reservoir for water supply purposes during a 50-year drought (KWO, 2008a). The study was initiated due to the lower-than-anticipated lake levels in 2006. This occurrence called their 2002 water supply yield projections into question and the methodology for determining the safe yield was revised for the current study. The current study projects a safe yield for the 50-year drought of 6.5 MGD in year 2047 and 5.9 MGD in year 2057. These projections depend to some extent on the rate of sedimentation in the reservoir. The USACE has found at many of their reservoirs in Kansas that the sedimentation has been occurring at a slower rate than anticipated. The KWO is also studying how to better optimize releases from Kanopolis Reservoir, as described in Chapter 7. Optimization of the releases may increase the volume of the water supply pool. Therefore, the projected future yield of the reservoir may increase.

Around 1997 the USACE investigated the impacts of raising the multi-purpose pool level by two feet and reallocating some flood storage to water supply storage in the multi-purpose pool (USACE, unknown). They are currently studying the impacts of this pool raise to the dam at Kanopolis Reservoir. The pool raise and reallocation were originally studied to supply Post Rock, Salina, and Lindsborg. The pool raise and reallocation would add an additional 20,000 acre-feet of storage to the water supply pool for a total of 32,500 acre-feet. This increase represents more than two and a half times the amount of water supply storage currently available. The KWO could then purchase this additional storage for the Water Marketing Program. Based on this pool raise and reallocation, the USACE estimates that the safe yield for the 50-year drought for the additional water supply storage would be 35 cfs (22.6 MGD). However, the USACE does not use the same methodology to determine the safe yield as the KWO; therefore, the potential yield as determined by the KWO could be different. Although there is interest in a pool raise to expand the water supply available, a pool raise would require environmental assessments, structural modifications, modifications to the outflow at the dam, among other things and would require funding from the USACE and Federal Government. The pool raise was studied by USACE approximately 12 years ago and has not yet come to fruition; therefore, it is not considered a near-term possibility for the Raw Water Supply Study.

Currently the only user under contract to purchase water from Kanopolis Reservoir under the Water Marketing Program is Ellsworth County Rural Water District (RWD) #1 (Post Rock). Various other entities have applied for contracts to purchase water from Kanopolis Reservoir. In 2006 the KWO put all active applications for water from Kanopolis on hold due to low lake levels, the subsequent yield study, and the release optimization study. The amount of water contracted for, applied for, and available in the reservoir is summarized in Table 10-2 (KWO, 2008b).

Table 10-2
Current and Pending Contracts
Kanopolis Reservoir

Applicant	*Date Filed*	*Expires*	*Quantity Requested (MGY)*	*Quantity Requested (MGD)*	*Quantity Contracted (MGY)*	*Quantity Contracted (MGD)*
Post Rock	9/12/1989	7/12/2041			400.000	1.096
Lindsborg	7/7/2000	7/7/2010	606.735	1.662		
PWWSD No. 15	6/17/2002	6/17/2012	2555.000	7.000		
McPherson	4/6/2006	4/6/2016	3650.000	10.000		
Post Rock (1)	6/22/2006	6/22/2016	730.000	2.082		
Russell (1)	6/23/2006	6/23/2016	465.000	1.274		
White Energy Partners (1)	7/14/2006	7/14/2016	550.000	1.507		
Totals			8556.735	23.525		
	Safe Yield (MGD) (2)			6.500		
	Less Quantity Under Contract (MGD)			1.096		
	Uncommitted Quantity (MGD)			5.404		
	Less Quantity in Applications (MGD)			23.525		
	Net Quantity Available (MGD)			-18.121 (3)		

Notes:
(1) There may be some overlap as a portion of Russell and White Energy Partners may also be included in the quantity requested by Post Rock.
(2) Projected safe yield of reservoir in 2048 for a 50-year drought (KWO, 2008a).
(3) The quantity currently requested through applications for water supply contracts is 18.121 MGD more than the water supply withdrawal allowed by the safe yield of the reservoir.

It is unknown when the KWO will resume negotiations with the current applications. Once they resume negotiations, they will require each applicant to justify the need for their requested quantities. In addition, some of the current requests for water supply (potentially Post Rock and Russell) could be moved to Wilson Reservoir if storage is transferred to the Water Marketing Program for water supply.

The safe yield of the reservoir during a 50-year drought will only decrease in the future due to sedimentation of the reservoir unless a pool raise is initiated or optimized operations open up additional water supply storage; therefore expandability of this supply source may not be likely.

There are two options for conveying water from water supply storage at Kanopolis Reservoir to Salina. The first option is conveyance through the Smoky Hill River channel. This option is not considered likely due to the potential losses from the stream to the aquifer during a drought, which are difficult to quantify; it is not guaranteed that the water that is released will make it to Salina. The City would have to purchase more water than is needed to ensure enough water at the intake in Salina. The second option is to construct a surface water intake, pump station, and pipeline (approximately 27 miles) to the water treatment plant in Salina. Construction of a pipeline would be costly, but would guarantee that the storage purchased was conveyed to Salina with minimal losses.

10.7 MILFORD RESERVOIR

The Milford Reservoir is located approximately 45 miles northeast of Salina on the Republican River, as shown in Figure 10-1. Milford Reservoir was constructed by the USACE for the purposes of flood control, water supply, water quality, navigation, recreation and fish and wildlife habitat. It is one of the largest reservoirs in the State and is generally thought of to be of better water quality that the water sources closer to the City of Salina.

The Milford Reservoir has a flood control pool of 32,979 surface acres and a multipurpose pool of 15,709 surface acres. The reservoir has 163 miles of shoreline at the top of a multipurpose pool elevation. The current yield for the conservation storage in the Milford Reservoir is 113 MGD (KWO, 2008b). Table 10-3 summarizes the uses of the multi-purpose storage available in the Milford Reservoir.

Table 10-3
Multi-Purpose Pool Storage
Milford Reservoir

	% of Multi-Purpose Pool	Current Yield (MGD)
Water Quality [1]	0.00%	0
Other/Local [2]	0.00%	0
Water Supply [3]	100.00%	113
Future Use [4]	66.12%	75
In Service [5]	33.88%	38
Water Marketing Program [6]	15.55%	17
Water Assurance District [7]	18.33%	21
Reserve Capacity [8]	0.00%	0

Notes:

[1] Storage that is utilized to make established minimum releases which are intended to maintain flow in the stream below the reservoir.

[2] Storage that has been contracted by the Corps of Engineers to a local water supplier and storage that has been retained by the Corps of Engineers.

[3] Storage that the State of Kansas has (under contract) to serve the needs of municipal and industrial users.

[4] Water supply storage that the Corps of Engineers has deferred payment from the State until the storage is needed. The Corps of Engineers retains ownership of the future use storage until the State calls that storage into service.

[5] Water supply storage that is currently needed.

[6] Storage that is committed to serve the customers of the Water Marketing Program.

[7] Storage that is owned by the municipal and industrial users below the reservoir that have formed an assurance district.

[8] Storage that the State purchased that has not yet been needed for either the Water Marketing or Water Assurance programs. Annual operation and maintenance costs of the Reserve Capacity are paid by the State Water Plan Fund.

Currently the only user under contract through the Water Marketing Program to purchase water from the Milford Reservoir is Westar Energy – Jeffrey Energy Center. Their contract ends in December, 2022 and their annual contract amount is 20 MGD or 22,403 acre-feet. There are no other pending applications on file for purchase of water supply storage through the Water Marketing Program. The Kansas River Water Assurance District #1 is under contract through the Water Assurance Program to pay for an assurance of a set amount of water to be available for use during drought periods (KWO, 2008b).

One of the advantages of potentially utilizing water from the Milford Reservoir is that it is in a different river basin (Kansas-Lower Republican River Basin) than the City's current water supply, which is in the Smoky Hill-Saline River Basin, as shown in Figure 10-8. This could provide a water supply source to the City at times when flows in the Smoky Hill River are low. Most likely though, during a regional drought, water levels in both the Kanopolis Reservoir and the Milford Reservoir will be low.

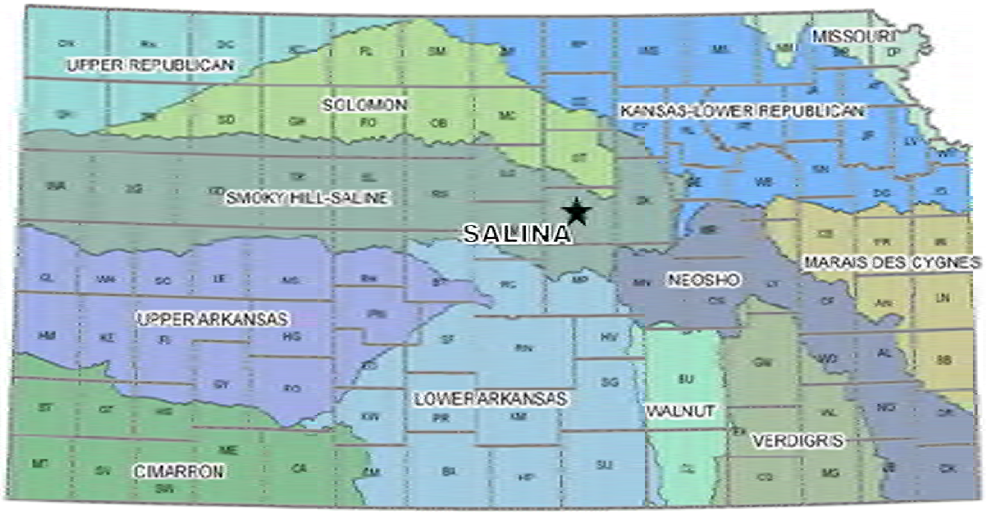


Figure 10-8
Kansas River Basins
(Kansas Water Office website www.kwo.org/BACs/Map_KS_River_Basins.pdf)

Using the Milford Reservoir would involve inter-basin transfer of water under the Water Transfer Act (KSA 82a-1501 through 82a-1508) if the water transferred is over 2,000 acre-ft and the point of use is more than 35 miles away (Salina is more than 35 miles from Milford Reservoir). The inter-basin transfer would need to be adjudicated through procedures established by State of Kansas statutes, which includes an application to the Chief Engineer of DWR requesting a water transfer and other applicable information, and a hearing with a panel consisting of the Chief Engineer of DWR, the Director of the KWO, and Secretary of KDHE. The panel decides whether the inter-basin transfer should be allowed based on the information presented. The hearing is open to the public in the area of the point of diversion; therefore the City could encounter some resistance from eastern Kansas water users, including members of the Kansas River Assurance District No. 1. The process could take up to 18 months to receive an initial determination of whether the inter-basin transfer is even allowed.

The quality of water in Milford Reservoir is better than water sources near Salina. Water quality reports were obtained from KDHE for the Republican River at Clay Center, just upstream of Milford Reservoir. These data show that the chlorides and sulfates are generally below the secondary drinking water standards; TDS averages nearly 575 ppm, which is less than the TDS in the Smoky Hill River at Salina. The level of hardness is similar to the Smoky Hill River at Salina.

The only method of transporting the purchased water to the City of Salina is by means of a pumping station and pipeline. The pipeline would be lengthy (approximately 45 miles in length) and therefore costly.

10.8 WILSON RESERVOIR

Wilson Reservoir is located approximately 55 miles west of Salina on the Saline River, as shown in Figure 10-1. Wilson Reservoir was originally authorized for construction by the U.S. Department of Interior, Bureau of Reclamation for the purposes of irrigation, navigation enhancement, flood control, recreation, fish and wildlife habitat, and water quality assurance. Due to the high salinity of the water, irrigation from the reservoir was determined generally impractical and the operation of the reservoir was transferred to the USACE. Also, due to the distance of the reservoir from the Missouri River, navigation is no longer a specific consideration for the daily operations of the reservoir.

The Wilson Reservoir has a flood control pool of 20,027 surface acres and a multipurpose pool of 9,045 surface acres. The reservoir has 100 miles of shoreline at the top of a multipurpose pool elevation. The multipurpose (conservation) pool has an estimated current capacity of 227,701 acre-feet. The safe yield from the Wilson Reservoir for the year 2044 is 29.0 MGD (KWO, 2004).

Currently there is no storage allocated for water supply in Wilson Reservoir since the KWO does not currently own any storage for the Water Marketing Program. In the past, the high salinity of the water and the high cost of treatment deemed the use of the reservoir impractical for water supply. In recent years, improved treatment technologies that address high salinity have now become available at a more reasonable cost. Therefore, there is renewed interest in utilizing the existing storage capacity for municipal and industrial water supply. The KWO recently initiated a reallocation study to purchase water supply storage in Wilson Reservoir for the Water Marketing Program. As part of this reallocation study, the reservoir yield for water supply may be investigated. Although the report is not available to the public yet, the KWO has projected a demand for water supply of 5.1 MGD in 2050; this projected demand included the City of Hays, City of Russell, and potentially Post Rock and did not include the City of Salina.

The quality of water in Wilson Reservoir is likely to be a concern. The water that flows into Wilson Reservoir is the Saline River; as discussed previously the Saline River is high in salinity, especially in its upper reaches upstream of Wilson Reservoir. Water quality reports were obtained from KDHE for the Saline River near Russell, just upstream of Wilson Reservoir. These data show that the chlorides and sulfates average above the secondary drinking water standards; chlorides average approximately 850 ppm and sulfates average approximately 580 ppm compared to the secondary standard of 250 ppm for both. TDS averages approximately 2,450 ppm and has been measured as high as 7,000 ppm.

Concerns with using water from the Wilson Reservoir are the poor water quality and the fact that this source has never been utilized for public water supply. The only method of transporting water from the reservoir to the City of Salina is by means of a pumping station and pipeline. The pipeline would be lengthy (approximately 55 miles in length) and therefore costly.

10.9 WATER ASSURANCE DISTRICT DEVELOPMENT

During drought periods, natural flow on rivers with reservoirs upstream may generally be considerably reduced. Municipal and industrial water users who hold water rights to the natural flow may find their ability to use the river as a water supply source is severely limited, at a time when their water demand is the highest. When evaluating flow downstream of a reservoir, natural flow is defined as that portion of streamflow that would have been available had the reservoir not been in place.

In 1986 the Water Assurance Program Act (K.S.A. 82a-1330 et seq.) was enacted. This program, when implemented, provides municipal and industrial water right holders downstream of a reservoir with an assurance of a water supply during times of low natural flow. The State of Kansas over the years has acquired water rights to store water in reservoirs and then marketed that stored water to municipalities and industries through the Water Marketing Program and the Water Assurance Program. In the case of the Water Assurance Program, a group of municipalities and industries who have rights to water from a river below a reservoir, could join together as an assurance district to purchase storage space in the reservoir upstream from their location. The assurance district contracts with the State and the State contracts with the Federal Government for storage. The State then coordinates with the USACE to operate the reservoirs in that particular water assurance district river basin as a system for increased efficiency in water delivery to meet the demands of the downstream municipal and industrial water assurance district members during drought conditions. This way the water assurance district members are assured to receive enhanced flow during times of drought; its like having a “drought insurance policy.”

The KWO is currently considering expanding water assurance district membership to water right holders other than municipal and industrial users. This would include extending membership to water right holders for such purposes as irrigation and recreation. In order for this to become a reality, there are various actions that need to be completed. For example, expansion of water district membership to users that are not defined in K.S.A 82a-1331 would require revision of K.S.A. 82a-1331, congressional action, revision of purchase contracts with the USACE, and stakeholder involvement.

Before any assurance district can be formed, the Chief Engineer of the DWR determines which municipal and industrial water right holders are eligible to benefit from water released from assurance district storage. Upon the formation of an assurance district, participation is mandatory for all eligible water right holders. The DWR is charged by statute to protect such releases from diversion by non-members. This is done by ordering non-members to stop pumping during a release.

Currently there are three assurance districts in Kansas: Kansas River Water Assurance District No. 1, Marais des Cygnes River Water Assurance District No. 2, and Cottonwood and Neosho River Basins Water Assurance District No. 3. These three assurance districts own storage in eight reservoirs: Milford, Tuttle Creek, Perry, Marion, Council Grove, John Redmond, Melvern, and Pomona Reservoirs. Figure 10-9 shows a map of the current water assurance districts in Kansas.

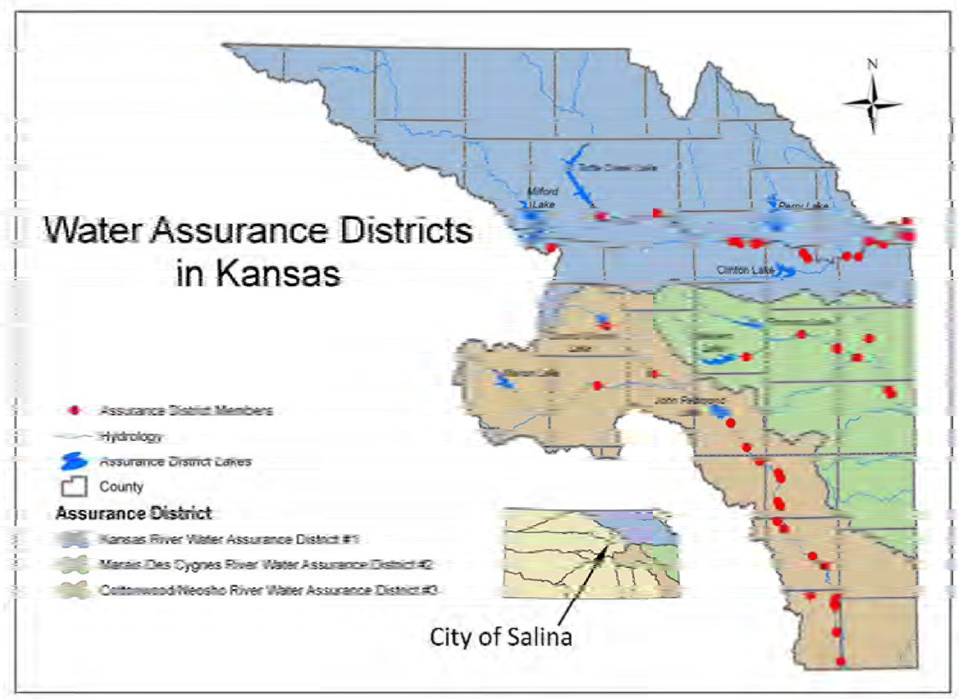


Figure 10-9
Water Assurance Districts in Kansas
Kansas Water Office – Water Assurance Program Fact Sheet No. 8 (September 2006)

There are costs involved with a Water Assurance Program. The assurance district pays whatever the Federal Government charges the State for storage, operation, and maintenance for its water allocation. The assurance district pays the State for their storage and service and whatever costs the State has in administering and enforcing the program. Costs vary by water assurance district and even by member within a water assurance district.

The City of Salina is currently not within an assurance district. The City does hold water rights to the natural flow from the Smoky Hill River downstream of Kanopolis Reservoir. In order to form an assurance district, municipal and industrial water right holders within the Smoky Hill River Basin and downstream of Kanopolis Reservoir would have to vote to become part of a water assurance district and petition to the DWR. According to the KWO there is currently no storage allotted in Kanopolis Reservoir for a Water Assurance Program.

11 ALTERNATIVES

The main objective of the Raw Water Supply study is to evaluate potential water supply alternatives and to select the preferred alternative that will be in the best interest of the City for meeting its goals and objectives through the planning horizon of year 2060. To this point, this report has identified several potential alternatives to be considered for the Raw Water Supply Study. These alternatives represent optimizing the existing sources, water reuse, and developing new sources of supply. Conservation is not considered an alternative but is something the City must continue to do that will only delay the need to bring new sources of supply on-line. From this point, the alternatives previously discussed will be evaluated through an orderly alternative evaluation process in order to narrow the options down to key alternatives that will meet the City's water supply needs over the planning horizon. The alternatives process is described and summarized in the following sections.

11.1 ALTERNATIVES EVALUATION PROCESS

As shown in Figure 11-1, a two-step evaluation process was utilized. The first phase focused on developing and screening initial alternative concepts for infeasible alternatives. The second phase consisted of refinement and evaluation of more specific alternatives. After screening the concepts during a workshop with City staff and agreement by the Citizen's Advisory Board and City Commission, initial concepts were reformulated to reflect new information and more feasible components. These concepts and supporting components were evaluated in more detail. The process and results are described in this chapter.

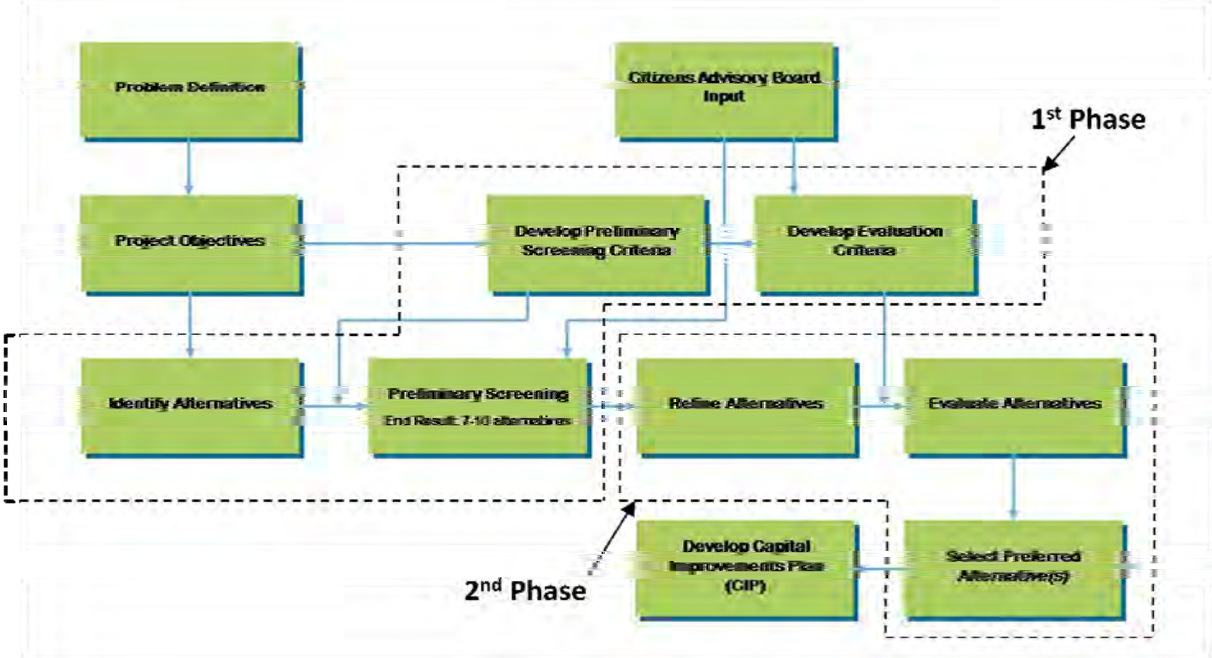


Figure 11-1
Schematic of Water Supply Alternatives Process

11.2 PROBLEM DEFINITION/PROJECT OBJECTIVES

The reasoning for developing this Raw Water Supply Study has been described in detail throughout this report. The extended drought conditions of 2000-2006 strained the ability of the City of Salina to maintain an adequate water supply for its customers. These challenges have resulted in the declaration of the Water Emergency in 2006 when flow in the Smoky Hill River declined to a record low of 1.2 cfs (0.82 MGD). The results of this most recent drought period, declining flows in the Smoky Hill River, and issues with the existing wellfields have led to the need to identify water supply options for the City to meet increasing demands for the next 50 years.

The project objectives are focused on achieving the following goals:

- Increase the reliability of the water supply, particularly during drought periods
- Support economic growth and development through 2060
- Optimize existing infrastructure where possible
- Minimize the risk to the City and its customers
- Minimize the costs to the City and is customers

11.3 IDENTIFICATION OF ALTERNATIVES

This section combines all of the alternatives identified previously that will be considered for the Raw Water Supply Study. Overall, fourteen alternatives were identified and are summarized below. Planning levels costs were estimated for each of the alternatives; costs are based on the likely capital costs for construction of infrastructure, a 30% factor as a planning level contingency, and a 20% factor for engineering and other administrative requirements.

Improvements at Downtown Wellfield

This alternative includes improvements at the Downtown Wellfield to maximize the use of the existing water right of 15.2 MGD. The improvements include re-drilling five of the existing wells with a shorter screen interval to obtain a higher yield, having the contamination that has impacted three of the existing wells treated, and expanding the capacity of the air strippers at the water treatment plant to treat the full allowable wellfield yield. KDHE is considering remediation of the contamination that is currently impacting the Downtown Wellfield. The costs for the wellfield improvements are approximately $6.4 million with a unit cost of $2.13 per gallon (based on an additional yield from the wellfield of 3.0 MGD). This is a source that has been historically used by the City for water supply and has seen reduced pumping capabilities during droughts in the past. The wellfield is not expandable beyond the existing water right as it is closed for new appropriations.

Improvements at South Wellfield

This alternative includes improvements at South Wellfield to maximize the existing water right of 3.7 MGD. The improvements include re-drilling two existing wells that do not have pumps, construction of a water treatment facility to treat iron, manganese, and hardness, and other miscellaneous improvements. The costs for the improvements are approximately $15.2 million with a unit cost of $4.10 per gallon. The aquifer near South Wellfield could be expanded by acquisition of new water rights or existing water rights. The wells at this wellfield are spaced further apart than Downtown Wellfield and water levels may not be as impacted by wellfield pumping.

Seasonal Water Right on Smoky Hill River

This alternative consists of obtaining a seasonal surface water right on the Smoky Hill River and increasing surface water usage during non-peak months to meet demands. Improvements required include a new surface water intake with pump station, raw water piping (could potentially tie in with the existing raw water line), and treatment for taste and odor issues associated with the increased use of surface water. The costs for the improvements are approximately $5.1 million at a unit cost of $0.51/gallon (based on capacity of 10 MGD to meeting average day demands). The Smoky Hill River is not closed to further water right appropriations, however, appropriations can only be diverted on a seasonal basis (October 1 through June 30). The DWR may specify a river flow or gage height above which the water right can be used, which would not guarantee that water can be withdrawn at all times during the non-peak season. The main advantage of this alternative is that using this water right to meet demands during the off-peak season will allow the more senior surface water and groundwater rights to be saved for the peak season and the water levels in the aquifer will be kept to a maximum.

Kanopolis Reservoir

This alternative includes purchase of water supply storage at Kanopolis Reservoir through KWO's Water Marketing Program. Improvements needed include a surface water intake, pump station, and approximately 27 miles of raw water pipeline. Costs for the improvements are approximately $14.0 million at a unit cost of $7.02 per gallon (based on 2 MGD capacity). The projected yield of the reservoir in 2048 is 6.5 MGD; this yield is projected based on decreased inflows to the reservoir. Past 2048 the yield for water supply will decrease due to sedimentation of the reservoir. Information from the KWO indicates they have received 23.5 MGD in applications requesting storage and that the reservoir is potentially over-committed.

Milford Reservoir

This alternative includes purchase of water supply storage at Milford Reservoir through KWO's Water Marketing Program. Improvements needed include a surface water intake and pump station, two booster pump stations, and approximately 45 miles of raw water pipeline. Costs for the improvements are approximately $30.8 million at a unit cost of $6.16 per gallon (based on 5 MGD capacity). Milford Reservoir represents the best water quality source that is available to Salina and is located in a different river basin which may increase reliability. There is currently 75 MGD of water supply yield that has not been opened up by the KWO. The KWO has indicated if an application has been received they would look at opening up more storage; however, they are limited to a certain number of times they can request more storage be opened. Potentially the largest risk would be permitting for inter-basin transfer, which is required if over 2,000 acre-feet is requested at a distance of more than 35 miles.

Wilson Reservoir

This alternative includes purchase of water supply storage at Wilson Reservoir. Improvements needed include a surface water intake and pump station, a reverse osmosis treatment facility including provisions for disposal of the concentrate and water storage, two booster pump stations, and approximately 55 miles of finished water pipeline. Costs for the improvements are approximately $70.5 million at a unit cost of $14.10 per gallon (based on 5 MGD capacity). Wilson Reservoir water quality is saline in nature with high chlorides and total dissolved solids and requires reverse osmosis treatment to get to a desirable water quality. Because of this salinity, the reservoir has not historically been used for water supply and the KWO has not yet purchased water supply storage. The KWO is currently looking into purchasing water supply storage; previous yield studies have indicated there may be 29 MGD of water supply yield available.

Saline River

This alternative includes development of new water right appropriations along the Saline River. Improvements needed include river bank filtration wells (alternatively could construct a horizontal collector well), a reverse osmosis treatment facility including provisions for disposal of the concentrate and water storage, pump station, and approximately 5 miles of finished water pipeline. Costs for the improvements are approximately $41.3 million at a unit cost of $8.25 per gallon (based on 5 MGD capacity). Saline River water quality is saline in nature with high chlorides and total dissolved solids and requires reverse osmosis treatment to get to a desirable water quality. Because of this salinity, the river has not been overly developed with water appropriations and may represent an opportunity for a senior water right for the City. The flow characteristics of the Saline River are similar to the Smoky Hill River in that it is prone to low flow conditions during droughts.

Confluence of Smoky Hill River and Solomon River

This alternative includes development of new water right appropriations along the Smoky Hill River downstream of the confluence with the Solomon River. Improvements needed include river bank filtration wells (alternatively could construct a horizontal collector well), a reverse osmosis treatment facility including provisions for disposal of the concentrate and water storage, pump station, and approximately 13 miles of finished water pipeline. Costs for the improvements are approximately $46.4 million at a unit cost of $9.28 per gallon (based on 5 MGD capacity). This reach of the Smoky Hill River has saline water with high chlorides and total dissolved solids due to the contribution of flow from the Saline River and the Solomon River. As a result it requires reverse osmosis treatment to get to a desirable water quality. Because of this salinity, the river has not been overly developed with water appropriations and may represent an opportunity for a senior water right for the City. The flow characteristics of the Smoky Hill River in this reach are less prone to drought due to the addition of flow from the Saline and Solomon Rivers.

Dakota Aquifer

This alternative includes development of new water right appropriations in the Dakota Aquifer. Improvements needed include approximately 24 wells and 24 miles of wellfield piping (based on ½ mile well spacing), water storage, two booster pump stations, and approximately 11 miles of raw water pipeline. The number of wells and amount of piping that is needed depend of the yield of the aquifer at the location chosen and the location in proximity to the existing water treatment facility. Costs for the improvements are approximately $31.2 million at a unit cost of $6.24 per gallon (based on 5 MGD capacity). The Dakota Aquifer is not connected to the local surface water features as the alluvial aquifer is; therefore this source may increase the reliability of the water supply system. The aquifer is highly variable in terms of well yields and water salinity increases further west of the City, which may increase project development risk.

Construct a Water Supply Reservoir

This alternative includes construction of a water supply reservoir near the City of Salina. Improvements needed include a 25,000 acre-feet reservoir with dam (for 5 MGD yield), surface water intake and pump station, and approximately 5 miles of raw water pipeline. The length of raw water pipeline needed depends on the location chosen for the reservoir. Costs for the improvements are approximately $162 million at a unit cost of $32.48 per gallon (based on 5 MGD capacity). Construction of a reservoir requires extensive time for study, design, and construction and would likely require other water supplies in the interim. Extensive permitting with DWR would be required including water structures permits and a water right would be required for diversion of water into the reservoir. In addition there is a significant amount of property acquisition that is needed for land to develop the reservoir and relocations of roads, utilities, and other surface features.

Acquisition of Existing Water Rights

This alternative includes acquisition of existing groundwater or surface water rights for water supply. Capital expenditures include the purchase of the water rights and land (if an irrigation water right is purchased), re-drilling of wells or construction of a surface water intake and pump station depending on the type of water right acquired, and approximately 5 miles of raw water pipeline. The length of raw water pipeline needed depends on the location of the existing water rights that are acquired. Five miles of pipeline was assumed for planning purposes only. Costs for the improvements are approximately $20.2 million at a unit cost of $4.05 per gallon (based on 5 MGD capacity). These costs are highly dependant of the number of water rights acquired and the locations. The water rights acquired would likely be from the same drought-impacted sources the City currently uses, but irrigation rights would likely be spread out over the aquifer and be less impacted by over-pumping. Groundwater rights cannot be easily moved over ½ mile from their existing point of diversion; surface water rights can be moved as long as the location doesn’t cross other water rights or tributaries to the river. In order to maintain a good relationship with irrigators along the Smoky Hill River, water rights should be acquired from willing sellers.

Develop a Water Assurance District

This alternative includes development of a Water Assurance District and associated purchase of water assurance district storage at Kanopolis Reservoir. There are no real capital expenditures as the Smoky Hill River would be used for conveyance of the water storage and the existing intake and pump station would be used for withdrawal. The only real cost is the annual payment for purchase of storage from the reservoir, which varies by member and is not quantifiable at this time. According to the definition of a water assurance district, the purchase of storage would ensure that flow is available in times of drought. The district would determine how much storage should be purchased based on water rights owned by members and potential stream losses; however during particularly bad drought years if stream losses exceed the pre-determined levels the City may not be able to divert the full water right. The KWO has not allocated any storage to date in Kanopolis Reservoir for a water assurance district. This allocation, if implemented someday, would be part of the 6.5 MGD yield projected for 2048; as discussed previously, the projected yield will only decrease in the future due to sedimentation of the reservoir.

Aquifer Recharge

As discussed in Chapter 7, there are three options for artificial aquifer recharge: infiltration ponds, direct recharge wells, and utilizing the existing river oxbow. This alternative assumes that direct recharge wells are the best option for active (direct) recharge of the aquifer. Improvements needed include five river bank filtration wells along the Smoky Hill River for the water source, approximately two miles of raw water piping, and eleven Class V injection wells. Costs for the improvements are approximately $7.8 million at a unit cost of $1.56 per gallon (based on 5 MGD capacity). The purpose of aquifer recharge is to allow the aquifer water levels to be as high as possible for the peak pumping season to make best use of the existing wellfields. However, during a drought year when the water source is impacted, aquifer recharge may not be possible. In addition, it is unknown if aquifer recharge will work due to the strong interaction between the river and the alluvial aquifer.

Water Reuse

As discussed in Chapter 9, there are three options for utilization of treated wastewater effluent. The options are as follows:

- All irrigation and industrial sites
- All irrigation sites only
- All City-owned irrigation sites only (except the Soccer Complex)

This alternative considers all three options and assumes that the preferred option will be chosen during the capital improvements planning process if this alternative is carried forward. Improvements needed include filtration facilities, additional disinfection for reduction of pathogens, finished water storage and pump station, and a reclaimed water pipeline. The capacities of the facilities and length and size of pipeline vary across the three options. Costs for the improvements are as follows:

- All irrigation and industrial sites – $16.6 million at $3.33 per gallon (based on 5 MGD capacity)
- All irrigation sites only – $11.7 million at $3.20 per gallon (based on 3.67 MGD capacity)
- All City-owned irrigation sites only (except the Soccer Complex) – $6.1 million at $3.19 per gallon (based on 1.90 MGD capacity)

The purpose of water reuse is put water that is normally discharged to the river to beneficial use for irrigation or industries. However, since most irrigation sites use private well water to irrigate their land, the water savings from the municipal water supply system with water reuse will be limited to 0.12 MGD to 0.61 MGD depending on the option chosen. Risks with a water reuse program include public acceptance and the impact of the quality of the treated wastewater on irrigated vegetation.

11.4 PRELIMINARY SCREENING OF ALTERNATIVES

The preliminary screening step is included in the alternatives evaluation process for the purpose of identifying fatal flaws and screening out infeasible options. A wide variety of alternatives were identified in the previous section; however, not all of these alternatives meet the objectives of the Raw Water Supply Study. The preliminary screening was set up to be a simple pass/fail analysis for each alternative based on five general criteria. Then the alternatives were ranked according to how many passing marks they received for further development. The intent was to carry forward to the alternatives evaluation a focused list of 7-10 reasonable alternatives reflecting a wide range of viable solutions.

The five preliminary screening criteria were developed based on the project objectives described previously. For each criterion, each alternative was rated on a pass/fail basis for whether or not it achieved the project objectives. A pass vote received one point and a fail vote received no points. If there were reasons that it could receive either a pass or a fail, a half-point was given. The preliminary screening criteria are summarized below.

- Optimizes Existing Resources – utilizes and makes existing resources as effective or functional as possible
    - Does the alternative utilize or make more effective an existing supply source or existing water rights?
    - Does the alternative utilize or make more effective existing infrastructure (i.e. existing raw water infrastructure, treatment plants, etc)?
- Increases Reliability During Drought Periods – the alternative performs its required functions and enhances the water supply system under drought conditions
    - Was the alternative available during past drought periods?
    - Will the alternative help to increase reliability of an existing source during drought periods (i.e. aquifer recharge)?
    - Does the alternative represent a source that is independent of an existing source that is drought sensitive?
- Minimizes Implementation Risk – the alternative meets institutional and regulatory implementation criteria and reduces the possibility of loss, injury, or hazard to the City and public
    - Is it questionable if the outcome of the alternative will work effectively (i.e. aquifer recharge)?
    - Will the public have any issues with the alternative (i.e. water reuse for certain purposes)?
    - Has the water source ever been utilized for public water supply?
    - Will there be a lengthy permitting, approval, or development process that may delay the water supply (i.e. new water reservoir or water assurance district)?
- Expandable For Future Demands – the alternative can be increased in extent, number, volume, or scope in order to meet future water needs

  - Is the alternative available for additional water rights?
  - Was the alternative available during past drought periods?
  - Is the alternative physically expandable?
- Cost Effective – the preliminary costs of the alternative is favorable in relation to other alternatives. It is above the natural breakpoint line of the costs of all alternatives.

Table 11-1 summarizes the planning levels costs that were determined for the preliminary screening. In most cases the capacity of the alternative was considered to be 5.0 MGD for cost estimating purposes unless more information was known about the alternative (i.e. it is assumed that the yield from Kanopolis would be approximately 2 MGD based on existing and pending contracts for water supply). The summary of costs clearly shows a natural breakpoint between the Confluence (of the Smoky Hill River and Solomon River) and Wilson Reservoir. Prior to this natural breakpoint line, the costs are steadily increasing; Wilson Reservoir and reservoir construction represent a dramatic increase compared to the alternatives above the line. Alternatives above the natural breakpoint line are given a passing score and alternatives below the natural breakpoint line are given a failing score. Development of a water assurance district is assumed to be above the natural breakpoint line since the only costs are annual costs for purchase of storage. Detailed information of the planning level costs is included in Appendix I.

Table 11-1
Summary of Initial Planning Level Costs

Alternative	Capacity (MGD)	Total Construction Cost	Other Costs	Total Project Costs	Cost/gal
Seasonal Water Right	10.00	$4,235,000	$847,000	$5,082,000	$0.51
Aquifer Recharge - Recharge Wells	5.00	$6,512,000	$1,302,000	$7,814,000	$1.56
Downtown Wellfield	3.00	$5,317,000	$1,063,000	$6,380,000	$2.13
Water Reuse City-owned irrigation	1.90	$5,051,000	$1,010,000	$6,061,000	$3.19
Water Reuse all irrigation	3.67	$9,790,000	$1,958,000	$11,748,000	$3.20
Water Reuse all industrial + irrigation	5.00	$13,863,000	$2,773,000	$16,636,000	$3.33
Acquire Existing Water Rights	5.00	$16,857,000	$3,371,000	$20,228,000	$4.05
South Wellfield	3.70	$12,648,000	$2,530,000	$15,178,000	$4.10
Milford Reservoir	5.00	$25,649,000	$5,130,000	$30,779,000	$6.16
Dakota Aquifer	5.00	$26,008,000	$5,202,000	$31,210,000	$6.24
Kanopolis Reservoir	2.00	$11,701,000	$2,340,000	$14,041,000	$7.02
Saline River	5.00	$34,381,000	$6,876,000	$41,257,000	$8.25
Confluence	5.00	$38,662,000	$7,732,000	$46,394,000	$9.28
Wilson Reservoir	5.00	$58,738,500	$11,748,000	$70,486,500	$14.10
Reservoir Construction	5.00	$135,350,800	$27,070,000	$162,420,800	$32.48

Note: The natural breakpoint line of the cost estimates is the bold line. Alternatives above this line are given a passing score while alternatives below the line are given a failing score. Development of a water assurance district is assumed to fall above the natural breakpoint line sine the only costs are the annual purchase of storage and no other capital costs are needed.

The preliminary screening process was completed by the project team and City staff, with confirmation from the Citizen's Advisory Board and the City Commission. The following paragraphs review the preliminary screening and reasoning for the scores given.

Improvements at Downtown Wellfield

- Criterion 1: Optimizes existing resources - PASS
  - Re-drill 5 wells, treat contamination, upsize air strippers to maximize existing water right of 15.2 MGD
- Criterion 2: Increases reliability during drought – PASS/FAIL
  - Same drought-prone source historically used by City
  - Partially increases reliability if all wells can be used
  - Reliability can be further increased with passive/direct recharge
- Criterion 3: Minimizes implementation risk - PASS
  - Minimal risk since it has historically been used by City
- Criterion 4: Expandable for future demands - FAIL
  - Area closed to further appropriations – cannot drill more wells
- Criterion 5: Cost effective – PASS
  - Total cost - $6.4 million
  - Cost/gallon - $2.13/gallon (based on 3 MGD)

Improvements at South Wellfield

- Criterion 1: Optimizes existing resources - PASS
  - Re-drill 2 wells to maximize existing water right of 3.7 MGD
  - Construct treatment plant to reduce iron/manganese/hardness
- Criterion 2: Increases reliability during drought - PASS
  - Considered an additional source to increase reliability
  - Well spacing increases reliability compared to Downtown Wellfield and groundwater not over-developed
- Criterion 3: Minimizes implementation risk - PASS
  - Conventional treatment capable of treating iron, manganese, and hardness with minimal permitting risk
- Criterion 4: Expandable for future demands - PASS
  - May be able to obtain additional water rights or acquire existing water rights
- Criterion 5: Cost effective - PASS
  - Total cost - $15.2 million
  - Cost/gallon - $4.10/gallon (based on 3.7 MGD)

Seasonal Water Right on Smoky Hill River

- Criterion 1: Optimizes existing resources - PASS
  - Use to meet demands during October - June

    - Optimizes wellfields and existing Smoky Hill River water right so that they can be used during times of peak usage
    - Need a new intake, pump station, and treatment for taste & odor
- Criterion 2: Increases reliability during drought – PASS/FAIL
    - Preserves aquifer levels and surface water right for peak usage
    - May be times when cannot use seasonal right due to low flows
- Criterion 3: Minimizes implementation risk - PASS
    - Smoky Hill River already used as a source
- Criterion 4: Expandable for future demands - PASS
    - May be able to obtain additional seasonal water rights
- Criterion 5: Cost effective - PASS
    - Total cost - $5.1 million
    - Cost/gallon - $0.51/gallon (based on 10 MGD)

Kanopolis Reservoir

- Criterion 1: Optimizes existing resources - FAIL
    - Need an intake, pump station, and 27+ miles of pipeline
- Criterion 2: Increases reliability during drought – PASS/FAIL
    - New source for City; decreased Smoky Hill River flows correspond with low levels in Kanopolis Reservoir
- Criterion 3: Minimizes implementation risk - FAIL
    - Risk in ability to obtain storage in the reservoir – over-committed
- Criterion 4: Expandable for future demands - FAIL
    - Safe yield of reservoir will decrease in future due to sedimentation
- Criterion 5: Cost effective - PASS
    - Total cost - $14.0 million
    - Cost/gallon - $7.02/gallon (based on 2 MGD)
    - $113,000 in 2009 to purchase storage (annual cost)

Milford Reservoir

- Criterion 1: Optimizes existing resources - FAIL
    - Need an intake, pump stations, and 45+ miles of pipeline
- Criterion 2: Increases reliability during drought - PASS
    - New source for City; different river-basin than current sources
- Criterion 3: Minimizes implementation risk - FAIL
    - Risk in ability to obtain storage in the reservoir – 75 MGD is allocated for future water supply but has not been opened up
    - Risk in potential inter-basin transfer requirements
- Criterion 4: Expandable for future demands - PASS
    - 75 MGD of storage not currently opened up
- Criterion 5: Cost effective – PASS

    - Total cost - $30.8 million
    - Cost/gallon - $6.16/gallon (based on 5 MGD)
    - $113,000 in 2009 to purchase storage (annual cost)

Wilson Reservoir

- Criterion 1: Optimizes existing resources - FAIL
    - Need an intake, pump stations, and 55+ miles of pipeline, reverse osmosis treatment facility, disposal of concentrate
- Criterion 2: Increases reliability during drought – PASS/FAIL
    - New source for City; decreased Smoky Hill River flows may correspond with low levels in Wilson Reservoir – same basin
- Criterion 3: Minimizes implementation risk - FAIL
    - Has not been used as a water supply source
    - Risk in ability to obtain storage in the reservoir – no allocation for water supply
    - Risk in development and permitting of RO facility
- Criterion 4: Expandable for future demands - PASS/FAIL
    - Possibly – depends if KWO purchases storage and how much they purchase
- Criterion 5: Cost effective – FAIL
    - Total cost - $70.5 million
    - Cost/gallon - $14.10/gallon (based on 5 MGD)
    - $113,000 in 2009 to purchase storage (annual cost)

Saline River

- Criterion 1: Optimizes existing resources - FAIL
    - Need wells to withdraw, reverse osmosis treatment facility, disposal of concentrate, pump station, 5+ miles of pipeline
- Criterion 2: Increases reliability during drought - PASS/FAIL
    - New source for City; decreased Smoky Hill River flows may correspond with low flows in Saline River – same basin
- Criterion 3: Minimizes implementation risk - FAIL
    - Has not been used as a water supply source (municipal)
    - Risk in development and permitting of RO facility
- Criterion 4: Expandable for future demands - PASS
    - Not over-developed with water rights
- Criterion 5: Cost effective – PASS
    - Total cost - $41.3 million
    - Cost/gallon - $8.25/gallon (based on 5 MGD)

Confluence of Smoky Hill River and Solomon River

- Criterion 1: Optimizes existing resources - FAIL

    - Need wells to withdraw, reverse osmosis treatment facility, disposal of concentrate, pump station, 13+ miles of pipeline
- Criterion 2: Increases reliability during drought - PASS
    - New source for City; more flow in river near confluence during past droughts due to Saline River and Solomon River
- Criterion 3: Minimizes implementation risk - PASS/FAIL
    - Currently used for municipal water supply
    - Risk in development and permitting of RO facility
- Criterion 4: Expandable for future demands - PASS
    - Not over-developed with water rights
- Criterion 5: Cost effective – PASS
    - Total cost - $46.4 million
    - Cost/gallon - $9.28/gallon (based on 5 MGD)

Dakota Aquifer

- Criterion 1: Optimizes existing resources - FAIL
    - Low yield wells – need many of them (24 for 5 MGD @ 150 gpm per well)
    - Need wells to withdraw, pump stations, 30+ miles of pipeline (due to well spacing requirements – depends where in Dakota Aquifer)
- Criterion 2: Increases reliability during drought - PASS
    - New source for City that is independent of drought-impacted sources
- Criterion 3: Minimizes implementation risk - FAIL
    - Aquifer highly variable in yield and water quality
- Criterion 4: Expandable for future demands - PASS
    - Not over-developed with water rights
- Criterion 5: Cost effective – PASS
    - Total cost - $31.2 million
    - Cost/gallon - $6.24/gallon (based on 5 MGD)

Construct a Water Supply Reservoir

- Criterion 1: Optimizes existing resources - FAIL
    - Assume can treat at existing WTP if surface water not in use
    - Need reservoir (25,000 AF), intake, pump station, 5+ miles of pipeline (depends on site)
- Criterion 2: Increases reliability during drought - PASS
    - New source for City; inflows into reservoir likely decreased during drought
- Criterion 3: Minimizes implementation risk - FAIL
    - Risk in permitting and development of reservoir – long lead time
    - Risk with dam breaks/flooding and loss of life/property
- Criterion 4: Expandable for future demands - PASS/FAIL
    - Design for planning horizon

    - Yield of reservoir will decrease in future due to sedimentation
- Criterion 5: Cost effective – FAIL
    - Total cost - $162 million
    - Cost/gallon - $32.48/gallon (based on 5 MGD)
    - Does not include costs for relocating roads and utilities, etc

Acquire Existing Water Rights

- Criterion 1: Optimizes existing resources - FAIL
    - If acquire groundwater rights – need to re-drill wells
    - If acquire surface water rights – need to construct intake
- Criterion 2: Increases reliability during drought - PASS/FAIL
    - Likely the same sources as existing sources
    - Water rights acquired would be spread out over aquifer and not as impacted by over-pumping
- Criterion 3: Minimizes implementation risk - PASS
    - Normal permitting with DWR as long as don't move well over ½ mile
    - Willing sellers minimize risk
- Criterion 4: Expandable for future demands - PASS
    - Could obtain additional water rights
- Criterion 5: Cost effective
    - Total cost - $20.2 million – PASS
    - Cost/gallon - $4.05/gallon (based on 5 MGD)
    - Costs depend on how many water rights are acquired and location

Form a Water Assurance District (Kanopolis Reservoir)

- Criterion 1: Optimizes existing resources - PASS
    - Use Smoky Hill River for conveyance and use existing intake
- Criterion 2: Increases reliability during drought – PASS/FAIL
    - Would be a water supply source that is ensured to be available during droughts; Kanopolis may see low levels during a drought
    - May not be able to divert full water right during particularly bad drought years where water losses to the aquifer exceed pre-determined levels and assurance district storage allocation
- Criterion 3: Minimizes implementation risk - FAIL
    - No storage in Kanopolis Reservoir allocated for Water Assurance District
    - Significant development time
- Criterion 4: Expandable for future demands - FAIL
    - Yield of Kanopolis Reservoir will only decrease in the future due to sedimentation
- Criterion 5: Cost effective – PASS
    - Costs vary by Water Assurance District, member, and reservoir
    - Must pay for storage even if don't use it that year; only use when needed

Aquifer Recharge

- Criterion 1: Optimizes existing resources – PASS/FAIL
    - Temporarily increases aquifer levels to optimize existing wellfields
    - Need bank storage diversion wells or off-season water right as source
    - May not optimize wellfield during drought years if can’t withdraw water
- Criterion 2: Increases reliability during drought – PASS/FAIL
    - Increases aquifer levels for wellfields during a drought
    - During drought years may not be able to withdraw water for recharge
- Criterion 3: Minimizes implementation risk - FAIL
    - Unknown if recharge will be effective due to alluvium/river interaction
    - Risk with permitting with DWR
- Criterion 4: Expandable for future demands - FAIL
    - The aquifer can only be recharged so much
    - Wellfields can only be optimized so much
- Criterion 5: Cost effective – PASS
    - Total cost - $7.8 million
    - Cost/gallon - $1.56/gallon (based on 5 MGD)

Water Reuse – 3 Alternatives

- All irrigation + industrial sites; all irrigation sites; City-owned irrigation sites (excluding Soccer Complex)
    - Criterion 1: Optimizes existing resources - PASS
        - Utilizes existing wastewater treatment infrastructure
        - Puts wastewater to beneficial use rather than discharging to river
        - Need additional treatment and pipeline
    - Criterion 2: Increases reliability during drought - FAIL
        - Does not save much from the municipal system (0.2 MGD – 0.6 MGD on average)
    - Criterion 3: Minimizes implementation risk – PASS/FAIL
        - Risk with public acceptance and effect of water quality on vegetation; however it has been done in Kansas successfully
    - Criterion 4: Expandable for future demands - PASS
        - Up to 3 MGD for consistent supply of reclaimed water
        - Minimum flow into wastewater treatment plant will increase as the City grows
    - Criterion 5: Cost effective - PASS
        - All irrigation + industrial sites
            - Total cost – $16.6 million
            - Cost per gallon – $3.33/gallon
            - 0.61 MGD saved from municipal water supply system
        - All irrigation sites
            - Total cost – $11.7 million
            - Cost per gallon – $3.20/gallon

    - 0.19 MGD saved from municipal water supply system
- City-owned irrigation sites (excluding Soccer Complex)
    - Total cost – $6.1 million
    - Cost per gallon – $3.19/gallon
    - 0.13 MGD saved from municipal water supply system

Table 11-2 summarizes the results of the preliminary screening in order of the number of passing criteria received. Alternatives with a score of 2.5 and higher were carried forward to the alternatives evaluation. Acquisition of existing water rights and development of a water assurance district were not carried forward to the evaluation, but instead will remain an integral role in future water supply planning for the City. A total of eight alternatives were carried forward and represent optimization of existing sources, water reuse, and new sources of supply.

Table 11-2
Summary of Results of Preliminary Screening

Alternatives	Preliminary Screening Criteria - # Passing					Total # Passing Criteria
	Optimizes Existing Resources	Increases Reliability during Drought Periods	Minimizes Implementation Risk	Expandable for Future Demands	Cost Effective (above natural breakpoint)	
Improvements at South Wellfield	P	P	P	P	P	5
Obtain a seasonal surface water right	P	P/F	P	P	P	4.5
Improvements at Downtown Wellfield	P	P/F	P	F	P	3.5
Confluence of Smoky Hill and Solomon Rivers	F	P	P/F	P	P	3.5
Acquisition of existing water rights	F	P/F	P	P	P	3.5
Water reuse	P	F	P/F	P	P	3.5
Milford Reservoir	F	P	F	P	P	3
Dakota Aquifer	F	P	F	P	P	3
Saline River	F	P/F	F	P	P	2.5
Develop a water assurance district	P	P/F	F	F	P	2.5
Aquifer recharge	P/F	P/F	F	F	P	2
Kanopolis Reservoir	F	P/F	F	F	P	1.5
Construct a water supply reservoir	F	P	F	P/F	F	1.5
Wilson Reservoir	F	P/F	F	P/F	F	1

Note: Acquisition of existing water rights and development of a water assurance district will not be carried forward to the alternatives evaluation but instead are considered an integral part of future water supply planning.

11.5 ALTERNATIVES EVALUATION

11.5.1 Alternatives Evaluation Process

Alternatives that passed the preliminary screening were developed and further evaluated to determine the preferred alternative(s) for inclusion in the CIP. The first step in the process was to develop and obtain agreement between the City and the Citizens Advisory Board on evaluation criteria for the alternatives. Ten criteria were reviewed and agreed upon to evaluate the alternatives.

The Citizens Advisory Board completed a paired comparison matrix survey in order to define the relative importance of each criterion. The comparison matrix allowed the Citizens Advisory Board to identify those criteria they felt should weigh more heavily in the final alternative selection.

Finally, the alternatives were developed and then evaluated by the project team based on the weighted evaluation criteria from the Citizens Advisory Board. The highest ranked alternatives were developed as the basis for the Capital Improvements Plan (CIP). The CIP will meet the City's water demands through the year 2060.

11.5.2 Alternatives Evaluation Criteria

The alternatives evaluation criteria were developed as a basis for comparing one alternative to another. Criteria were developed by the project team, refined by the City staff and Citizens Advisory Board, and approved by the City Commission. Ten criteria were agreed upon. During the evaluation, each alternative was given a value of 1, 2, or 3 for each criterion. A value of 3 was the highest score and indicated the alternative was very likely to fulfill the criterion objective. A value of 2 was given if the alternative was moderately likely to fulfill the objective, and a value of 1 was assigned if the alternative was not likely to achieve the criterion objective. Each of the ten alternative evaluation criterion and their scoring definitions are described below:

1. Optimizes Existing Resources
   High – 3 Points
   - ✓ The alternative utilizes or makes more effective <u>all</u> of the following: existing water rights, water sources, and infrastructure.

   Moderate – 2 Points
   - ✓ The alternative utilizes or makes more effective <u>one</u> of the following: existing water rights, water sources, or infrastructure.

   Low – 1 Point
   - ✓ The alternative <u>doesn't utilize any</u> existing resources.
2. Increases Reliability During Drought
   High – 3 Points
   - ✓ The alternative <u>will</u> most likely be available during drought and is a <u>different water source</u> than currently utilized.

   Moderate – 2 Points

   - ✓ The alternative will most likely be available during drought but is from the same water source currently utilized.

   Low – 1 Point
   - ✓ The alternative most likely will not be available during drought.

3. Minimizes Implementation Risk (includes public acceptance)

   High – 3 Points
   - ✓ There are no risks involved with implementing this alternative. Public acceptance will not be an issue.

   Moderate – 2 Points
   - ✓ There is only maybe one risk involved with implementing this alternative but most likely this is a minor risk and can be easily mitigated. Public acceptance will not be an issue.

   Low – 1 Point
   - ✓ There is one major or more than one minor risk involved with implementing this alternative that may not be easily mitigated. Public acceptance could be an issue.

4. Expandable for Future Demand

   High – 3 Points
   - ✓ The alternative is easily expandable for future demand and there is adequate water available for future demand.

   Moderate – 2 Points
   - ✓ The alternative is expandable for future demand and there is limited water available for future demand.

   Low – 1 Point
   - ✓ The alternative is not expandable for future demand or there is not adequate water available for future demand.

5. Cost Effective

   High – 3 Points
   - ✓ The alternative has low capital costs (compared to the other alternatives). It is in the range of up to $5/gallon.

   Moderate – 2 Points
   - ✓ The alternative has moderate capital costs (compared to the other alternatives). It is in the range of $5/gallon to $10/gallon.

   Low – 1 Point
   - ✓ The alternative has high capital costs (compared to the other alternatives). It is higher than $10/gallon.

6. Time to Implement

   High – 3 Points
   - ✓ The time to design, permit, and construct this alternative is most likely up to a 3 year process.

   Moderate – 2 Points
   - ✓ The time to design, permit, and construct this alternative is most likely a 3-6 year process

   Low – 1 Point

- ✓ The time to design, permit, and construct this alternative is most likely longer than a 6 year process.

7. Minimizes Environmental Impacts

   High – 3 Points
   - ✓ The alternative avoids or minimizes all potential environmental impacts. All environmental impacts can be easily mitigated.

   Moderate – 2 Points
   - ✓ The alternative avoids or minimizes most potential environmental impacts. Most of the environmental impacts can be mitigated.

   Low – 1 Point
   - ✓ The alternative will have a negative environmental impact that cannot be mitigated.

8. Desirable Water Quality

   High – 3 Points
   - ✓ The alternative will require no additional water treatment above what is currently provided at the existing water treatment facility.

   Moderate – 2 Points
   - ✓ The alternative will require additional conventional water treatment processes (i.e. softening or iron & manganese removal, etc.).

   Low – 1 Point
   - ✓ The alternative will require additional advanced water treatment process (i.e. reverse osmosis, ozone, etc.).

9. Permitability

   High – 3 Points
   - ✓ The alternative will require minor additional permitting/approval process (KDHE approval of plans and specifications is not included.

   Moderate – 2 Points
   - ✓ The alternative will require a number of permits not out of the ordinary in Kansas (i.e. water right acquisition, facility permitting, pilot testing, etc.).

   Low – 1 Point
   - ✓ The alternative will require major permitting/approval process (i.e. injection well, inter-basin transfer, etc.).

10. Sustainability

    High – 3 Points
    - ✓ The alternative will have the ability to optimize its benefits without diminishing the capacity for similar benefits in the future (i.e. the alternative will be able to supply water in 50 years.)

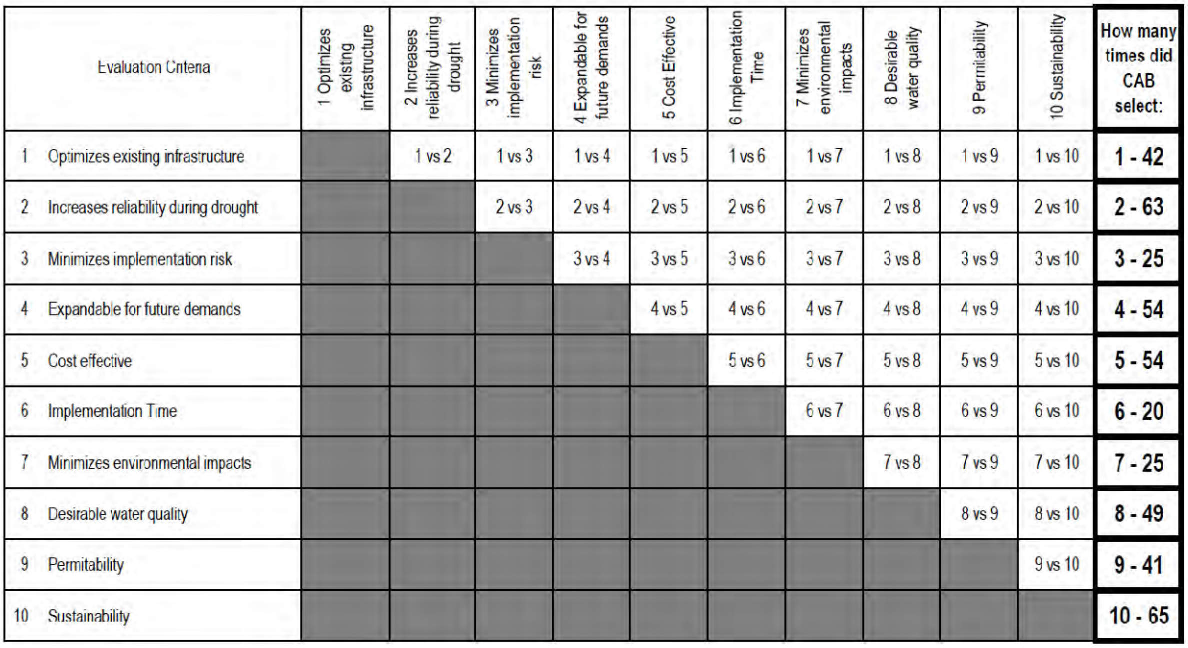
    Moderate – 2 Points
    - ✓ The alternative may have the ability to optimize its benefits without diminishing the capacity for similar benefits in the future (i.e. the alternative may be able to supply water in 50 years.)

    Low – 1 Point

✓ The alternative will not have the ability to optimize its benefits without diminishing the capacity for similar benefits in the future (i.e. the alternative will not be able to supply water in 50 years.)

The ten criteria are all important factors that should be considered in selecting a preferred alternative. However, the criteria are not of equal importance in meeting the City's water supply objectives. A weighting system was developed in order to determine which criteria are the most important and should factor more heavily into the alternative evaluation. A paired comparison matrix was completed by the Citizens Advisory Board in order to determine the relative importance and assign a numerical weighting value to each criterion. Table 11-3 shows the paired comparison matrix and the results of the survey.

Table 11-3
Paired Comparison Matrix and Results



Evaluation Criteria	1 Optimizes existing infrastructure	2 Increases reliability during drought	3 Minimizes implementation risk	4 Expandable for future demands	5 Cost Effective	6 Implementation Time	7 Minimizes environmental impacts	8 Desirable water quality	9 Permitability	10 Sustainability	How many times did CAB select:
1 Optimizes existing infrastructure		1 vs 2	1 vs 3	1 vs 4	1 vs 5	1 vs 6	1 vs 7	1 vs 8	1 vs 9	1 vs 10	**1 - 42**
2 Increases reliability during drought			2 vs 3	2 vs 4	2 vs 5	2 vs 6	2 vs 7	2 vs 8	2 vs 9	2 vs 10	**2 - 63**
3 Minimizes implementation risk				3 vs 4	3 vs 5	3 vs 6	3 vs 7	3 vs 8	3 vs 9	3 vs 10	**3 - 25**
4 Expandable for future demands					4 vs 5	4 vs 6	4 vs 7	4 vs 8	4 vs 9	4 vs 10	**4 - 54**
5 Cost effective						5 vs 6	5 vs 7	5 vs 8	5 vs 9	5 vs 10	**5 - 54**
6 Implementation Time							6 vs 7	6 vs 8	6 vs 9	6 vs 10	**6 - 20**
7 Minimizes environmental impacts								7 vs 8	7 vs 9	7 vs 10	**7 - 25**
8 Desirable water quality									8 vs 9	8 vs 10	**8 - 49**
9 Permitability										9 vs 10	**9 - 41**
10 Sustainability											**10 - 65**

Members of the Citizens Advisory Board participated in the paired comparison matrix survey. In each box in Table 11-3, the participant selected which criterion s/he felt was more important. The results of how often each criterion was selected are tallied in the far right column in Table 11-3. The criterion most frequently selected by the Citizens Advisory Board was Sustainability, which received 65 of the 438 selections (14.8%). Table 11-4 lists the criteria from most often selected in the paired comparison matrix survey to the least selected. The far right column in Table 11-4 lists the weighting factors for each criterion. The weighting factor reflects the number of times a criterion was selected divided by the total number of selections (438). The use of the weighting factor is discussed in Section 6.4.

Table 11-4
Paired Comparison Matrix Survey Results and Weighting Factors

Evaluation Criteria	# Times Selected:	Weighting Factor
Sustainability	65	14.8%
Increased reliability during drought	63	14.4%
Expandable for future demands	54	12.3%
Cost effective	54	12.3%
Desirable water quality	49	11.2%
Optimizes existing infrastructure	42	9.6%
Permitability	41	9.4%
Minimizes implementation risk	25	5.7%
Minimizes environmental impacts	25	5.7%
Implementation Time	20	4.6%
Total	438	100.0%

11.5.3 Description of Alternatives

The ten alternatives that were developed for final evaluation are described in more detail in this section.

11.5.3.1 Improvements at South Well Field

As discussed previously, the City currently owns water rights for five public water supply wells (Vested Right SA035) at South Wellfield, which previously provided service for the former Schilling Air Force Base. The individual water right totals to 2,511 acre-feet per year or 3.7 MGD on a maximum diversion basis. The City owns and operates three active wells at this wellfield; the remaining two wells previously had their pumps removed and are not in use. The City has not used this source consistently in the past due to the water being high in iron and manganese and the associated complaints they receive from industrial customers when they operate the wellfield. Therefore, this alternative is based on utilizing the existing water rights and three of the existing wells to make this wellfield usable for water supply purposes.

The existing wells at the South Wellfield draw from the Smoky Hill River alluvium, similar to the Downtown Wellfield. Although the alluvium at the South Wellfield is not independent of the Smoky Hill River, the reliability of this wellfield is greater than that of the Downtown Wellfield. The wells in the South Wellfield are spaced further apart than wells in the Downtown Wellfield; therefore, pumping may not have as big of an impact on aquifer levels near the South Wellfield due to minimizing overlapping cones of depression. In addition, the development of private wells which impact the local levels of the aquifer may not be as developed in this part of town.

Under this alternative, the following infrastructure improvements are required:

- Rehabilitate or offset/replace the two existing wells that do not currently have pumps (Wells No. 3 and 4). These two wells have the ability to add 1,000 to 1,600 gpm based on the aquifer transmissivity. An additional 995 to 1,125 gpm is needed to maximize the water right.
- Addition of two groundwater observation wells to continuously monitor the aquifer levels. One observation well should be located within the wellfield to monitor aquifer response to pumping; the other observation well should be located away from the wellfield to monitor the general aquifer levels.
- Demolition of the existing Schilling Water Treatment Plant (the assumption as a conservative approach is that none of the equipment or infrastructure at this plant is reusable).
- Addition of a conventional treatment facility to remove hardness, iron, and manganese. The plant would also include finished water storage and high service pumping.
- Replacement of the raw water piping.
- Addition of finished water piping to connect the new treatment facility to the distribution system

The South Wellfield is located in the Schilling Pressure Zone, which is a higher pressure zone than most of the City (Base Pressure Zone). If the South Wellfield is developed as a source, the City should consider using the existing hydraulic model to determine if any improvements are needed to improve flow from the Schilling Pressure Zone to the Base Pressure Zone. For the South Wellfield to be most effective, especially during a drought, the system should be capable of adequately transferring flow between the two pressure zones.

The area near South Wellfield is mostly rural and can be expanded to accommodate increasing future demands. Two options exist for expansion of the water rights: 1) obtain a new appropriated water right for groundwater near the South Wellfield; or 2) purchase existing groundwater water rights in the area and convert them to municipal use. The City could purchase land adjacent to the existing Schilling Water Treatment Plant to construct the new treatment facility with space for expansion. The plant could be expanded to accommodate additional groundwater treatment and/or a surface water settling basin could be added to accommodate the potential for surface water treatment as well.

There are no anticipated risks associated with the development of the wellfield and water treatment facility. The treatment scheme would likely include lime softening, which is a common practice in Kansas and involves routine permitting requirements. Implementation of this alternative includes time for design, permitting, and construction and will likely take less than three years.

11.5.3.2 Obtain a Seasonal Surface Water Right

As discussed previously, the Smoky Hill River has been the main source of the City's raw water supply, accounting for approximately 60% on average. The Downtown Wellfield constitutes the other 40%. Most of the time, flow in the Smoky Hill River is plentiful to support additional surface water diversions. A seasonal surface water right on the Smoky Hill River could be obtained to meet demands during off-season months (October through June). An off-season surface water right would serve two purposes: 1) it would preserve the more senior appropriated surface water right and vested and appropriated rights at the

Downtown Wellfield for the peak summer months, and 2) preserves aquifer levels at the Downtown Wellfield (passive recharge) for the peak summer months so that pumping capacities are not reduced by aquifer level declines. The Downtown Wellfield may need to be pumped a minimum of 1,000 gpm in order to temper the surface water during the colder months; however, this impact to the aquifer levels at the wellfield should be minimal. There is also an added benefit that utilizing more surface water will decrease treatment costs as compared to treatment of groundwater.

Under this alternative, the following infrastructure improvements are required:

- A new surface water intake is needed in order to avoid “stacking” of water rights. If the existing intake were to be used for the seasonal water right in addition to the existing appropriated water right, the more senior water right would be “pumped” first and the purpose of the seasonal water right would be partially defeated. A surface water intake requires construction in the river and could cause some environmental impacts.
- Raw water piping from the new intake. This piping could be tapped into the existing raw water piping that runs to the existing water treatment plant.
- Ozone treatment for reduction of taste and odor impacts and control of DBPs due to the increased use of surface water. Ozone treatment is needed for treatment of surface water regardless of whether this alternative is implemented; therefore, costs for ozone treatment are not included.

The seasonal water right does not directly support water supply during a drought; however, it does indirectly support water supply during a drought by allowing the aquifer levels to be at their highest at the start of a drought period provided there is sufficient water from the river available for use before the drought. At this time the benefit of the alternative in terms of sustained aquifer levels is not quantifiable and it is unknown how effective the seasonal water right would be on aquifer levels. This alternative does not guarantee that the City can withdraw from the river everyday and there may be short periods of time during drought periods when the City cannot use this water right and must either use their senior surface water right, which is not conditioned for seasonal flow, or the wellfields. Although this alternative is likely expandable for future demands with the acquisition of additional seasonal water rights, the declining flow trend of the Smoky Hill River indicates that this alternative may not be sustainable.

The seasonal surface water right would require obtaining the water right from the DWR as well as permitting for a new surface water intake. The time to implement this alternative including design, permitting, and construction would likely take less than three years.

11.5.3.3 Improvements at Downtown Wellfield

As discussed previously, the City currently owns water rights for fifteen (15) public water supply wells at Downtown Wellfield. The water rights total to 4,993 acre-feet per year or 15.2 MGD on a maximum diversion basis. The Downtown Wellfield has historically been one of the main sources of supply for the City, contributing to approximately 40% of the raw water supply on average. However, aquifer levels during a drought can be negatively impacted due to the connection with the Smoky Hill River and the proximity of the wells to each other, producing overlapping cones of depression. This alternative is based on fully utilizing the existing water rights and infrastructure.

The total pumpage available from the existing wells is 8,420 gpm, or 12.2 MGD. The existing water right limits the wellfield to a maximum diversion of 10,568 gpm, or 15.2 MGD; therefore there is a potential to get an additional 2,148 gpm (3.0 MGD) from the existing wellfield to maximize use of the existing water right. The groundwater area around the Downtown Wellfield is closed for additional water right appropriations, therefore it is not expandable for future demands.

As discussed previously, the industrial contamination plume is affecting Wells No. 11, 12, 15, and 16, the best-producing wells in the wellfield. 1,2-DCA concentrations are seen in excess of what the existing air-strippers at the water treatment plant can treat and because of this the City has discontinued use of wells No. 11, 15 and 16. KDHE has looked into potential scenarios to clean-up the contamination and mitigate impacts to the Downtown Wellfield, including installing a capture well. It is unknown whether KDHE will proceed with this mitigation or not; however, in order for the City to maximize use of the Downtown Wellfield, something must be done for the City to be able to use the wells they have discontinued.

This alternative alone does not increase the reliability of the raw water supply system. However, in conjunction with other alternatives, such as the seasonal surface water right which preserves the aquifer levels for the times that they are needed the reliability of the existing source can be increased.

Under this alternative, the following infrastructure improvements are required:

- Plug, abandon, offset the location, and re-drill five wells with a shorter screen interval to increase the capacity of the well. Issues to consider when choosing which wells to replace include age of the well, location with respect to the contamination plume, ability to move well with respect to surrounding surface features, and availability of capacity per the water rights.
- Increase capacity of the air strippers at the water treatment plant from 10 MGD to 15.2 MGD to accommodate the full wellfield yield.
- Improvements to the raw water piping to accommodate flows at the full water right.

The following infrastructure improvements are optional:

- Installation of a granular activated carbon treatment system on the combined piping from Wells No. 11, 12, 15, and 16 to treat 1,2-DCA to levels the existing air-strippers can treat.

There are no significant implementation risks, environmental risks, or permitting requirements associated with this alternative. Obtaining property for drilling the new wells is the critical item. Implementation time including design, permitting, and construction would likely take less than three years.

11.5.3.4 Confluence of Smoky Hill and Solomon Rivers

The City does not currently own any water rights along the Smoky Hill River near the confluence of the Saline River and Solomon River. Therefore, this source represents a new source that is independent of the

City's existing sources. The confluence of the Smoky Hill River, Saline River, and Solomon River is approximately 12 miles downstream of Salina.

As discussed previously, the water rights along the confluence have not been significantly developed; however, the City of Salina would be junior to a large surface water right for Westar Energy. Although this source is in the same region as the existing sources of supply for the City, the contribution of flow from the Saline River and the Solomon River, two major tributaries, increases the reliability of the river during a drought in this reach compared to the reach at the City's existing intake at Salina. For example, during the drought period of 2000-2006, the flow at the USGS gage at Enterprise, the 90% exceedence was 127 cfs compared to 25 cfs at the USGS gage at Mentor.

One reason for the underdevelopment of water rights along the confluence is the brackish water quality. Water quality reports show that the TDS average approximately 1150 ppm and have been measured as high as 2,500 ppm, compared to the secondary standard of 500 ppm. Although the Smoky Hill River near Salina does not experience this level of TDS, the flow from the Saline River and the Solomon River, which both cut through the Dakota Aquifer, contribute to the salinity of the water near the confluence. Although TDS is not an enforceable primary drinking water standard, it is a secondary standard that is recommended to enhance the aesthetic and taste qualities of the water. Because of these high levels of TDS, a reverse osmosis facility is required to treat the water to the secondary drinking water standard of 500 ppm as conventional treatment process are not capable of treating this level of TDS.

Under this alternative, the following infrastructure improvements are required:

- Installation of river bank filtration wells along the Smoky Hill River downstream of the confluence with the Solomon River. River bank filtration wells are recommended as opposed to a surface water intake as withdrawal will subsequently not be limited to certain times of the year, and the process of river bank filtration can provide some pretreatment of the water prior to the water treatment plant. Alternatively, a horizontal collector well could be constructed.
- Raw water piping from the wellfield to the water treatment facility.
- A reverse osmosis treatment facility for removal of chlorides and total dissolved solids. The water treatment facility would be located adjacent to the river and wellfield in order to minimize the costs of pumping what would become product (finished) water and concentrate water for the reverse osmosis process. The treatment process will include the following:
    - Pre-treatment
    - Reverse osmosis membrane system
    - Post-treatment for stabilization
- Deep-well injection wells (Class I) for disposal of concentrate
- Clearwell and pumping facilities
- Finished water piping from the reverse osmosis water treatment facility to the finished water storage reservoirs at the existing water treatment plant in Salina

There are risks associated with this alternative. This source has not typically been used in the past as a water supply due to the brackish water quality. In addition, there is risk with public acceptance of the disposal of the concentrate and its potential environmental impacts. A Class I Underground Injection permit from KDHE would be required for the deep injection wells. Implementation time including design, permitting, and construction would likely be three to six years.

11.5.3.5 Water Reuse – All Irrigation & Industrial

As discussed previously, the City could provide reclaimed water to irrigate Bill Burke Park, the Soccer Complex, Salina Municipal Golf Course, Salina County Club, Elks Country Club, and the East Crawford Recreational Area. The City would also provide reclaimed water for industrial use (non irrigation) to the Exide Corporation, Philips Lighting Company, Metlcast Products, Great Plains Manufacturing, and El Dorado National. The projected average day demand is 2.1 million gallons and the peak day demand is 5.0 million gallons.

Under this alternative, the following infrastructure improvements are required at the existing wastewater treatment plant:

- Filtration facilities
- Additional disinfection
- Storage tank and pump station
- 13 miles of pipeline (16” and 8”)

There are implementation risks associated with this alternative including public acceptance of the use of treated wastewater, the impact of the water quality on vegetation, the ability of industries to accept and further treat treated wastewater for use in their processes, and the willingness of irrigators with private water rights to convert to the municipal reclaimed water system.

Water reuse has been permitted in Kansas in many other communities and would require an update of the existing NPDES permit to include the irrigation and industrial facilities as permitted discharge sites. Implementation time including design, permitting, construction, and conversion of customers to the reclaimed water system would likely take between three and six years.

11.5.3.6 Water Reuse – All Irrigation Only

As discussed previously, the City could provide reclaimed water to irrigate Bill Burke Park, the Soccer Complex, Salina Municipal Golf Course, Salina County Club, Elks Country Club, and the East Crawford Recreational Area. The projected average day demand is 1.7 million gallons and the peak day demand is 3.7 million gallons.

Under this alternative, the following infrastructure improvements are required at the existing wastewater treatment plant:

- Filtration facilities
- Additional disinfection

- Storage tank and pump station
- 6.5 miles of 16” pipeline

There are implementation risks associated with this alternative including public acceptance of the use of treated wastewater, the impact of the water quality on vegetation, and the willingness of irrigators with private water rights to convert to the municipal reclaimed water system.

Water reuse has been permitted in Kansas in many other communities and would require an update of the existing NPDES permit to include the irrigation and industrial facilities as permitted discharge sites. Implementation time including design, permitting, construction, and conversion of customers to the reclaimed water system would likely take between three and six years.

11.5.3.7 Water Ruse – All City-Owned Irrigation Only

As discussed previously, the City could provide reclaimed water for irrigation to City-owned properties only, including Bill Burke Park, Salina Municipal Golf Course, and the East Crawford Recreational Area. The soccer complex, despite being City-owned, is excluded due to the requirement for an additional 11,600 feet of pipeline to serve its relatively small flow. The projected average day demand is 0.6 million gallons and the peak day demand is 1.9 million gallons.

Under this alternative, the following infrastructure improvements are required:

- Filtration facilities
- Additional disinfection
- Storage tank and pump station
- 3.4 miles of 10” pipeline

There are implementation risks associated with this alternative including public acceptance of the use of treated wastewater and the impact of the water quality on vegetation.

Water reuse has been permitted in Kansas in many other communities and would require an update of the existing NPDES permit to include the irrigation and industrial facilities as permitted discharge sites. Implementation time including design, permitting, construction, and conversion of customers to the reclaimed water system would likely take between three and six years.

11.5.3.8 Milford Reservoir

The City does not currently own any water supply storage in Milford Reservoir. Water supply storage is purchased through KWO’s Water Marketing Program. Therefore, this source represents a new source that is independent of the City’s existing sources. Milford Reservoir is approximately 45 miles east of Salina in the Republican River drainage basin. Water quality is likely similar to or better than the Smoky Hill River.

As discussed previously, there is 75 MGD of water supply capacity that is available in the reservoir although payment on this storage by the State has been deferred (i.e. it is not open for use). The KWO would consider beginning payment on part of this storage if there was interest; however they are limited to a certain number of times that they can request storage be opened up. Currently there are no pending applications on file for this water supply capacity.

Under this alternative, the following infrastructure improvements are required:

- Installation of a surface water intake and pump station at the reservoir for direct withdrawal.
- Approximately 45 miles of 16” raw water piping from the intake and pump station to Salina. There could be some environmental impacts with the construction of a 45 mile pipeline that could need to be mitigated.
- Two booster pump stations between Milford Reservoir and Salina to overcome head losses due to pipe friction and elevation differences.
- It is assumed that water obtained from Milford Reservoir can be treated at the existing water treatment plant. Water quality testing at Milford Reservoir may indicate some savings in water treatment chemical costs if the water quality is better than the Smoky Hill River.

Using the Milford Reservoir would involve inter-basin transfer of water under the Water Transfer Act (KSA 82a-1501 through 82a-1508) if the water transferred is over 2,000 acre-ft and the point of use is more than 35 miles away (Salina is more than 35 miles from Milford Reservoir). The inter-basin transfer process is open to the public and Salina may encounter resistance from Eastern water users including Water Assurance District #1, who may not want existing supply sources to leave their basin. The process could take 18 months to two years to receive a determination of whether the inter-basin transfer is allowed. Implementation time including design, permitting, and construction would likely take more than six years.

11.5.3.9 Dakota Aquifer

The City does not currently own any water rights in the Dakota Aquifer. Therefore, this source represents a new source that is independent of the City’s existing sources. The Dakota Aquifer is found outside of the City limits and outside of the extents of the Smoky Hill River alluvial aquifer.

Under this alternative, the following infrastructure improvements are required:

- Construction of a wellfield consisting of approximately 24 wells (depending on the local aquifer yield) at a depth of approximately 300’ deep. The wells would be spaced ½ mile apart requiring 12 miles of raw water pipelines.
- Water storage tank and pump station
- Booster pump station between the wellfield and Salina to overcome friction losses and elevation difference
- Approximately 12 miles of 16” raw water pipeline between the wellfield and Salina (depends on where in the aquifer the wellfield is located).
- It is assumed that water obtained from the Dakota Aquifer can be treated at the existing water treatment plant.

The number of wells required for the wellfield is dependent on the yield obtained from each new well. The Dakota Aquifer is highly variable in yield and water quality; depending on the particular location, yields of 50 gpm to 300 gpm and total dissolved solids between 250 mg/L and 2,000 mg/L can be obtained.

Implementation time including design, permitting, and construction would likely take between three and six years.

11.5.3.10 Saline River

The City does not currently own any water rights along the Saline River. Therefore, this source represents a new source that is independent of the City's existing sources. The Saline River is approximately 5 miles northeast of the City of Salina.

As discussed previously, the water rights along the Saline River have not been significantly developed. The flow in the Saline River is similar to the Smoky Hill River in that it is prone to low flows during drought periods.

One reason for the underdevelopment of water rights along the Saline River is the brackish water quality. Water quality reports show that the TDS average approximately 1150 ppm and have been measured as high as 2,000 ppm, compared to the secondary standard of 500 ppm. Although TDS is not an enforceable primary drinking water standard, it is a secondary standard that is recommended to enhance the aesthetic and taste qualities of the water. Because of these high levels of TDS, a reverse osmosis facility is required to treat the water to the secondary drinking water standard of 500 ppm as conventional treatment process are not capable of treating this level of TDS.

Under this alternative, the following infrastructure improvements are required:

- Installation of river bank filtration wells along the Saline River. River bank filtration wells are recommended as opposed to a surface water intake as withdrawal will subsequently not be limited to certain times of the year, and the process of river bank filtration can provide some pretreatment of the water prior to the water treatment plant. Alternatively, a horizontal collector well could be constructed.
- Raw water piping from the wellfield to the water treatment facility.
- A reverse osmosis treatment facility for removal of chlorides and total dissolved solids. The water treatment facility would be located adjacent to the river and wellfield in order to minimize the costs of pumping what would become product (finished) water and concentrate water for the reverse osmosis process. The treatment process will include the following:
    - Pre-treatment
    - Reverse osmosis membrane system
    - Post-treatment for stabilization
- Deep-well injection wells (Class I) for disposal of concentrate
- Clearwell and pumping facilities

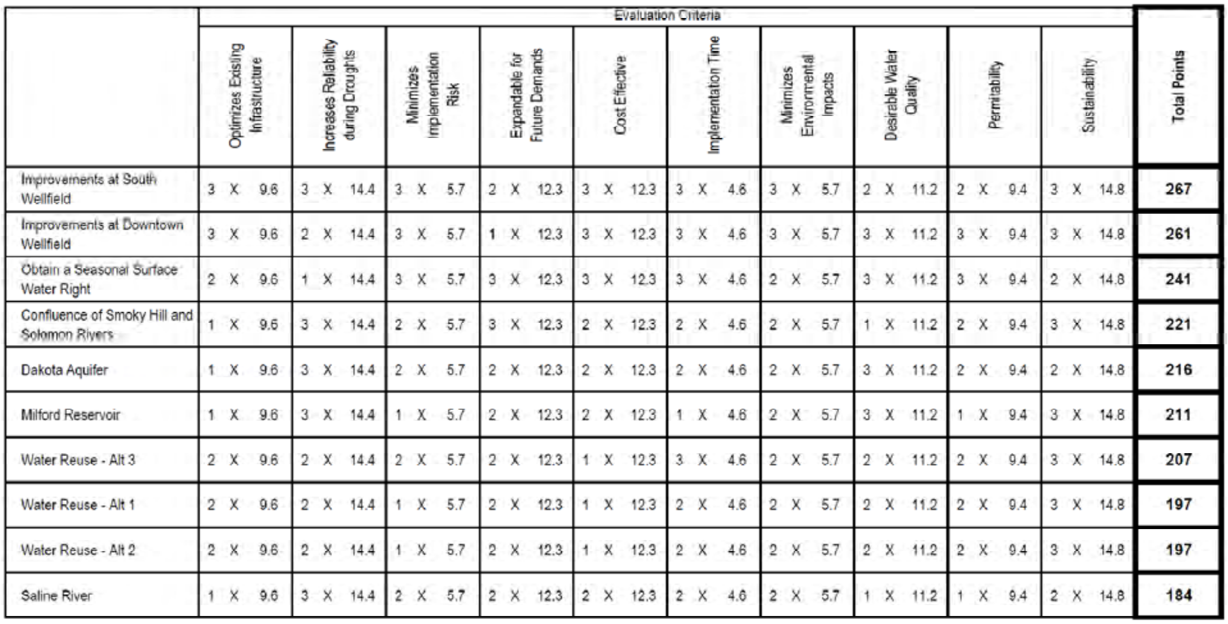
- Finished water piping from the reverse osmosis water treatment facility to the finished water storage reservoirs at the existing water treatment plant in Salina

There are risks associated with this alternative. This source has not typically been used in the past as a water supply due to the brackish water quality. In addition, there is risk with public acceptance of the disposal of the concentrate and its potential environmental impacts. A Class I Underground Injection permit from KDHE would be required for the deep injection wells. Implementation time including design, permitting, and construction would likely three to six years.

11.6 RESULTS OF ALTERNATIVES EVALUATION

The alternatives described above were scored based on a combination of the alternative evaluation criteria values and the paired matrix weighting factors. Each alternative was evaluated based on all ten criteria. For each criterion, an alternative was assigned an evaluation criteria score of 1, 2, or 3 by the project team, which was then multiplied by the weighting factor corresponding to that particular criterion. For example, the completion of improvements at South Wellfield optimize existing resources including wells and water rights, so the alternative is assigned a value of 3, which is weighed by multiplying by 9.6. Scoring was conducted for all of the alternatives that passed the preliminary screening step. The assigned scoring and results of the alternatives evaluation are shown in Table 11-5.

Table 11-5
Alternatives Evaluation



	Evaluation Criteria										
	Optimizes Existing Infrastructure	Increases Reliability during Droughts	Minimizes Implementation Risk	Expandable for Future Demands	Cost Effective	Implementation Time	Minimizes Environmental Impacts	Desirable Water Quality	Permitability	Sustainability	**Total Points**
Improvements at South Wellfield	3 X 9.6	3 X 14.4	3 X 5.7	2 X 12.3	3 X 12.3	3 X 4.6	3 X 5.7	2 X 11.2	2 X 9.4	3 X 14.8	**267**
Improvements at Downtown Wellfield	3 X 9.6	2 X 14.4	3 X 5.7	1 X 12.3	3 X 12.3	3 X 4.6	3 X 5.7	3 X 11.2	3 X 9.4	3 X 14.8	**261**
Obtain a Seasonal Surface Water Right	2 X 9.6	1 X 14.4	3 X 5.7	3 X 12.3	3 X 12.3	3 X 4.6	2 X 5.7	3 X 11.2	3 X 9.4	2 X 14.8	**241**
Confluence of Smoky Hill and Solomon Rivers	1 X 9.6	3 X 14.4	2 X 5.7	3 X 12.3	2 X 12.3	2 X 4.6	2 X 5.7	1 X 11.2	2 X 9.4	3 X 14.8	**221**
Dakota Aquifer	1 X 9.6	3 X 14.4	2 X 5.7	2 X 12.3	2 X 12.3	2 X 4.6	2 X 5.7	3 X 11.2	2 X 9.4	2 X 14.8	**216**
Milford Reservoir	1 X 9.6	3 X 14.4	1 X 5.7	2 X 12.3	2 X 12.3	1 X 4.6	2 X 5.7	3 X 11.2	1 X 9.4	3 X 14.8	**211**
Water Reuse - Alt 3	2 X 9.6	2 X 14.4	2 X 5.7	2 X 12.3	1 X 12.3	3 X 4.6	2 X 5.7	2 X 11.2	2 X 9.4	3 X 14.8	**207**
Water Reuse - Alt 1	2 X 9.6	2 X 14.4	1 X 5.7	2 X 12.3	1 X 12.3	2 X 4.6	2 X 5.7	2 X 11.2	2 X 9.4	3 X 14.8	**197**
Water Reuse - Alt 2	2 X 9.6	2 X 14.4	1 X 5.7	2 X 12.3	1 X 12.3	2 X 4.6	2 X 5.7	2 X 11.2	2 X 9.4	3 X 14.8	**197**
Saline River	1 X 9.6	3 X 14.4	2 X 5.7	2 X 12.3	2 X 12.3	2 X 4.6	2 X 5.7	1 X 11.2	1 X 9.4	2 X 14.8	**184**

In Table 11-5, the alternatives are sorted by score, with the highest score listed first. Improvements at South Wellfield received the highest score, followed by improvements at the Downtown Wellfield and the seasonal surface water right. The highest ranking alternatives were carried forward for implementation into the CIP to address the water demands for the City through 2060.

12 SOURCE OF SUPPLY REQUIREMENTS

In order to develop future sources of supply, it is important to know the future demand requirements compared to the yield from the existing sources of supply. In Chapter 4, projected water usage through 2060 was determined for average day, summer average day, and maximum day. Chapter 5 discussed the projected demands compared to the "paper" water rights the City currently owns. This section will determine the yield for the existing sources of supply for normal conditions and drought conditions and compare to the demand projections for the planning horizon. The raw water source requirements described in this section will be further developed once the preferred alternatives and associated capital improvements projects are identified.

Under non-drought conditions, the City has access to and is capable of diverting 10 MGD of surface water from the Smoky Hill River. As discussed in Chapter 5, the worst-case scenario during a drought for planning purposes is that no flow is available in the Smoky Hill River for short-term use by the City. This scenario would likely be during the dry summer months when water usage is at the highest.

Based on the maximum pumping recommendations by Layne Christensen the total yield of the wellfield during non-drought conditions is 11.65 MGD (Well #13 is not capable of pumping at the recommended rate since it has a 500 gpm pump installed). With two wells out of service (assume wells #11 and 15) the firm yield of the wellfield is 9.89 MGD. During a drought, the wellfield likely will experience a lower water table as in past droughts. During the drought of 2000-2006 the water table within the wellfield had decreased by nearly 7 feet by the end of the drought. A decline in the water table also indicates a decline in the pumping capacity of the wellfield due to less drawdown available. During drought conditions, assuming an average decline of 5.25 feet in the wellfield, the firm yield (two wells out of service) of the wellfield is 8.4 MGD. Table 12-1 summarizes the yield of Downtown Wellfield during normal and drought conditions.

Based on the information above, the firm yield of the existing sources (Downtown Wellfield and Smoky Hill River) during non-drought conditions is 19.9 MGD; the yield during drought conditions is 8.4 MGD. This analysis does not include South Wellfield as a current water supply source. Although the City has water rights and three operational wells, it is not regularly used for water supply due to high levels of iron, manganese, and hardness. This analysis assumes that treatment is needed before the South Wellfield can become a reliable water supply source for the City.

Figure 12-1 shows the maximum day demands compared to the yield of the existing sources during non-drought and drought conditions as described above. One of the main goals of the Raw Water Supply Study is to increase the reliability of the raw water supply system during a drought; therefore, future water supply alternatives should be based on the amount of water needed during drought conditions. In 2030, the amount of water needed is approximately 9.0 MGD and in 2060 11.7 MGD is needed to satisfy maximum day demands.

Table 12-1
Yield of Downtown Wellfield

Well #	Normal		Drought	
	Rec. Pumping Rate (gpm)	Water Right Flow Rate Limit (gpm)	Yield Decrease Factor	Max Drought Well Yield (gpm)
1	440	870	0.15	374
2	295	1,085	0.15	251
3	850	1,000	0.15	723
4	310	1,160	0.15	264
5	175	1,000	0.15	149
6	365	1,140	0.15	310
7	405	1,215	0.15	344
8	525	1,140	0.15	446
10	450	1,310	0.15	383
11	720	1,195	0.15	612
12	835	1,270	0.15	710
13A	500[1]	1,160	0.15	425
14	845	1,085	0.15	718
15	400	965	0.15	425
16	875	905	0.15	744
Total (gpm)	8,090	16,500		6,877
Limits (gpm)	-	10,568		-
TOTAL (MGD)	11.65	15.22		9.90
FIRM (MGD) [2]	9.89			8.41

[1] Recommended pumping rate was 930 gpm however only a 500 gpm pump is installed
[2] Firm yield considers two pumps out of service, wells 11 and 15

Since water rights specify both maximum withdrawal rate and annual volume quantity, the City must also ensure that they have enough volume in their raw water supply to meet demands throughout each year. Average annual volume needs can be projected by assuming average day demands throughout the year. Maximum annual volume needs, which are representative of the annual volume needed during a drought year, can be projected by assuming average day demands throughout nine months of the year and summer average day demands throughout the dry summer months. The current annual volume limit based on water rights at the Downtown Wellfield and the Smoky Hill River is 10,021 acre feet. In 2030, the amount of water needed is approximately 1,400 acre feet and in 2060, approximately 3,200 acre feet are needed. Figure 12-2 shows the annual volume requirements for the raw water supply.

Appendix J contains the calculations and tables associated with Figures 12-1 and 12-2.

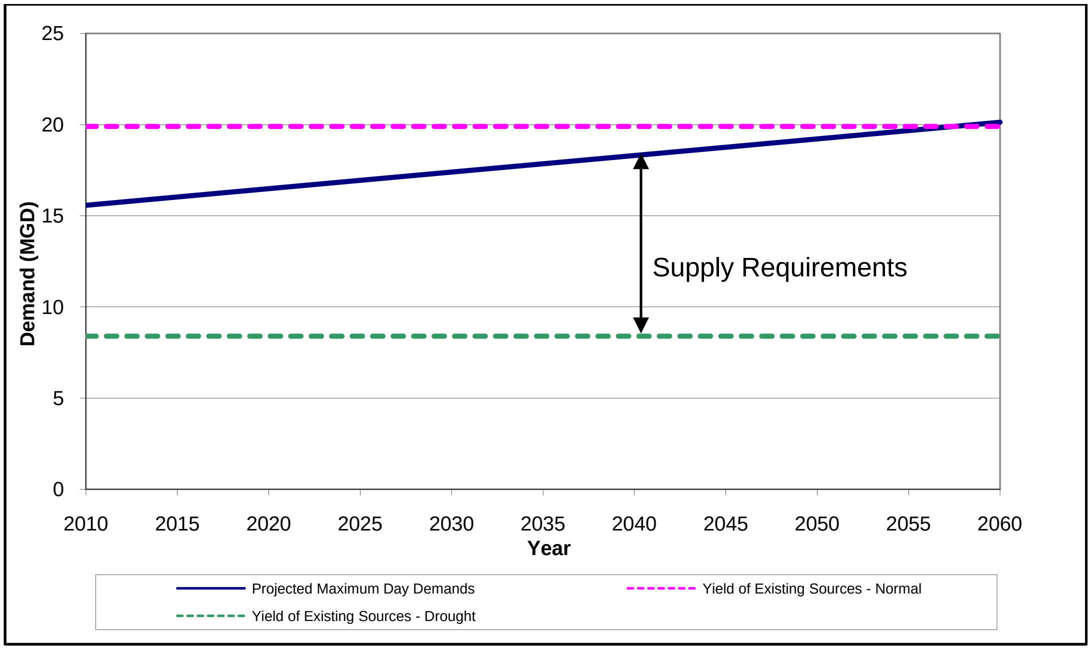


Figure 12-1
Raw Water Supply Requirements
Maximum Day Demands

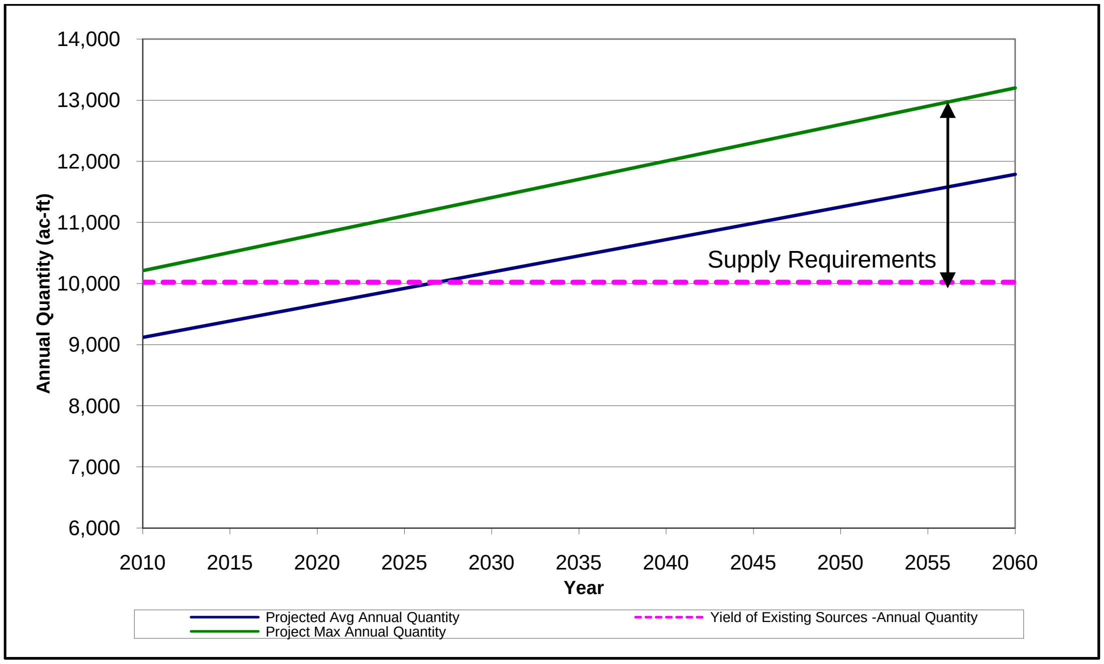


Figure 12-2
Raw Water Supply Requirements
Annual Volume

13 CAPITAL IMPROVEMENTS PLAN

The ultimate product of the Raw Water Supply Study is a CIP that will describe the preferred alternative(s), identifying each of the system components needed to implement the alternative(s). Projects to improve the raw water supply system will be identified for the short-term period from 2010 to 2015, with potential long-term projects identified for 2016 to 2060.

13.1 SUPPLY SOURCE AND ENGINEERING CONSIDERATIONS

A capital improvements plan (CIP) was created to indentify specific projects and timeframes to provide additional drought supply and meet the annual demand quantity of the City through the year 2060. As stated in Section 7.0, and shown in Figure 12-1, the City will require approximately an additional 7.2 MGD of drought supply in 2010 on a maximum day, 9.0 MGD of supply on a maximum day in 2030, and 11.7 MGD of drought supply on a maximum day in 2060. These deficits require that drought supply be added as quickly as possible to meet the needs of the City.

The City must also ensure that it has enough volume in its raw water supply to meet demands throughout each year as discussed in Section 7.0 and shown in Figure 12-2. In 2010, the City will require an additional 191 acre feet annually; in 2030, the amount of water needed is approximately 1,400 acre feet and in 2060, approximately 3,200 acre feet are needed.

The CIP requires that the alternatives meet the demand requirements of the City. Therefore, each of the top-ranked alternatives was examined to determine the amount of supply that could be expected as well as specific engineering considerations, including how quickly an alternative could be constructed. The alternatives' expected supply and significant engineering considerations are listed below, listed in the order of highest ranking to lowest based on the alternatives evaluation:

1. South Wellfield Improvements
    a. Between 3.7 and 7.5 MGD of supply (3.7 MGD is an existing water right)
    b. Potential for new water rights
    c. Could acquire existing water rights
2. Downtown Wellfield Improvements
    a. Conservatively an additional 4.6 MGD of supply
    b. Optimizes existing facilities
3. Seasonal Surface Water Right
    a. 5.0-10.0 MGD
    b. Provides additional water during off-season
    c. During drought may not be available
4. Confluence of Smoky Hill and Solomon Rivers
    a. 5.0-20.0 MGD

    b. Drought resistant supply
    c. Volume of supply sufficient for projected needs
5. Dakota Aquifer
    a. 5.0-7.5 MGD
    b. Drought resistant supply
    c. Variable yield of aquifer

Water supply available from the Downtown Wellfield was revised from 3.0 MGD to 4.6 MGD during the CIP phase. As discussed in Section 7.0, the existing drought yield is 8.4 MGD with two wells out of service. With the improvements proposed under the CIP the City should be able to use all wells under a drought scenario and achieve a total yield of 13 MGD, which includes the factor for withdrawal rates during a drought due to lower aquifer levels. An added water supply of 4.6 MGD with the proposed improvements will be used for the CIP planning.

13.2 CAPITAL IMPROVEMENTS PLAN PHASES

Based upon the alternatives evaluation, the amount of supply, and engineering considerations (including cost), a CIP was developed to provide supply during a drought through 2060. The CIP includes improvements at South Wellfield and Downtown Wellfield, implemented in phases, to provide adequate supply. Figure 13-1 is a graphical representation of the CIP and shows that the improvements will provide adequate supply to meet maximum day demand for the City through the year 2060. The solid line represents the maximum day demands. The height of each rectangle represents the amount of supply added with each phase and the width represents the years it is online. The bottom rectangle represents the existing source of supply during a drought, which assumes no flow is available from the Smoky Hill River and all supply is provided from the Downtown Wellfield on a drought supply basis as discussed in Section 7.0. Figure 13-2 shows that the improvements to provide adequate drought supply to meet the maximum day demand (Figure 13-1) also will result in enough supply for the City's projected maximum annual quantity through the year 2060. A detailed description of each phase follows which includes the schedule and preliminary cost estimates.

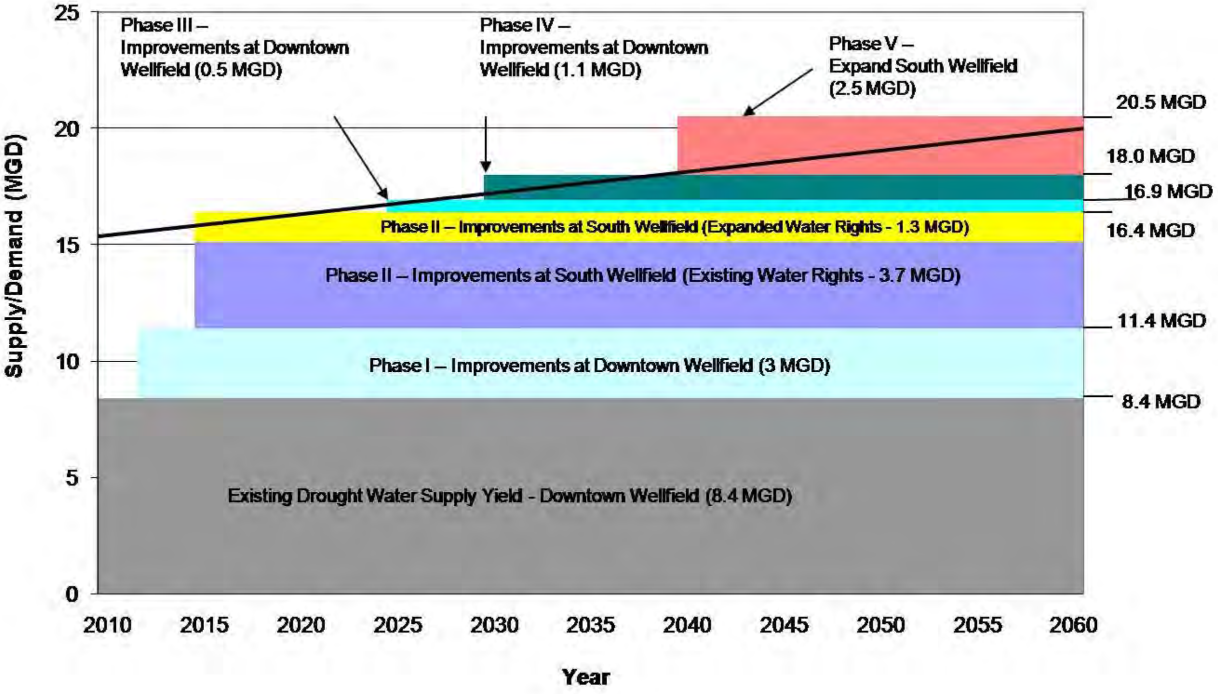


Figure 13-1
Capital Improvements Plan to Meet Maximum Day Demand Through 2060

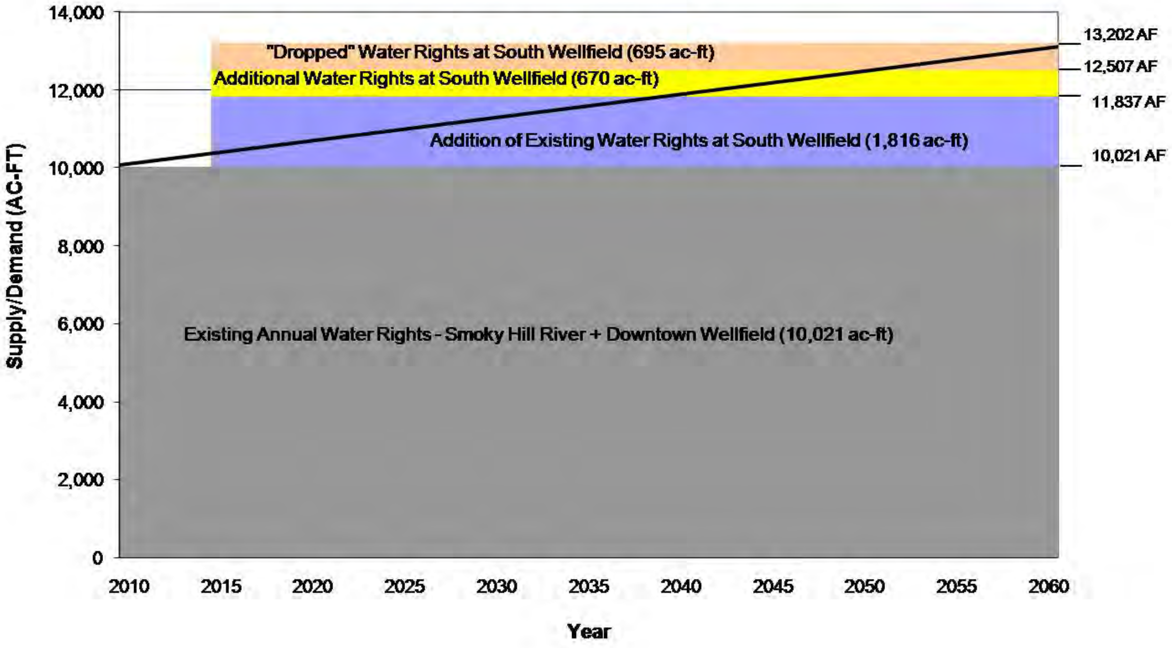


Figure 13-2
Capital Improvements Plan to Meet Annual Quantity Needs Through 2060

Phase I – Improvements at Downtown Wellfield (3.0 MGD)

Description:

Phase I will increase the supply capacity from the Downtown Wellfield by an additional 3 MGD. The wellfield improvements are to include the re-drilling of four wells, the replacement of approximately 4,900 linear feet (lf) of raw water piping, and a retrofit of the existing air stripping facilities at the existing water treatment plant to treat an additional 5 MGD, for a stripping facility throughput of 15 MGD. The raw water piping improvements include replacement of undersized wellfield piping as defined by Wilson & Company in their report to the City and updated for the Raw Water Supply Study to reflect the proposed well improvements. The wellfied piping improvements are shown in Figure 7-9. The upgrades to the air stripping facility includes the replacement of three blowers and three pumps at 5,278 gallons per minute each.

The Phase I improvements assume that KDHE has mitigated the Downtown Wellfield contamination impacts. The City needs to continue to work with KDHE to mitigate these impacts in order for the Downtown Wellfield to achieve its full capacity.

Schedule:

The Downtown Wellfield improvements were selected as the first improvements to be made because the supply can be available quickly and operational by 2012. The design phase should start in the 1st Quarter of 2010 and the construction phase should begin no later than the 1st Quarter of 2011.

Cost:

The Engineer's Estimate of Probable Costs of the Phase I improvements is $3,170,000. The construction costs are estimated to be $2,650,000, which includes a 30% contingency. Total engineering fees (including design and construction services) were approximated at 11% (7% for design, 4% for construction services) of the construction cost. The legal and administrative fees were estimated to be 9% of the construction cost. In total, the engineering, legal, and administrative fees were estimated to be 20% of the construction cost. Table 13-1 lists the total cost breakdown for Phase I.

Table 13-1
Phase I Engineer's Estimate of Probable Cost

Capital Costs	
General Requirements (Mobilization, Equipment Rental, etc.)	$150,000
Wellfield Improvements (4 Wells and 4900 lf of Pipe)	$2,100,000
Air Stripper Capacity (Blowers, Pumps, Distributors)	$400,000
Subtotal:	$2,650,000
Engineering	
Design (7%)	$180,000
Construction Services (4%)	$110,000
Subtotal:	$290,000
Legal/Administrative (9%)	$230,000
Subtotal:	$230,000
Total	$3,170,000

Notes:

1) Preliminary costs are level of accuracy +30% to -20%.
2) Estimates are in 2009 Dollars.

Phase II – Improvements at South Wellfield (5.0 MGD)

Description:

Phase II will provide supply and treatment capacity at the South Wellfield of 5 MGD. The improvements include the demolition of the existing Schilling Water Treatment Plant and the addition of a 5 MGD (expandable to 7.5 MGD) groundwater treatment facility and one, 1 MG finished water storage tank. The treatment facility will be supplied by eight water supply wells. The five existing wells under the existing water rights (3.7 MGD) are in need of rehabilitation and will be closed and re-drilled with shorter screen intervals. In addition, three new wells must be drilled, which will produce 1.3 MGD. Two of the wells should yield the required flow, and one will be provided as backup. Approximately 7,500 lf of raw water piping will also be required for the new wells. The three new wells (1.3 MGD) will require that a new water right be obtained from DWR. Upgrades at the wellfield will also include 8,500 feet of piping improvements for the existing raw water piping and 2 observation wells.

Phase II also contains components beyond construction. When ownership of water right SA035 was transferred from the Schilling Air Force Base to the City of Salina, a limitation of 11,760 acre feet and 16,450 gpm was written in to include all of the City's water rights (excluding 31,636) including their vested water right SA002 and SA035. It is our opinion, which has been confirmed by individuals at the DWR, that such a limitation should not have been made to include vested water rights. Phase II should include negotiations with DWR to correct this limitation to allow the full water right to be used at the South Wellfield.

Under Phase II the City should try to obtain new water rights for a minimum of 3.8 MGD for the South Wellfield. This would provide the supply for the future (Phase V) 2.5 MGD expansion of the water plant. Preliminary discussions with DWR indicate that once an application for an appropriation is approved the municipal user has twenty years to develop the water right. If the area is closed for appropriations, the City should begin identifying potential water right acquisitions.

Schedule:

The Phase II improvements are to be operational by 2015. A feasibility study should start in the 2nd Quarter of 2010 with design and permitting beginning in the 3rd Quarter of 2011. Construction should begin no later than the 4th Quarter of 2012.

Cost:

The Engineer's Estimate of Probable Costs of the Phase II improvements is $23,180,000. The construction costs are estimated to be $19,300,000, which includes a 30% contingency. Total engineering fees (including design and construction services) were approximated at 13% (1% for the feasibility study and water rights acquisition for the water treatment plant, 7% for design, and 5% for construction services). The legal and administrative fees were estimated to be 7% of the construction cost. In total, the engineering, legal, and administrative fees were estimated to be 20% of the construction cost. Table 13-2 lists the total cost breakdown for Phase II.

Table 13-2
Phase II Engineer's Estimate of Probable Cost

Capital Costs	
General Requirements (Mobilization, Equipment Rental, etc.)	$1,200,000
Wellfield Improvements - 3.7 MGD (Re-drill 5 wells, 2 observation wells, 8,500 lf of piping)	$2,400,000
Wellfield Improvements - 1.3 MGD (Drill 3 Wells, 7,500 lf of Piping)	$1,700,000
Water Treatment Facility (Demolition and Construction of Plant and 1 MG Finished Storage)	$14,000,000
Subtotal:	**$19,300,000**
Engineering	
Feasibility Study (1%)	$180,000
Design (7%)	$1,350,000
Construction Services (5%)	$1,000,000
Subtotal:	**$2,530,000**
Legal/Administrative (7%)	$1,350,000
Subtotal:	**$1,350,000**
Total	**$23,180,000**

Notes:

1) Preliminary costs are level of accuracy +30% to -20%.
2) Estimates are in 2009 Dollars.

<u>Phase III – Improvements at South Wellfield (0.5 MGD)</u>

Description:

Phase III will increase the capacity at the Downtown Wellfield by an additional 0.5 MGD. The wellfield improvements are to include re-drilling 2 wells and adding approximately 600 lf of raw water piping.

The Phase III improvements assume that KDHE has mitigated the Downtown Wellfield contamination impacts. The City needs to continue to work with KDHE to mitigate these impacts.

Schedule:

The Phase III improvements are to be operational by 2025. The design phase should start in 2023 with construction in 2024.

Cost:

The Engineer's Estimate of Probable Costs of the Phase III improvements is $975,000. The construction costs are estimated to be $810,000, which includes a 30% contingency. Total engineering fees (including design and construction services) were approximated at 10% (6% for design, 4% for construction services) of the construction cost. The legal and administrative fees were estimated to be 10% of the construction cost. In total, the engineering, legal, and administrative fees were estimated to be 20% of the construction cost. Table 13-3 lists the total cost breakdown for Phase III.

Table 13-3
Phase III Engineer's Estimate of Probable Cost

Capital Costs	
General Requirements (Mobilization, Equipment Rental, etc.)	$50,000
Wellfield Improvements (Drill 2 Wells, 600 lf of Piping)	$760,000
Subtotal:	**$810,000**
Engineering	
Design (6%)	$50,000
Construction Services (4%)	$35,000
Subtotal:	**$85,000**
Legal/Administrative (10%)	$80,000
Subtotal:	**$80,000**
Total	**$975,000**

Notes:

1) Preliminary costs are level of accuracy +30% to -20%.
2) Estimates are in 2009 Dollars.

Phase IV – Downtown Wellfield Improvements (1.1 MGD)

Description:

Phase IV consists of increasing the capacity at the Downtown Wellfield by an additional 1.1 MGD. The wellfield improvements are to include re-drilling 1 well and adding approximately 300 lf of raw water piping. In addition to the single well, it is assumed that there will no longer be the potential for reduced pumpage from the wellfield due to the contamination mitigation implemented by KDHE in 2012.

Schedule:

The Phase IV improvements are to be operational by 2030. The design phase should start in 2028 with construction in 2029.

Cost:

The estimated cost of the Phase IV improvements is $486,000. The construction costs are estimated to be $405,000, which includes a 30% contingency. Total engineering fees (including design and construction services) were approximated at 10% (6% for design, 4% for construction services) of the construction cost.

The legal and administrative fees were estimated to be 10% of the construction cost. In total, the engineering, legal, and administrative fees were estimated to be 20% of the construction cost. Table 13-4 lists the total cost breakdown for Phase IV.

Table 13-4
Phase IV Engineer's Estimate of Probable Cost

Capital Costs	
General Requirements (Mobilization, Equipment Rental, etc.)	$25,000
Wellfield Improvements (Drill 1 Well, 300 lf of Piping)	$380,000
Subtotal:	**$405,000**
Engineering	
Design (6%)	$25,000
Construction Services (4%)	$16,000
Subtotal:	**$41,000**
Legal/Administrative (10%)	$40,000
Subtotal:	**$40,000**
Total	**$486,000**

Notes:

1) Preliminary costs are level of accuracy +30% to -20%.
2) Estimates are in 2009 Dollars.

Phase V Option 1 – South Wellfield Improvements (2.5 MGD)

Description:

Phase V will increase the capacity at the South Wellfield and water treatment plant by an additional 2.5 MGD; Option 1 includes purchase of land and negotiation of water rights if not obtained under Phase II. Once land is acquired and appropriations approved, a well field will be constructed with 4 new wells, 1 observation well, and approximately 15,000 lf of piping. The water treatment plant will be expanded from 5.0 MGD to 7.5 MGD to treat raw water from the wellfield. A 1 MG ground storage tank will also be constructed to store the finished water.

Schedule:

The Phase V improvements are to be operational by 2040. A feasibility study should be conducted in 2036 with the design beginning in 2037. Construction of the wellfield and plant expansion should begin in late 2037.

Cost:

The estimated cost of the Phase V improvements is $18,100,000. The construction costs are estimated to be $15,000,000, which includes a 30% contingency. Total engineering fees (including design and construction services) were approximated at 13% (1% for feasibility study and water rights acquisition, 7% for design, 5% for construction services) of the construction cost. The legal and administrative fees were estimated to be 7% of the construction cost. In total, the engineering, legal, and administrative fees were estimated to be 20% of the construction cost. Table 13-5 lists the total cost breakdown for Phase V.

Table 13-5
Phase V Option 1 Engineer's Estimate of Probable Cost

Capital Costs	
General Requirements (Mobilization, Equipment Rental, etc.)	$500,000
Purchase of Water Rights (3000 Acres of Land and the Water Rights)	$6,200,000
Wellfields and Piping (4 Wells, 1 Observation Well, 15,000 lf of Piping)	$2,900,000
Water Treatment Facility (2.5 MGD Plant Expansion, 1 MG Finished Storage)	$5,400,000
Subtotal:	$15,000,000
Engineering	
Feasibility Study/Water Rights Negotiations (1%)	$150,000
Design (7%)	$1,100,000
Construction Services (5%)	$750,000
Subtotal:	$2,000,000
Legal/Administrative (7%)	
Subtotal:	$1,100,000
Total	$18,100,000

Notes:
1) Preliminary costs are level of accuracy +30% to -20%.
2) Estimates are in 2009 Dollars.

Phase V Option 2 – South Wellfield Improvements (2.5 MGD)

Description:

Phase V will increase the capacity at the South Wellfield and water treatment plant by an additional 2.5 MGD; Option 2 assumes acquisition of additional water rights was obtained under Phase II. A well field will be constructed with 4 new wells, 1 observation well, and approximately 10,000 lf of piping. The water treatment plant will be expanded from 5.0 MGD to 7.5 MGD to treat raw water from the wellfield. A 1 MG ground storage tank will also be constructed to store the finished water.

Schedule:

The Phase V improvements are to be operational by 2040. A feasibility study should be conducted in 2036 with the design beginning in 2037. Construction of the wellfield and plant expansion should begin in late 2037.

Cost:

The estimated cost of the Phase V improvements is $9,943,000. The construction costs are estimated to be $8,280,000, which includes a 30% contingency. Total engineering fees (including design and construction services) were approximated at 13% (1% for the feasibility study, 7% for design, and 5% for construction services) of the construction cost. The legal and administrative fees were estimated to be 7% of the construction cost. In total, the engineering, legal, and administrative fees were estimated to be 20% of the construction cost. Table 13-6 lists the total cost breakdown for Phase V.

Table 13-6

Phase V Option 2 Engineer's Estimate of Probable Cost

Capital Costs	
General Requirements (Mobilization, Equipment Rental, etc.)	$480,000
Wellfields and Piping (4 Wells, 1 Observation Well, 10,000 FT of Piping)	$2,400,000
Water Treatment Facility (2.5 MGD Plant Expansion, 1 MG Finished Storage)	$5,400,000
Subtotal:	**$8,280,000**
Engineering	
Feasibility Study (1%)	$83,000
Design (7%)	$580,000
Construction Services (5%)	$420,000
Subtotal:	**$1,083,000**
Legal/Administrative (7%)	$580,000
Subtotal:	**$580,000**
Total	**$9,943,000**

Notes:

1) Preliminary costs are level of accuracy +30% to -20%.
2) Estimates are in 2009 Dollars.

13.3 FINANCING

The City will need to do short term and long term fiscal planning in order to fund the phases. Figure 13-3 shows when funding is required for the design and construction of Phases I and II, which will run through

2015. Figure 13-4 shows when funding is required for the design and construction of Phases III, IV, and V (including the purchase of water rights), which will meet the supply demands of the City through the year 2060. Figure 13-5 shows when funding is required for Phases III, IV, and V (assuming acquisition of additional water rights from DWR).

Figure 13-3
Short-Term Capital Improvement Financing Plan (2009-2015)
Design & Construction Phases I & II

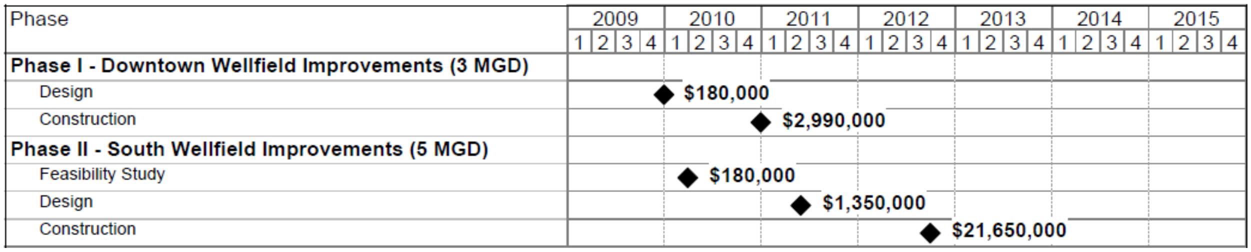


Figure 13-4
Long-Term Capital Improvement Financing Plan (2016-2060)
Design & Construction Phases III, IV, & V

Figure 13-5
Long-Term Capital Improvement Financing Plan (2016-2060)
Design & Construction Phases III, IV, & V
(Assuming Acquisition of Additional Water Rights From DWR Previously Completed)

13.4 ON-GOING CONSIDERATIONS

On-going considerations are practices and alternatives the City should evaluate throughout each phase of the program. The on-going considerations should be viewed as enhancements, rather than replacements, for the CIP. Enhancements to the CIP that should be considered include water conservation, water reuse, and the potential development of a Water Assurance District.

13.4.1 Water Conservation

Water conservation projects can be implemented along with the selected alternatives and can provide many benefits for the municipal water and wastewater utility, environment, and community. Some of these benefits include reduced energy and chemical use for water treatment, downsized or postponed expansions of water treatment facilities, and reduced costs and impacts on wastewater collection and treatment facilities. Common water conservation measures include customer education, water-efficient fixtures, water-efficient landscaping, economic incentives, and water-use restriction ordinances. Table 13-7 lists the preferred ten conservation measures for implementation, as discussed in Chapter 8.

Table 13-7
Recommended Top Ten Water Conservation Measures

Order of Importance of Implementation	Type of Measure	Potential Water Conservation Measure
1	Outreach and Education	Understandable and Informative Water Bill
2	Outreach and Education	Water Conservation Classes
3	Outreach and Education	Teaching Water Conservation in Schools
4	Outreach and Education	Public Awareness for Commercial & Industrial (placards, stickers, etc.)
5	Commercial & Industrial Incentive Program	Commercial High-Efficiency Toilets
6	Rebate Program	High Efficiency or Low Flow Toilets Rebate
7	Rebate Program	High Efficiency Clothes Washer Rebate
8	Outreach and Education	Water Conservation Garden
9	Ordinance	Xeriscape Ordinance
10	Rebate Program	Rain Sensors Rebate

* The City should continue to implement all their current water conservation measures

The following describes the capital and maintenance expenditures necessary to implement the recommended water conservation measures:

1. <u>Understandable and Informative Water Bill:</u>
    - New software or modifications to existing software to show volume of usage and presentation of monthly consumption
    - Training of staff to use the new/modified software

2. <u>Water Conservation Classes:</u>
    - Incentives for attending the classes such as free rain barrel, coupon to purchase low water use plants, free irrigation products, etc.
    - Payment for qualified personnel to conduct classes

3. Teaching Water Conservation in Schools:
   - Costs to provide teachers with teaching materials (i.e. examples of water bills)
   - Costs to provide educational opportunities for students (field trips to learn about water supply)

4. Public Awareness for Commercial & Industrial:
   - Costs for public awareness items (placards, decals, stickers, posters, etc)
   - Costs for distribution public awareness items

5. Commercial High-Efficiency Toilets:
   - Costs for rebates
   - Staff time to ensure old toilet rendered inoperable and not available to be sold for reuse and inspection of installation of high-efficiency toilet

6. High Efficiency or Low Flow Toilets Rebate (Residential):
   - Costs for rebates
   - Staff time to ensure old toilet rendered inoperable and not available to be sold for reuse and inspection of installation of high-efficiency toilet

7. High Efficiency Clothes Washer Rebate:
   - Costs for rebates
   - Staff time to ensure old washer rendered inoperable and not available to be sold for reuse and inspection of installation of high efficiency washer

8. Water Conservation Garden:
   - Costs for plants and labor to plant the garden
   - Costs for maintaining the garden

9. Xeriscape Ordinance:
   - Taxpayer funds for local government to pass ordinance

10. Rain Sensor Rebates:
    - Costs for rebates

13.4.2 Water Reuse

Water reuse should also be evaluated and potentially implemented when it becomes economically viable. The water reuse alternative will require filtration facilities, additional disinfection for reduction of pathogens, finished water storage and pump station, and a reclaimed water pipeline. While the savings from the municipal water supply system with water reuse will be likely limited to less than 1 MGD, water reuse is a practice that, if economically viable, can play a part in making Salina a more sustainable community.

13.4.3 Creation of a Water Assurance District

A Water Assurance District could be developed by the municipal and industrial users downstream of the Kanopolis Reservoir if the KWO develops storage in the reservoir for a Water Assurance District. This would require a vote of the municipalities and industrial water rights holders in the Smoky Hill Basin downstream of the Kanopolis Reservoir to become part of a water assurance district. DWR would then need to be petitioned and negotiations could begin. Creating a Water Assurance District will require long-term planning and education among the various stakeholders within the basin and will require KWO to allocate storage in the Kanopolis Reservoir. The City should continue to monitor progress and work with DWR and KWO in developing a Water Assurance District.

14 REFERENCES

Ayers, R.S. (1977). “Quality of irrigation water.” *Journal of the Irrigation and Drainage Division. ASCE*. VOl. 103, No. IR2, June 1977, 140.

Ayers, R.S. and Westcot, D.W. (1985). “Water Quality for Agriculture.” FOA Irrigation and Drainage Paper 29. http://www.fao.org.

Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) (2008). *Final Groundwater and Solute Transport Modeling Report, City of Salina, Kansas, Prepared for Kansas Department of Health and Environment, 1-2, 2-2, 4-2 through 4-10, 5-1 through 5-3*.

Gould Evans (2008). “Existing Conditions Report (Draft).” *Salina Comprehensive Plan Update*, p. 5-7.

Kansas Department of Agriculture Division of Water Resources (DWR) and Kansas Geological Survey (KGS) (2009). *Water Information Management and Analysis System (WIMAS), http://hercules.kgs.ku.edu/geohydro/wimas/index.cfm* (January 20, 2009).

DWR and KGS (2009). *Water Information Management and Analysis System (WIMAS), http://hercules.kgs.ku.edu/geohydro/wimas/index.cfm* (February 10, 2009).

DWR and KGS (2009). *Water Information Management and Analysis System (WIMAS), http://hercules.kgs.ku.edu/geohydro/wimas/index.cfm* (May, 2009).

Kansas Division of the Budget (2005). “2005 Kansas Population by County.” *Kansas Certified Population Data.* http://budget.ks.gov/ecodemo.htm.

Kansas Division of the Budget (2006). “2006 Kansas Population by County.” *Kansas Certified Population Data.* http://budget.ks.gov/ecodemo.htm.

KGS (1996). Dakota Aquifer program, Vol. 1. www.kgs.ku.edu/Dakota/vol1/dakotaHome.html. Accessed 1/16/2009.

KGS Geohydrology Section (2008). *Smoky Hill River Valley Ground-water Model, Kansas Water Office Contract 07-136 (KAN 46570),* 51-53, 82-86.

KGS (2008). Surficial Geology of Kansas. Kansas Geological Survey. Map M-118. Scale 1:500,000.

Kansas State Research and Extension. “Precipitation Summary, Saline County, Salina Municipal AP.” *Weather Data Library*. www.oznet.ksu.edu.

Kansas State University (KSU), Agricultural Experiment Station and Cooperative Extension Service (1998). *A Guide to Turfgrass Nutrient Recommendations,* 1.

Kansas Water Office (KWO). “Public Water Supply/Water Marketing: Population.” *Reports and Publications.* http://www.kwo.org.

KWO (2004). *Wilson Lake Yield Analysis Report,* 1.

KWO (2007). *Request for Deviation from Minimum Release Schedule for Kanopolis Lake (Draft),* 1-11.

KWO (2008). *Kanopolis Reservoir Model,* *http://www.kwo.org/Reports%20&%20Publications/KWO_Presentations/Presentations.htm*..

KWO (2008). *Kanopolis Water Supply Yield Analyses and Review of Reservoir Inflow Depletions,* 1-29.

KWO (2008). *Surplus Water Available in Water Marketing Program Lakes, Calendar Year 2009,* 1-29.

Latta, B.F. (1949). Ground-Water Conditions in the Smoky Hill Valley in Saline, Dickinson, and Geary Counties, Kansas. Kansas Geological Survey. Bulletin No. 84. 152 p.

Layne Christensen (Layne) (2007). *Well Field Evaluation for the City of Salina, Salina, Kansas (Phase I),* 1-7.

Layne (2007). *Well Field Evaluation for the City of Salina, Salina, Kansas (Phase II),* 1-9.

Professional Engineering Consultants (PEC), P.A. (2007). *Final Report: Wastewater Treatment Facility Study,* p. 2-1 – 2-3, 4-3 – 4-4.

PEC. (2007). *Final Report: 2007 Water Distribution System Model, Phase I,* III-8.

Putnam, J.E., Perry, C.A., and Wolockt, D.M. (2008). “Hydrologic Droughts in Kansas – Are They Becoming Worse?” U.S. Department of the Interior, U.S Geological Survey, 1-6.

State of Kansas, Department of Health and Environment (KDHE) (1978). “Irrigation Use of Municipal Wastewater Effluents.” *Minimum Standards of Design for Water Pollution Control Facilities,* 1-3.

KDHE (1978). "Section XIII, Agricultural Application of Wastewater or Sludge." *Minimum Standards of Design for Water Pollution Control Facilities,* 1-12, Appendix.

KDHE (2002). "Kansas Water Pollution Control Permit and Authorization to Discharge under the National Pollutant Discharge Elimination System – Effective June 1, 2002 – Park City, Kansas." *Environmental Protection Agency Water Discharge Permit (PCS) Database,* www.epa.gov/enviro/html/pcs/pcs_query_java.html (December 1, 2008).

US Army Corps of Engineers (USACE) Kansas City District (unknown). *Draft Reallocation Report for Kanopolis Lake, Kansas.* 1-28.

United States Bureau of the Census (1993). *1990 Census of Population and Housing: Population and Housing Unit Counts, United States.* http://www.census.gov.

United States Bureau of the Census (2001). "Kansas – County." GCT-PH1 – Population, Housing Unit, Area and Density: 2000. http://www.census.gov/census2000/states/ks.html.

United States Bureau of the Census (2001). "Kansas – Place." GCT-PH1 – Population, Housing Unit, Area and Density: 2000. http://www.census.gov/census2000/states/ks.html.

U.S. Environmental Protection Agency(EPA) (2004). *Guidelines for Water Reuse,* iii, 46, 160-170.

Wilson & Company, Inc., Engineers & Architects (WCI) (2008). *Water Treatment Plant Study, Taste and Odor Control,* 2.4-2.5.

WCI (2008). *Hydraulic Modeling of Wells, City of Salina, Kansas,* 1-3, enclosures.

Appendix A

Water Right Certificates

STATE OF KANSAS
DIVISION OF WATER RESOURCES
STATE BOARD OF AGRICULTURE
TOPEKA, KANSAS

BEFORE R. V. SMRHA
CHIEF ENGINEER, DIVISION OF WATER RESOURCES
KANSAS STATE BOARD OF AGRICULTURE

IN THE MATTER OF THE APPLICATION OF THE CITY OF SALINA, SALINA, KANSAS, FOR APPROVAL OF A CHANGE IN THE LOCATION OF THE POINT OF DIVERSION.

On this 16th day of October, 1961, after due consideration to the written application of the City of Salina, Salina, Kansas, for approval of a change in the location of the points of diversion under its vested right to beneficial use of water and other information submitted by the applicant, the Chief Engineer, Division of Water Resources, Kansas State Board of Agriculture, being fully advised in the premises, does hereby make the following findings and order;

FINDINGS

1. That on January 6, 1955, the Chief Engineer, Division of Water Resources, Kansas State Board of Agriculture, in accordance with Section 82a-704, General Statutes of Kansas, 1949, issued an order in the name of the City of Salina, Salina, Kansas, determining and establishing its vested right to continue the use of ground water to be withdrawn by means of eight (8) wells located in the E½ of Section 13, Township 14 South, Range 3 West in Saline County, Kansas, to a maximum quantity of 1,152 million gallons per year to be diverted at a maximum rate of 5,550 gallons per minute for municipal use at the City of Salina and immediate vicinity;
2. That on January 19, 1961, the City of Salina, Salina, Kansas, in accordance with Section 82a-708b, 1957 Supplement, General Statutes of Kansas, 1949, filed an application to change the location of the points of diversion under its vested right to beneficial use of water as stated and set forth in the order of the Chief Engineer, Division of Water Resources, Kansas State Board of Agriculture, dated January 6, 1955, to

fifteen (15) wells located in the drainage basin of the Smoky Hill River; three (3) wells in the Southeast Quarter (SE¼) of Section 12, more particularly described as well #11 in the southeast corner of Lot 10, Atherton and Phillips Addition, well #15 west of Oakdale Avenue, Riverside Park, Riverside Addition, well #16 in Lot 35, Block 2, Riverside Park Addition; five (5) wells in the Northeast Quarter (NE¼) of Section 13, more particularly described as well #7 in Lot 10, Block 11, Oakdale Addition, well #8 in the west central part of Oakdale Park near Smoky Valley Museum, well #10 in the southeast corner of Lot 10, Block 15 of Cunningham Replat of Oakdale Park Addition, well #12 in the southeast corner of Lot 2 in Geis Addition, well #14 in Lot 11, Block 8, Oakdale Addition; one (1) well in the Southeast Quarter (SE¼) of the Northwest Quarter (NW¼) of Section 13, more particularly described as well #13 one hundred feet south of Walnut and Second Street in the northeast corner of City Park; two (2) wells in the Northeast Quarter (NE¼) of the Southwest Quarter (SW¼) of Section 13, more particularly described as well #1 in Lot 1 of Neeley's Addition, well #3 at the water plant on Fourth Street, Lot 1, Hollands Addition; one (1) well in the Southeast Quarter (SE¼) of the Southwest Quarter (SW¼) of Section 13, more particularly described as well #4 in Lot 41, Block 2, Van Trine Addition; two (2) wells in the North Half (N½) of the Southeast Quarter (SE¼) of Section 13, more particularly described as well #2 in the east half of Kenwood Park, well #6 near the southwest corner of Kenwood Park; and one (1) well in the East Half (E½) of the Northwest Quarter (NW¼) of Section 24, more particularly described as well #5 in Lot 13, Block 1, College View Addition;all in Township 14 South, Range 3 West in Saline County, Kansas;

3. That the applicant has demonstrated to the satisfaction of the Chief Engineer, Division of Water Resources, Kansas State Board of Agriculture, that the proposed change in the location of the points of diversion is reasonable and will not impair existing water rights;

4. That the applicant has demonstrated to the satisfaction of the Chief Engineer, Division of Water Resources, Kansas State Board of Agriculture, that the source of supply remains the same as that to which the water right relates.

ORDER

NOW THEREFORE, It is the decision and order of the Chief Engineer, Division of Water Resources, Kansas State Board of Agriculture, that the application filed on January 19, 1961, by the City of Salina, Salina, Kansas, for approval to change the location of the points of diversion under its vested right as determined and established by the order of the Chief Engineer, Division of Water Resources, Kansas State Board of Agriculture, dated January 6, 1955, to

> fifteen (15) wells located in the drainage basin of the Smoky Hill River; three (3) wells in the Southeast Quarter (SE¼) of Section 12, more particularly described as well #11 in the southeast corner of Lot 10, Atherton and Phillips Addition, well #15 west of Oakdale Avenue, Riverside Park, Riverside Addition, well #16 in Lot 35, Block 2, Riverside Park Addition; five (5) wells in the Northeast Quarter (NE¼) of Section 13, more particularly described as well #7 in Lot 10, Block 11, Oakdale Addition, well #8 in the west central part of Oakdale Park near Smoky Valley Museum, well #10 in the southeast corner of Lot 10, Block 15 of Cunningham Replat of Oakdale Park Addition, well #12 in the southeast corner of Lot 2 in Geis Addition, well #14 in Lot 11, Block 8, Oakdale Addition; one (1) well in the Southeast Quarter (SE¼) of the Northwest Quarter (NW¼) of Section 13, more particularly described as well #13 one hundred feet south of Walnut and Second Street in the northeast corner of City Park; two (2) wells in the Northeast Quarter (NE¼) of the Southwest Quarter (SW¼) of Section 13, more particularly described as well #1 in Lot 1 of Neeley's Addition, well #3 at the water plant on Fourth Street, Lot 1, Hollands Addition; one (1) well in the Southeast Quarter (SE¼) of the Southwest Quarter (SW¼) of Section 13, more particularly described as well #4 in Lot 41, Block 2, Van Trine Addition; two (2) wells in the North Half (N½) of the Southeast Quarter (SE¼) of Section 13, more particularly described as well #2 in the east half of Kenwood Park, well #6 near the southwest corner of Kenwood Park; and one (1) well in the East Half (E½) of the Northwest Quarter (NW¼) of Section 24, more particularly described as well #5 in Lot 13, Block 1, College View Addition; all in Township 14 South, Range 3 West in Saline County, Kansas;

should be and is hereby approved.

The effective date of the change shall be October 16, 1961, after which the authorized points of diversion under its vested right to beneficial use of water shall be as set forth in this order of the Chief Engineer, Division of Water Resources, Kansas State Board of Agriculture.

That in all other respects the said determined vested right of the City of Salina, Salina, Kansas, to the use of water for beneficial purposes is as determined and established by the order of the Chief Engineer, Division of Water Resources, Kansas State Board of Agriculture, dated January 6, 1955.

R V Smrha

R. V. Smrha, Chief Engineer,
Division of Water Resources,
Kansas State Board of Agriculture.

STATE OF KANSAS, Shawnee COUNTY, ss.

BE IT REMEMBERED, That on this 16th day of October, A.D. 1961, before me the undersigned, a notary public in and for said County and State, came R. V. Smrha, Chief Engineer, Division of Water Resources, Kansas State Board of Agriculture, who is personally known to me to be the same person who executed the within instrument of writing as such official and such person duly acknowledged the execution of the same as such Chief Engineer.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my official seal, the day and year last above written.

Signature: Carmelita Hutton

1

KANSAS STATE BOARD OF AGRICULTURE

SAM BROWNBACK, Secretary

DAVID L. POPE, Chief Engineer-Director
DIVISION OF WATER RESOURCES
TOPEKA • • KANSAS

FIELD OFFICE, DIVISION OF WATER RESOURCES
Scott E. Ross, Water Commissioner
425 Main Street
P.O. BOX 192, STOCKTON, KANSAS 67669-0192
Telephone (913) 425-6152

June 12, 1990

Jim Wendell
Water Superintendent
401 South 5th
Salina, Kansas 67401

Re: Vested Right
File No. SA035

Dear Mr. Wendell:

As per your request to our Topeka office, I am enclosing a copy of the original vested right order and a copy of the approval for change in point of diversion, place of use and use made of water.

If you should have any further questions, please feel free to contact this office.

Sincerely,

Duane Harris

Duane Harris
Engineering Technician

Enclosures

THE STATE OF KANSAS

STATE BOARD OF AGRICULTURE
W. W. Duitsman, *Secretary*

DIVISION OF WATER RESOURCES
Guy E. Gibson, *Chief Engineer*

APPROVAL OF APPLICATION

FOR

CHANGE IN POINT OF DIVERSION, PLACE OF USE AND USE MADE OF THE WATER

VESTED RIGHT, CODE 6235, SALINE COUNTY

RECEIVED
AUG 21 1978
DIVISION OF WATER RESOURCES
STOCKTON

On this 11th day of August, 1978, the Chief Engineer, Division of Water Resources, Kansas State Board of Agriculture, after due consideration of the written application of the Salina Airport Authority by M.J. Kennedy, Chairman, 905 United Building, Salina, Kansas 67401, and Norris D. Olson, City Manager, City Offices, Salina, Kansas 67401, received on March 10, 1967, for approval of proposed changes in the location of the point of diversion, the place of use and the use made of the water under a vested right as set forth in the order of the Chief Engineer, Division of Water Resources, Kansas State Board of Agriculture, dated November 29, 1956, determining and establishing a vested right to continue the beneficial use of water, identified in the office of the Chief Engineer as Vested Right Code 6235, Saline County, Kansas, finds that the proposed changes are reasonable and will not impair existing rights and that the proposed changes relate to the same local source of supply. The application, therefore, is approved subject to the condition that the proposed appropriation shall be limited to a quantity not in excess of 11,760 acre-feet of water for any calendar year with a maximum diversion rate not in excess of 16,450 gallons per minute when combined with Vested Right Code 622, Saline County, Kansas and Appropriation of Water Application Nos. 3043, 5989, 7635 and 9572. The proposed changes are authorized as follows:

The effective date of the changes shall be August 11th, 1978, after which the authorized point of diversion under the vested right shall be five

(5) wells

one (1) well located in the Northwest Quarter of the Southwest Quarter of the Southwest Quarter (NW¼ SW¼ SW¼),

of Section 6,

one (1) well located in the Northwest Quarter of the Northwest Quarter of the Northwest Quarter (NW¼ NW¼ NW¼),

one (1) well located in the Northeast Quarter of the Northeast Quarter of the Northwest Quarter (NE¼ NE¼ NW¼),

one (1) well located in the Northwest Quarter of the Northeast Quarter of the Northeast Quarter (NW¼ NE¼ NE¼),

of Section 7, and

one (1) well located in the Northeast Quarter of the Northwest Quarter of the Northwest Quarter (NE¼ NW¼ NW¼),

of Section 8,

all in Township 15 South, Range 2 West, Saline County, Kansas,

and the authorized place of use under this vested right shall be

the City of Salina and immediate vicinity and the Salina Airport Industrial Center and related areas.

The authorized use of water under this vested right shall be for municipal use.

In all other respects, this vested right to beneficial use of water is as stated and set forth in the order of the Chief Engineer dated November 29, 1956.

Dated at Topeka, Kansas, this 11th day of August, 1978.

GUY E. GIBSON
CHIEF ENGINEER

Guy E. Gibson

Guy E. Gibson, Chief Engineer
Division of Water Resources
Kansas State Board of Agriculture

STATE OF KANSAS, Shawnee COUNTY, SS.

BE IT REMEMBERED, That on this 11th day of August, A.D. 1978, before me, the undersigned, a notary public in and for said County and State, came Guy E. Gibson, Chief Engineer, Division of Water Resources, Kansas State Board of Agriculture, who is personally known to me to be such duly appointed, qualified and acting official, and who is personally known to me to be the same person who executed the within instrument of writing as such official and such person duly acknowledged the execution of the same as such Chief Engineer.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my official seal, the day and year last above written.

Signature ______________________
Denise J. Waters, Notary Public

My Commission Expires March 1, 1982.

KANSAS STATE BOARD OF AGRICULTURE

ROY FREELAND · SECRETARY
TOPEKA · · KANSAS

DIVISION OF WATER RESOURCES
R. V. SMRHA, Chief Engineer
512 CENTRAL BUILDING
700 KANSAS AVENUE

Smoky Hill Air Force Base
Salina, Kansas

Attention: Walter A. Harizog, Jr.
LTCOL, USAF
Deputy Base Commander

Gentlemen:

Transmitted herewith is the "Notice of Contents of Order Determining and Establishing Vested Rights to Continue the Beneficial Use of Water", having actually been applied to beneficial use prior to the effective date of the Water Appropriation Act of 1945, (82a-701 d. and 82a-704 1947 Supp., G. S. 1935), copy enclosed.

The order of the Chief Engineer determining and establishing the "vested right" of the Smoky Hill Air Force Base, Saline County, Kansas, is as follows: 2511 acre feet per year, at a maximum rate of 5.7 cubic feet per second. This order corresponds in all respects to the vested right claim for the quantity of water as made by Walter A. Harizog, Jr., LTCOL, USAF, Deputy Base Commander.

As a matter of information, there is enclosed also an Abstract of all the "vested rights" to use of water in Saline County, Kansas, as determined by the Chief Engineer of the Division of Water Resources of the Kansas State Board of Agriculture.

Very truly yours,

R. V. Smrha
Chief Engineer

RVS:GEG:mb
3 encls.

NOTICE OF CONTENTS OF ORDER DETERMINING AND ESTABLISHING VESTED RIGHTS TO CONTINUE THE BENEFICIAL USE OF WATER

TO: Smoky Hill Air Force Base
Salina, Kansas

You are hereby notified that on the 29th day of November, 19 56, the Chief Engineer of the Division of Water Resources, Kansas State Board of Agriculture, entered in the records of his office in accordance with the provisions of section 82a-704 of the 1947 Supplement to the General Statutes of Kansas, 1935, the following order, made by him, determining and establishing your vested right to continue the use of water for beneficial purposes from Five (5) wells in the drainage basin of the Smoky Hill River, located in the S½ of Section 7, NE¼ NE¼ of Section 8, NW¼ NW¼ of Section 6, all in Township 15 South, Range 2 West, in Saline County, Kansas.

ORDER

The extent of your vested right to continue the beneficial use of water from the source as stated has been determined and established to be a maximum quantity of 2511 acre feet per year to be diverted at a maximum rate of 5.7 cubic feet per second for Industrial-military use at or upon the following described property: Smoky Hill Air Force Base in Saline County, Kansas

Any appeal from this order must be made to the district court of the county in which the point of diversion is located within 60 days after posting and mailing of this notice.

Dated at Topeka, Kansas, this 29th day of November, 19 56.

R. V. Smrha
Chief Engineer
Division of Water Resources
Kansas State Board of Agriculture

[illegible]

NOTICE OF CONTENTS OF ORDER DETERMINING AND ESTABLISHING VESTED RIGHTS TO CONTINUE THE BENEFICIAL USE OF WATER

TO Smoky Hill Air Force Base
Salina, Kansas

You are hereby notified that on the 29th day of November, 1956, the Chief Engineer of the Division of Water Resources, Kansas State Board of Agriculture, entered in the records of his office in accordance with the provisions of section 82a-704 of the 1947 Supplement to the General Statutes of Kansas, 1935, the following order, made by him, determining and establishing your vested right to continue the use of water for beneficial purposes from five (5) wells in the drainage basin of the Smoky Hill River, located in the N½ of Section 7, NW¼ NW¼ of Section 8, SW¼ SW¼ of Section 6, all in Township 15 South, Range 2 West, in Saline County, Kansas.

ORDER

The extent of your vested right to continue the beneficial use of water from the source as stated has been determined and established to be a maximum quantity of 2511 acre feet per year to be diverted at a maximum rate of 5.7 cubic feet per second for industrial-military use at or upon the following described property:

Smoky Hill Air Force Base in Saline County, Kansas

Any appeal from this order must be made to the district court of the county in which the point of diversion is located within 60 days after posting and mailing of this notice.

Dated at Topeka, Kansas, this 29th day of November, 1956.

R V Smrha
Chief Engineer
Division of Water Resources
Kansas State Board of Agriculture

STATE OF KANSAS } ss.
COUNTY OF SALINE }
FILED FOR RECORD IN MY OFFICE AT
4:30 O'CLOCK P. M. JUN 20 1978
AND DULY RECORDED
VOL. 112 OF Misc AT PAGE 928
Helen Jaggers REG. OF DEEDS

23-435 7-49—10M

State of Kansas)
County of Rooks)
This instrument was acknowledged before me on January 28, 1993 by Scott E. Ross as Water Commissioner of the Kansas State Board of Agriculture, Division of Water Resources.

Nila L Denton
Nila L. Denton, Notary Public

NILA L. DENTON
State of Kansas
My Appt. Exp. 8-18-93

I hereby certify that this instrument is a true and correct copy of the original as purported.
Dated at Stockton, Kansas this 28th day
of January 19 93
Scott E Ross
DIVISION OF WATER RESOURCES
KANSAS STATE BOARD OF AGRICULTURE

RECEIVED
DEC 16 1981
FIELD OFFICE
DIVISION OF WATER RESOURCES
STOCKTON

THE STATE OF KANSAS

STATE BOARD OF AGRICULTURE
W. W. Duitsman, *Secretary*

DIVISION OF WATER RESOURCES
Guy E. Gibson, *Chief Engineer-Director*

CERTIFICATE OF APPROPRIATION

FOR BENEFICIAL USE OF WATER

WATER RIGHT, File No. 3043

PRIORITY DATE October 16, 1954

WHEREAS, It has been determined by the undersigned that construction of the appropriation diversion works has been completed, that water has been used for beneficial purposes and that the appropriation right has been perfected, all in conformity with the conditions of approval of the application pursuant to the water right referred to above and in conformity with the laws of the State of Kansas.

NOW, THEREFORE, Be It Known that GUY E. GIBSON, the duly appointed, qualified and acting Chief Engineer-Director of the Division of Water Resources of the Kansas State Board of Agriculture, by authority of the laws of the State of Kansas, and particularly K.S.A. 82a-714, does hereby certify that, subject to vested rights and prior appropriation rights, the appropriator is entitled to make use of surface water in the Smoky Hill River to be diverted at a point located in the Northwest Quarter of the Northeast Quarter of the Southwest Quarter (NW¼ NE¼ SW¼) of Section 13, Township 14 South, Range 3 West, Saline County, Kansas, at a rate not in excess of 6,955 gallons per minute (15.49 c.f.s.) and in a quantity not to exceed 1,638,402,000 gallons (5,028 acre-feet) per calendar year for municipal use in the City of Salina, Kansas, and immediate vicinity.

MICROFILMED

The appropriation right as perfected is appurtenant to and severable from the land herein described.

The appropriation right shall be deemed abandoned and shall terminate when without due and sufficient cause no lawful beneficial use is made of water under this appropriation for three (3) successive years.

The right of the appropriator shall relate to a specific quantity of water and such right must allow for a reasonable raising or lowering of the static water level and for the reasonable increase or decrease of the stream flow at the appropriator's point of diversion.

IN WITNESS WHEREOF, I have hereunto set my hand at my office at Topeka, Kansas, this 25th day of November, 1981.

GUY E. GIBSON

Guy E. Gibson

Guy E. Gibson, P.E.
Chief Engineer-Director
Division of Water Resources
Kansas State Board of Agriculture

State of Kansas)
) SS
County of Shawnee)

The foregoing instrument was acknowledged before me this 25th day of November, 1981, by Guy E. Gibson, P.E., Chief Engineer-Director, Division of Water Resources, Kansas State Board of Agriculture.

DENISE J. WATERS

Denise J. Waters
Notary Public

My appointment expires March 1, 1982

(Record in the Office of the Register of Deeds in the county or counties wherein the point of diversion is located)

WATER APPROPRIATION

CERTIFICATE

No. 7948

STATE OF KANSAS

Water Right, File No. 3043

To

State of Kansas, ____ County, ss.

Filed for record this ____ day of ____ 198__

____ o'clock ____ m. and

recorded in Book ____ Page ____

Fee $ ____

____ Register of Deeds

State of Kansas)
County of Rooks)
This instrument was acknowledged before me on January 28, 1993 by Scott E. Ross as Water Commissioner of the Kansas State Board of Agriculture, Division of Water Resources.

Nila L Denton
Nila L. Denton, Notary Public

NILA L. DENTON
State of Kansas
My Appt. Exp. 8-18-93

I hereby certify that this instrument is a true and correct copy of the original as purported.
Dated at Stockton, Kansas this 28th da
of January 19 93
DIVISION OF WATER RESOURCES
KANSAS STATE BOARD OF AGRICULTURE

THE STATE OF KANSAS

STATE BOARD OF AGRICULTURE
Harland E. Priddle, *Secretary*

DIVISION OF WATER RESOURCES
David L. Pope, *Chief Engineer-Director*

CERTIFICATE OF APPROPRIATION
FOR BENEFICIAL USE OF WATER

WATER RIGHT, File No. 7635

PRIORITY DATE October 30, 1957

RECEIVED
AUG 12 1985
FIELD OFFICE
DIVISION OF WATER RESOURCES
STOCKTON

WHEREAS, It has been determined by the undersigned that construction of the appropriation diversion works has been completed, that water has been used for beneficial purposes and that the appropriation right has been perfected, all in conformity with the conditions of approval of the application pursuant to the water right referred to above and in conformity with the laws of the State of Kansas.

NOW, THEREFORE, Be It Known that DAVID L. POPE, the duly appointed, qualified and acting Chief Engineer-Director of the Division of Water Resources of the Kansas State Board of Agriculture, by authority of the laws of the State of Kansas, and particularly K.S.A. 82a-714, does hereby certify that, subject to vested rights and prior appropriation rights, the appropriator is entitled to make use of groundwater in the drainage basin of the Smoky Hill River to be withdrawn by means of fifteen (15) wells: one (1) well located in Lot 35, Block 2, Riverside Park Addition, City of Salina, in Section 12, more particularly described as being near a point 2100 feet North and 1230 feet West of the Southeast Corner of said Section, at a diversion rate not in excess of 902 gallons per minute (2.01 c.f.s.) and in a quantity not to exceed 149,181,100 gallons (457.82 acre-feet) per calendar year; one (1) well located West of Oakdale Avenue, Riverside Park Addition, City of Salina, in Section 12, more particularly described as being near a point 1750 feet North and 2050 feet West of the Southeast Corner of said Section, at a diversion rate not in excess of 963 gallons per minute (2.15 c.f.s.) and in a quantity not to exceed 83,056,200 gallons (254.89 acre-feet) per calendar year; one (1) well located near the

Re: File No. 7635

Southeast Corner of Lot 10, Atherton and Phillips Addition, City of Salina, in Section 12, more particularly described as being near a point 320 feet North and 2350 feet West of the Southeast Corner of said Section, at a diversion rate not in excess of 1194 gallons per minute (2.66 c.f.s.) and in a quantity not to exceed 36,723,400 gallons (112.70 acre-feet) per calendar year; one (1) well located in Lot 11, Block 8, Oakdale Addition, City of Salina, in Section 13, more particularly described as being near a point 4530 feet North and ~~670~~ 1300 feet West of the Southeast Corner of said Section, at a diversion rate not in excess of 1081 gallons per minute (2.41 c.f.s.) and in a quantity not to exceed 160,970,400 gallons (494.00 acre-feet) per calendar year; one (1) well located in the Southeast Corner of Lot 2, Geis Addition, City of Salina, in Section 13, more particularly described as being near a point 4700 feet North and 2380 feet West of the Southeast Corner of said Section, at a diversion rate not in excess of 1269 gallons per minute (2.83 c.f.s.) and in a quantity not to exceed 55,257,800 gallons (169.58 acre-feet) per calendar year; one (1) well located near the Southeast Corner of Lot 10, Block 15, Cunningham Replat, City of Salina, in Section 13, more particularly described as being near a point 3600 feet North and 2200 feet West of the Southeast Corner of said Section, at a diversion rate not in excess of 1307 gallons per minute (2.91 c.f.s.) and in a quantity not to exceed 100,854,100 gallons (309.51 acre-feet) per calendar year; one (1) well located in Lot 10, Block 11, Oakdale Addition, City of Salina, in Section 13, more particularly described as being near a point 3900 feet North and 850 feet West of the Southeast Corner of said Section, at a diversion rate not in excess of 1213 gallons per minute (2.70 c.f.s.) and in a quantity not to exceed 160,253,500 gallons (491.80 acre-feet) per calendar year; one (1) well located 100 feet Southeast of the intersection of Walnut and Second Street, Northeast Corner of City Park, City of Salina, in Section 13, more particularly described as being near a point 3850 feet North and 3100 feet West of the Southeast Corner of said Section, at a diversion rate not in excess of 1159 gallons per minute (2.58 c.f.s.) and in a quantity not to exceed 85,698,800 gallons (263.00 acre-feet) per calendar year; one (1) well located in the West Central Part of Oakdale Park, City of Salina, in Section 13, more particularly described as being near a point 2900 feet North and 2500 feet

State of Kansas)
County of Rooks)
This instrument was acknowledged before me
on January 28, 1993 by Scott E. Ross as
Water Commissioner of the Kansas State Board
of Agriculture, Division of Water Resources.

Nila L Denton
Nila L. Denton, Notary Public

NILA L. DENTON
State of Kansas
My Appt. Exp. 8-18-93

I hereby certify that this instrument is a true and correct copy of the original as purported.
Dated at Stockton, Kansas this 28th day of January, 19 93
Scott E. R
DIVISION OF WATER RESOURCES
KANSAS STATE BOARD OF AGRICULTURE

West of the Southeast corner of said Section, at a diversion rate not in excess of 1137 gallons per minute (2.53 c.f.s.) and in a quantity not to exceed 61,334,900 gallons (188.23 acre-feet) per calendar year; one (1) well located in Lot 1, Hollands Addition, City of Salina, in Section 13, more particularly described as being near a point 2450 feet North and 3720 feet West of the Southeast Corner of said Section, at a diversion rate not in excess of 996 gallons per minute (2.22 c.f.s.) and in a quantity not to exceed 70,973,600 gallons (217.81 acre-feet) per calendar year; one (1) well located in Lot 1, Neeley's Addition, City of Salina, in Section 13, more particularly described as being near a point 1850 feet North and 3450 feet West of the Southeast Corner of said Section, at a diversion rate not in excess of 870 gallons per minute (1.94 c.f.s.) and in a quantity not to exceed 155,287,600 gallons (476.56 acre-feet) per calendar year; one (1) well located in Lot 41, Block 2, Vantrine Addition, City of Salina, in Section 13, more particularly described as being near a point 150 feet North and 3150 feet West of the Southeast Corner of said Section, at a diversion rate not in excess of 1156 gallons per minute (2.58 c.f.s.) and in a quantity not to exceed 185,021,500 gallons (567.81 acre-feet) per calendar year; one (1) well located in the East Half of Kenwood Park, City of Salina, in Section 13, more particularly described as being near a point 2150 feet North and 1350 feet West of the Southeast Corner of said Section, at a diversion rate not in excess of 1081 gallons per minute (2.41 c.f.s.) and in a quantity not to exceed 126,804,900 gallons (389.15 acre-feet) per calendar year; one (1) well located near the Southwest Corner of Kenwood Park, City of Salina, in Section 13, more particularly described as being near a point 2000 feet North and 2570 feet West of the Southeast Corner of said Section, at a diversion rate not in excess of 1137 gallons per minute (2.53 c.f.s.) and in a quantity not to exceed 157,200,300 gallons (482.43 acre-feet) per calendar year; and one (1) well located in Lot 13, Block 1, Collegeview Addition, City of Salina, in Section 24, more particularly described as being near a point 4250 feet North and 3280 feet West of the Southeast Corner of said Section, at a diversion rate not in excess of 996 gallons per minute (2.22 c.f.s.) and in a quantity not to exceed 166,907,400 gallons (512.22 acre-feet) per calendar year, all in Township 14 South, Range 3 West, Saline County, Kansas, for municipal use in the City of Salina, Kansas, and immediate vicinity.

This appropriation right is further limited to a quantity and diversion rate which when combined with the water right set forth in the order of the Chief Engineer, Division of Water Resources, Kansas State Board of Agriculture, dated January 6, 1955 (identified as Vested Right, File No. SA 002), will provide a diversion rate not in excess of 9118 gallons per minute (20.32 c.f.s.) and a quantity not to exceed 1,601,823,000 gallons (4915.8 acre-feet) per calendar year for municipal use at the location described herein.

The appropriator shall maintain records from which the quantity of water actually diverted during each calendar year may be readily determined. Such records shall be furnished to the Chief Engineer-Director by March 1 of each year following.

The appropriator shall maintain, in an operating condition satisfactory to the Chief Engineer-Director, all check valves installed for the prevention of chemical or other foreign substance pollution of the water supply.

The appropriation right as perfected is appurtenant to and severable from the land herein described.

The appropriation right shall be deemed abandoned and shall terminate when without due and sufficient cause no lawful beneficial use is made of water under this appropriation for three (3) successive years.

The right of the appropriator shall relate to a specific quantity of water and such right must allow for a reasonable raising or lowering of the static water level and for the reasonable increase or decrease of the stream flow at the appropriator's point of diversion.

IN WITNESS WHEREOF, I have hereunto set my hand at my office at Topeka, Kansas, this 25th day of July , 1985.

RECEIVED
AUG 12 1985
FIELD OFFICE
DIVISION OF WATER RESOURCES
STOCKTON

David L. Pope

David L. Pope, P.E.
Chief Engineer-Director
Division of Water Resources
Kansas State Board of Agriculture

State of Kansas)
) SS
County of Shawnee)

The foregoing instrument was acknowledged before me this 25th day of July , 1985, by David L. Pope, P.E., Chief Engineer-Director, Division of Water Resources, Kansas State Board of Agriculture.

Sara Arbaiza
Notary Public

My appointment expires October 29, 1986

Deeds in the county or counties wherein the point of diversion is located)

WATER APPROPRIATION
CERTIFICATE
No. 12,681
STATE OF KANSAS
Water Right, File No. 7635

MICROFILMED

State of Kansas, ____ County, ss.
Filed for record this ____ day of ____ 198__
at ____ o'clock ____ m. and
recorded in Book ____ Page ____
Fee $ ____
Register of Deeds

THE STATE OF KANSAS

KANSAS DEPARTMENT OF AGRICULTURE
Alice A. Devine, Secretary of Agriculture

DIVISION OF WATER RESOURCES
David L. Pope, Chief Engineer

CERTIFICATE OF APPROPRIATION FOR BENEFICIAL USE OF WATER

WATER RIGHT, File No. 31,636

PRIORITY DATE April 11, 1978

WHEREAS, It has been determined by the undersigned that construction of the appropriation diversion works has been completed, that water has been used for beneficial purposes and that the appropriation right has been perfected, all in conformity with the conditions of approval of the application pursuant to the water right referred to above and in conformity with the laws of the State of Kansas.

NOW, THEREFORE, Be It Known that DAVID L. POPE, the duly appointed, qualified and acting Chief Engineer of the Division of Water Resources of the Kansas Department of Agriculture, by authority of the laws of the State of Kansas, and particularly K.S.A. 82a-714, does hereby certify that, subject to vested rights and prior appropriation rights, the appropriator is entitled to make use of groundwater in the drainage basin of the Smoky Hill River to be withdrawn by means of fifteen (15) wells:

> Well No. 1 located in Lot 1, Neeley's Addition, City of Salina, Kansas, in the Southwest Quarter of the Northeast Quarter of the Southwest Quarter (SW¼ NE¼ SW¼) of Section 13, more particularly described as being near a point 1,850 feet North and 3,450 feet West of the Southeast corner of said section, at a diversion rate not in excess of 870 gallons per minute (1.94 c.f.s.) and a quantity of water not to exceed 1,375,000 gallons (4.22 acre-feet) per calendar year;
>
> Well No. 2 located in the East Half (E½) of Kenwood Park, City of Salina, Kansas, near the center of the North Half of the Southeast Quarter (N½ SE¼) of Section 13, more particularly described as being near a point 2,150 feet North and 1,350 feet West of the Southeast corner of said section, at a diversion rate not in excess of 1,085 gallons per minute (2.41 c.f.s.) and a quantity of water not to exceed 1,625,000 gallons (4.99 acre-feet) per calendar year;

Well No. 3 located in Lot 1, Holland's Addition, at water plant on 4th Street, City of Salina, Kansas, in the Northwest Quarter of the Northeast Quarter of the Southwest Quarter (NW¼ NE¼ SW¼) of Section 13, more particularly described as being near a point 2,450 feet North and 3,720 feet West of the Southeast corner of said section, at a diversion rate not in excess of 1,000 gallons per minute (2.22 c.f.s.) and a quantity of water not to exceed 1,500,000 gallons (4.60 acre-feet) per calendar year;

Well No. 4 located in Lot 41, Block 2, Van Trine Addition, City of Salina, Kansas, in the Southeast Quarter of the Southeast Quarter of the Southwest Quarter (SE¼ SE¼ SW¼) of Section 13, more particularly described as being near a point 150 feet North and 3,150 feet West of the Southeast corner of said section, at a diversion rate not in excess of 1,160 gallons per minute (2.58 c.f.s.) and a quantity of water not to exceed 1,750,000 gallons (5.37 acre-feet) per calendar year;

Well No. 5 located in Lot 13, Block 1, College View Addition, City of Salina, Kansas, near the center of the South Half of the Northeast Quarter of the Northwest Quarter (S½ NE¼ NW¼) of Section 24, more particularly described as being near a point 4,250 feet North and 3,280 feet West of the Southeast corner of said section, at a diversion rate not in excess of 1,000 gallons per minute (2.22 c.f.s.) and a quantity of water not to exceed 1,500,000 gallons (4.60 acre-feet per calendar year;

Well No. 6 located near the Southwest corner of Kenwood Park, City of Salina, Kansas, near the center of the North Half of the South Half (N½ S½) of Section 13, more particularly described as being near a point 2,000 feet North and 2,570 feet West of the Southeast corner of said section, at a diversion rate not in excess of 1,140 gallons per minute (2.54 c.f.s.) and a quantity of water not to exceed 1,750,000 gallons (5.37 acre-feet) per calendar year;

Well No. 7 located in Lot 10, Block 11, Oakdale Addition, City of Salina, Kansas, near the center of the West Half of the East Half of the Northeast Quarter (W½ E½ NE¼) of Section 13, more particularly described as being near a point 3,900 feet North and 850 feet West of the Southeast corner of said section, at a diversion rate not in excess of 1,215 gallons per minute (2.70 c.f.s.) and a quantity of water not to exceed 1,750,000 gallons (5.37 acre-feet) per calendar year;

Well No. 8 located in the West Central part of Oakdale Park, near Smoky Valley Museum, City of Salina, Kansas, in the Southwest Quarter of the Southwest Quarter of the Northeast Quarter (SW¼ SW¼ NE¼) of Section 13, more particularly described as being near a point 2,900 feet North and 2,500 feet West of the Southeast corner of said section, at a diversion rate not in excess of 1,140 gallons per minute

(2.53 c.f.s.) and a quantity of water not to exceed 1,750,000 gallons (5.37 acre-feet) per calendar year;

Well No. 10 located in the Southeast corner of Lot 10, Block 15, Cunningham Replat of Oakdale Park Addition, City of Salina, Kansas, in the Northwest Quarter of the Southwest Quarter of the Northeast Quarter (NW¼ SW¼ NE¼) of Section 13, more particularly described as being near a point 3,600 feet North and 2,200 feet West of the Southeast corner of said section, at a diversion rate not in excess of 1,310 gallons per minute (2.91 c.f.s.) and a quantity of water not to exceed 2,000,000 gallons (6.14 acre-feet) per calendar year;

Well No. 11 located in the Southeast corner of Lot 10, Atherton Addition, City of Salina, Kansas, in the Southwest Quarter of the Southwest Quarter of the Southeast Quarter (SW¼ SW¼ SE¼) of Section 12, more particularly described as being near a point 320 feet North and 2,350 feet West of the Southeast corner of said section, at a diversion rate not in excess of 1,195 gallons per minute (2.66 c.f.s.) and a quantity of water not to exceed 1,750,000 (5.37 acre-feet) per calendar year;

Well No. 12 located in the Southeast corner of Lot 2, Geis Addition, City of Salina, Kansas, in the Northwest Quarter of the Northwest Quarter of the Northeast Quarter (NW¼ NW¼ NE¼) of Section 13, more particularly described as being near a point 4,700 feet North and 2,380 feet West of the Southeast corner of said section, at a diversion rate not in excess of 1,270 gallons per minute (2.83 c.f.s.) and a quantity of water not to exceed 2,000,000 gallons (6.14 acre-feet) per calendar year;

A well located in the Northeast Quarter of the Southeast Quarter of the Northwest Quarter (NE¼ SE¼ NW¼) of Section 13, more particularly described as being near a point 3,800 feet North and 3,100 feet West of the Southeast corner of said section, at a diversion rate not in excess of 1,160 gallons per minute (2.22 c.f.s.) and a quantity of water not to exceed 1,750,000 gallons (5.37 acre-feet) per calendar year;

Well No. 14 located in Lot 11, Block 8, Oakdale Addition, City of Salina, Kansas, near the center of the North Half of the North Half of the Northeast Quarter (N½ N½ NE¼) of Section 13, more particularly described as being near a point 4,530 feet North and 670 feet West of the Southeast corner of said section, at a diversion rate not in excess of 1,085 gallons per minute (2.41 c.f.s.) and a quantity of water not to exceed 1,625,000 gallons (4.99 acre-feet) per calendar year;

Well No. 15 located West of Oakdale Ave., Riverside Park Addition, City of Salina, Kansas, near the center of the Northwest Quarter of the Southeast Quarter (NW¼ SE¼) of Section 12, more particularly described as being near a point 1,750 feet North and 2,050 feet West of the Southeast corner of said section, at a diversion rate not in excess of 965 gallons per minute (2.15 c.f.s.) and a quantity of water not to exceed 1,500,000 gallons (4.60 acre-feet) per calendar year, and

Well No. 16 located in Lot 35, Block 2, Riverside Park Addition, City of Salina, Kansas, near the center of the North Half of the North Half of the Southeast Quarter (N½ N½ SE¼) of Section 12, more particularly described as being near a point 2,100 feet North and 1,230 feet West of the Southeast corner of said section, at a diversion rate not in excess of 905 gallons per minute (2.0 c.f.s.) and a quantity of water not to exceed 1,375,000 gallons (4.22 acre-feet) per calendar year,

all in Township 14 South, Range 3 West, Saline County, Kansas, located substantially as shown on the plats accompanying the application.

for municipal use in the City of Salina, Kansas and immediate vicinity, within the boundaries of Rural Water District No. 3, Saline County, Capehart Housing Area, South Half of the South Half (S½ S½) of Section 35, Township 14 South, Range 3 West, Saline County, Kansas and the Northwest Quarter of the Northwest Quarter (NW¼ NW¼) of Section 2, Township 15 South, Range 3 West, Saline County, Kansas, School Specialty Supply and General Battery Corporation, South Half of the North Half (S½ N½) of Section 1, Township 15 South, Range 3 West, Saline County, Kansas, South Industrial Area, South Half of the Northwest Quarter (S½ NW¼) of Section 1, Township 15 South, Range 1 West, Saline County, Kansas, John Deere Company, North Half of the Southeast Quarter (N½ SE¼) of Section 1, Township 15 South, Range 3 West, Saline County, Kansas, Western Auto Warehouse, South Half of the South Half of the Southwest Quarter (S½ S½ SW¼) of Section 1, Township 15 South, Range 3 West, Saline County, Kansas and Westinghouse Corporation, Northwest Quarter (NW¼) of Section 12, Township 15 South, Range 3 West, Saline County, Kansas.

This appropriation right is further limited to a diversion rate which when the wells operate simultaneously will provide a diversion rate not in excess of 1,450 gallons per minute (3.23 c.f.s.) for municipal use on the property described herein.

The appropriator shall maintain records from which the quantity of water actually diverted during each calendar year may be readily determined. Such records shall be furnished to the Chief Engineer by March 1 of each year following.

The appropriator shall maintain, in an operating condition satisfactory to the Chief Engineer, all check valves installed for the prevention of chemical or other foreign substance pollution of the water supply.

The appropriation right as perfected is appurtenant to and severable from the land herein described.

The appropriation right shall be deemed abandoned and shall terminate when without due and sufficient cause no lawful beneficial use is made of water under this appropriation for three (3) successive years.

The right of the appropriator shall relate to a specific quantity of water and such right must allow for a reasonable raising or lowering of the static water level and for the reasonable increase or decrease of the stream flow at the appropriator's point of diversion.

IN WITNESS WHEREOF, I have hereunto set my hand at my office at Topeka, Kansas, this 23rd day of May, 1996.

David L. Pope, P.E.
Chief Engineer
Division of Water Resources
Kansas Department of Agriculture

State of Kansas)
) SS
County of Shawnee)

The foregoing instrument was acknowledged before me this 23rd day of May, 1996, by David L. Pope, P.E., Chief Engineer, Division of Water Resources, Kansas Department of Agriculture.

Denise J. Rolfs
Notary Public

My appointment expires: My Appt. Exp. 3-1-98

(Record in the Office of Register of Deeds in the county or counties wherein the point of diversion is located)

CERTIFICATE OF APPROPRIATION
FOR BENEFICIAL USE OF WATER

STATE OF KANSAS

Water Right, File No. 31,636

STATE OF KANSAS, ____ COUNTY, ss.

Filed for record this ____ day of ____, 19____

at ____ o'clock ____ m. and

recorded in Book ____ Page ____

Fee $ ____

____ Register of Deeds.

Appendix B

Water Right and Future Demand Tables

Table B-1
Future Demands and Existing Water Rights – Normal Conditions
(Corresponds with Figures 5-3 and 5-4)

Year	Average Day w/ Reserve (MGD)	Seasonal Average Day w/ Reserve (MGD)	Maximum Day w/ Reserve (MGD)	River + DT Wellfield Max Rate (MGD)	Total Annual Quanitity Needed (ac-ft)	River + DT Wellfield Annual Quantity Limit (ac-ft)	Existing Annual Quantity Limit (ac-ft)
2010	8.14	12.05	15.57	25.2	9,119	10,021	11,837
2015	8.38	12.40	16.03	25.2	9,386	10,021	11,837
2020	8.62	12.76	16.48	25.2	9,653	10,021	11,837
2025	8.85	13.11	16.94	25.2	9,920	10,021	11,837
2030	9.09	13.46	17.40	25.2	10,186	10,021	11,837
2035	9.33	13.81	17.85	25.2	10,453	10,021	11,837
2040	9.57	14.17	18.31	25.2	10,720	10,021	11,837
2045	9.81	14.52	18.76	25.2	10,987	10,021	11,837
2050	10.05	14.87	19.22	25.2	11,254	10,021	11,837
2055	10.28	15.23	19.67	25.2	11,521	10,021	11,837
2060	10.52	15.58	20.13	25.2	11,788	10,021	11,837

Table B-2
Future Demands and Existing Water Rights – Drought Conditions
Utilization of Downtown Wellfield Only
(Corresponds with Figure 5-5)

Year	Average Day w/ Reserve (MGD)	Seasonal Average Day w/ Reserve (MGD)	Maximum Day w/ Reserve (MGD)	Limits of Water Rights for DT Wellfield (MGD)	Deficit for Seasonal Average (MGD)	Deficit for Max Day (MGD)
2010	8.14	12.05	15.57	15.2	0.00	-0.37
2015	8.38	12.40	16.03	15.2	0.00	-0.83
2020	8.62	12.76	16.48	15.2	0.00	-1.28
2025	8.85	13.11	16.94	15.2	0.00	-1.74
2030	9.09	13.46	17.40	15.2	0.00	-2.20
2035	9.33	13.81	17.85	15.2	0.00	-2.65
2040	9.57	14.17	18.31	15.2	0.00	-3.11
2045	9.81	14.52	18.76	15.2	0.00	-3.56
2050	10.05	14.87	19.22	15.2	0.00	-4.02
2055	10.28	15.23	19.67	15.2	-0.03	-4.47
2060	10.52	15.58	20.13	15.2	-0.38	-4.93

Table B-3
Future Demands and Existing Water Rights – Drought Conditions
Utilization of Downtown Wellfield & South Wellfield Only
(Corresponds with Figure 5-6)

Year	Average Day w/ Reserve (MGD)	Seasonal Average Day w/ Reserve (MGD)	Maximum Day w/ Reserve (MGD)	Water Rights for DT Wellfield & South Wellfield (MGD)	Deficit for Seasonal Average (MGD)	Deficit for Max Day (MGD)
2008	8.05	11.91	15.39	18.9	0.00	0.00
2010	8.14	12.05	15.57	18.9	0.00	0.00
2015	8.38	12.40	16.03	18.9	0.00	0.00
2020	8.62	12.76	16.48	18.9	0.00	0.00
2025	8.85	13.11	16.94	18.9	0.00	0.00
2030	9.09	13.46	17.40	18.9	0.00	0.00
2035	9.33	13.81	17.85	18.9	0.00	0.00
2040	9.57	14.17	18.31	18.9	0.00	0.00
2045	9.81	14.52	18.76	18.9	0.00	0.00
2050	10.05	14.87	19.22	18.9	0.00	-0.32
2055	10.28	15.23	19.67	18.9	0.00	-0.77
2060	10.52	15.58	20.13	18.9	0.00	-1.23

Appendix C

Draft Contaminant Candidate List 3

Appendix C
Draft CCL3 Contaminant Candidates

Microbial Contaminant Candidates

Caliciviruses
Campylobacter jejuni
Entamoeba histolytica
Escherichia coli (0157)
Helicobacter pylori
Hepatitis A virus
Legionella pneumophila
Naegleria fowleri
Salmonella enterica
Shigella sonnei
Vibrio cholerae

Chemical Contaminant Candidates

Alpha-Hexachlorocyclohexane
1,1,1,2-Tetrachloroethane
1,1-Dichloroethane
1,2, 3-Trichloropropane
1,3-Butadiene
1,3-Dinitrobenzene
1,4-Dioxane
1-Butanol
2-Methoxyethanol
2,1-Propenol
3-Hydroxycarbofuran
4,4-Methylenedianiline
Acephate
Acetaldehyde
Acetamide
Acetochlor
Ethanesulfonic Acid (ESA)
Methyl tert-butyl ether
Metolochlor
Metolachlor ethanesulfonic acid (ESA)
Metolachlor oxanilic acid (OA)
Molinate
Molybdenum
Nibrobenzene
Nitrofen
Nitroglycerin
N-Methyl-2-pyrrolidone
N-nitrosodiethylamine (NDEA)
N-nitrosodimethylamine (NDMA)
N-nitroso-di-n-propylamine (NDPA)
N-Nitrosodiphenylamine
N-nitrosopyrrolidine (NPYR)
N-Propylbenzene
o-Toluidine

Acetochlor oxanilic acid (OA)

Aniline

Bensulide

Benzyl chloride

Butylated hydroxyanisole

Captan

Chloromethane (Methyl chloride)

Clethodim

Cobalt

Cumene hydroperoxide

Cyanotoxins (3)

Dicrotophos

Dimethipin

Demethoate

Disulfoton

Diuron

Ethion

Ethoprop

Ethylene glycol

Ethylene oxide

Ethylene thiourea

Fenamiphos

Formaldehyde

Germanium

HCFC-22

Oxirane, methyl-

Oxydemeton-methyl

Oxyfluorfen

Perchlorate

Permethrin

PFOA (perfluorooctanoic acid)

Profenofos

Quinoline

RDX

Sec-Butylbenzene

Strontium

Tebucanazole

Tebufenozide

Tellurium

Terbufos

Terbufos sulfone

Thiodicarb

Thiophanate-methyl

Toluene diisocyanate

Tribufos

Triethylamine

Triphenyltin hydroxide

Urethane

Vanadium

Vinclozolin

Hexane

Hydrazine

Methamidophos

Methanol

Methyl bromide (Bromomethane)

Ziram

Appendix D

Regulatory Meeting Notes

City of Salina
Raw Water Supply Study
Regulatory Meeting

Meeting Notes

Capital Plaza Hotel, River Room
Topeka, Kansas
October 31, 2008
9:00 AM – 12:00 PM

1. Introductions (5 min)

   Meeting attendees included:
   Martha Tasker, City of Salina
   Kurt Williams, City of Salina
   Jeff Cart, City of Salina
   Don Lindeman, HDR
   Glenn Dostal, HDR
   Lorrie Hill, HDR
   Jason Schlickbernd, Wilson & Co.
   Luca DeAngelis, Layne
   Dave Waldo, KDHE (Public Water Supply Section)
   Rod Geisler, KDHE (Municipal Section)
   Jennifer Nichols, KDHE (North Central District)
   Marsha Carpenter, KDHE (North Central District)
   Rick Bean, KDHE (Bureau of Remediation)
   Margaret Fast, KWO
   Diane Coe, KWO
   Nathan Westrup, KWO
   Lane Letourneau, DWR
   Scott Ross, DWR
   Kent Askren, Kansas Farm Bureau
   John Grothaus, Corps of Engineers
   Steve Spaulding, Corps of Engineers

2. Background (10 min) – *this was presented to the group, see attached presentation*
   a. Study Drivers/Scope of Study
   b. Purpose of Meeting

3. Future Regulatory Impacts (15 min)
   a. Upcoming Drinking Water Regulations *(Dave Waldo spoke for this issue)*
      - *Total Coliform Rule Revisions – should have no impacts for Salina*
      - *Lead and Copper Rule Revisions – no impacts as far as water supply*
      - *Distribution System Rule – does not affect the source*
      - *Radon Rule – no compliance concerns for groundwater blended with surface water*
      - *Atrazine is a concern for surface waters – KDHE recommended quarterly or monthly sampling to bring down the average concentration (City currently does sampling twice per year)*
      - *LT2ESWTR – monitoring would be required for a new source. City stated that their current monitoring indicates they may fall into Bin 1.*
      - *Salina currently meets requirements for TTHM/HAA5*
      - *Endocrine disruptors more of a wastewater issue*

4. Contamination Impacts at Downtown Wellfield (15 min)
    a. Burns & McDonnell Studies *(Rick Bean spoke for this issue)*
        - *Original contamination at downtown mostly due to dry cleaners*
        - *Recent contamination due to industrial contamination*
        - *Northern 4 wells most impacted (wells #11, 12, 15, 16)*
        - *Current concentration of 1,2 DCA cannot be decreased to meet MCL by existing air strippers at plant and continue to be drawn towards the wells*
        - *Schilling contamination is not currently impacting or threatening any of Salina's wells*
    b. Proposed Operation of Wellfield *(Rick Bean spoke for this issue)*
        - *Burns & McDonnell has created a groundwater model of this area – it is nearly complete*
        - *Currently modeling pumping scenarios that will mitigate impacts to PWS wells*
        - *One pumping scenario is that KDHE will install another well to pump water out (intercepts the contaminants) and treat with a GAC system at the well then send to the water treatment plant – Salina would get beneficial use of this water*
        - *Another pumping scenario is to change the pumping strategies at the affected wells*
        - *Pumping scenarios and report should be complete the week of November 3, 2008*
        - *City finds that they can pull the contaminants toward the wellfield by pumping any of the wells – the impacted wells (#11, 12, 15, 16) not currently being operated*
        - *If nothing is done, the wells would be un-usable in the short-term.*
        - *It was stated that the City could abandon impacted wells and redrill or can move the water rights to other wells*
        - *Wells are close together – the volume that can be pumped is limited by the cone of depression*
        - *The City struggles with fouling of the well screens at the Downtown Wellfield – the wells date back to the 1930s*
    c. Treatment Requirements

5. Conservation (30 min)
    a. Incorporating Private Wells into Conservation Plan *(Scott Ross spoke for this issue)*
        - *In order to incorporate private wells into Conservation Plan, just outline how it would be done and request Chief's approval – then incorporate conservation plan into City ordinance*
        - *City ordinance covers the City limits + ½ mile*
        - *KWO has language needed in conservation plan/ordinance – the ordinance references the conservation plan*
        - *When Hays IGUCA was put into place none of the existing tools were available*
        - *Chief can regulate waste of water, time of day when they can water, but not domestic well drilling*
        - *Odd/even days of watering make it harder to enforce and does not make sense to do with private wells*
        - *City is working with industries on conservation plans for the industry*
        - *From talking with other cities, front loading washing machines save a lot of water*
    b. Intensive Groundwater Use Control Areas (IGUCA)
        - *It is difficult to prove the criteria needed to establish an IGUCA, especially in Salina*
        - *IGUCA allows for regulation of private wells outside City limits*

6. Water Reuse (15 min)
    a. Impacts on Downstream Users *(Scott Ross mostly spoke for this issue)*
        i. *Cannot increase consumptive use*
        ii. *Consumptive use would not be increased if the City reused the water prior to discharging – "as long as it is under your use its your water"*
        iii. *Hays is using some of their water for irrigation, which will have future impacts on downstream Russell*

        - iv. *Downstream water right holders have counted on the return flows from wastewater treatment plant*
        - v. *There is one surface water right downstream of Salina prior to the confluence with Saline*
        - vi. *Can swap irrigation rights/municipal rights for reuse water*
        - vii. *Could discharge wastewater and get a water right to take it back out of the river – would lessen impacts of future problems with downstream users*
    - b. Current/Future Regulations
        - i. *Some capital improvements for nutrient removal may be avoided if some of the effluent is being reused*
        - ii. *NPDES permit will be less strict if using effluent for irrigation and not putting in river*
        - iii. *Direct reuse should only be considered as a last resort, should look for any industrial uses or irrigation first*
        - iv. *Need to add filtration for high contact irrigation uses – see minimum design standards*

7. Aquifer Recharge (30 min)
    - a. Using Surface Water Diversions
        - *Can get a seasonal surface water permit to divert river flows – would be conditioned with flow regime or season*
        - *Stacking of water rights is not an issue with a seasonal water right*
        - *City says they have problems with taste and odor if they use too much of the surface water*
        - *Water structures issue for using the oxbow*
        - *May need COE participation if use the oxbow for aquifer recharge – COE and Kansas Wildlife and Parks may contribute money by a cost-share program to beautify the oxbow area*
        - *The oxbow is basically silted in – water velocities are very low*
        - *Friends of the River is looking at enhancing the oxbow area*
        - *KWO's Smoky Hill River – Aquifer model shows a downward trend in aquifer levels*
        - *In summer the wellfield can see a 6-8' decline with pumping*
    - b. Using Reclaimed Water
        - *If use wastewater effluent for recharge, consider chloride build-up and THM issues – Hays looked at this and the public may not like*
        - *There is typically 6 months to 1 year travel time between 2 points in the aquifer*
        - *Could pump reuse water to Lakewood Lake, pump to start of oxbow and recirculate the water – or could do this with Smoky Hill River flows which would improve water quality too*
        - *If use oxbow to recirculate water and for recharge, would also have secondary benefit of making sure there is plenty of water at the existing Smoky Hill River intake*

8. Potential New Sources of Supply (60 min)
    - a. Kanopolis Reservoir
        - i. Review of Lake Regulation Manual
            - *See end of notes for information from Steve Spaulding's presentation on Kanopolis Lake regulation*
        - ii. Request for Deviation of Releases *(Margaret Fast spoke for this issue)*
            - *Request was never submitted to COE and has been shelved*
            - *Lake levels in 2007 rose and releases were not concern anymore*
            - *There may be a better way to regulate the releases – 50 cfs is often more than is needed*
            - *KWO looking at what releases are needed to meet downstream needs – working with COE so that release is small enough that it won't waste or may only release water when needed*
            - *7Q10 flow at Salina is 20 cfs*
            - *KWO has not pursued protection of the releases*

iii. Status of Water Marketing Program
  - *The contract for Post Rock includes Russell & White Energy – there are overlapping requests here*
  - *McPherson contract will likely not come to fruition – their request pre-dated the drought*
  - *Overall Kanopolis would still be an option for the City*
  - *No longer water supply for irrigation*

iv. Safe Yield Projections
  - *6.5 MGD yield stated in report is a continuous yield*
  - *COE may raise water quality pool by 2' which would add to the yield for water supply - a study is being done for dam safety evaluation and there may be some concerns with this*

b. Wilson and Milford Reservoirs

  i. Status of Water Marketing Program
    - *KWO does not currently own water in Wilson Reservoir – not part of Marketing Program*
    - *The main reason they have not bought any storage in Wilson is water quality*
    - *Disposal of brine concentrate could be done by double-lined evaporation ponds on a seasonal basis or deep well injection (Class 1 – expensive)*
    - *Milford doesn't see the kind of inflow reductions that are seen at Kanopolis*
    - *Most of the storage for water supply in Milford hasn't been opened up, but if an application were to be submitted they may look at opening a portion*
    - *Milford has interbasin transfer issues if over 2,000 acre-ft and more than 35 miles*

  ii. Safe Yield Projections
    - *KWO pursued a reallocation study to purchase water supply storage in Wilson – yield calculations (currently 29 MGD) may need to be recalculated*
    - *KWO is currently working on a report for Wilson that calculated a demand of 9.1 MGD but the projected demands did not include Salina (included Hays, Russell, and others). 2050 demand is 5.1 MGD.*

c. New Wellfields
  - *There are not a lot of appropriations on file around South Wellfield – if submit an application they would look at what is available using the 2-mile radius study*
  - *Further inside the City limits (closer to DT wellfield) DWR has had to deny appropriations*
  - *The Dakota is an unconfined aquifer near Salina which is more restrictive than the alluvial*
  - *The Dakota west of Salina has better water quality than east of Salina*
  - *Dakota is not closed to further appropriations but there are spacing limitations (4 miles in the unconfined aquifer)*
  - *If water quality is poor may as well look at Saline River*
  - *Spacing limitations in general are ¼ miles in the alluvium, ½ mile in unconfined Dakota, 4 miles in confined Dakota*

d. Acquire Existing Irrigation Rights
  - *Acquiring priority should be of importance*
  - *Reduction in consumptive use to be accounted for*
  - *Change in point of diversion up to ½ mile – need to account for well proximity*
  - *Variability in groundwater formation*
  - *Use of eminent domain remains difficult (find a willing seller)*
  - *All of the volume/rate for the water right will not be transferred – DWR can tell us what the conversion would be*

e. Local Rivers

  i. Saline River

        - *A direct surface water diversion would be restricted to times other than July 1 – October 1, whereas wells along the river bank are not restricted any time of the year*
        - *Saline River is not subject to MDS below Wilson Lake*
        - *If wanted to do a direct surface water diversion and a water right prior to 1990 was purchased there would be no restriction on time of year to withdraw*
        - *The withdrawal rates from the alluvium around Saline are not as great as around Smoky Hill*
        - *When an application is submitted, DWR looks at the impacts to streamflows*
    - ii. Confluence of Smoky Hill/Saline/Solomon Rivers
        - *There is a minimum desirable streamflow (MDS) gage above the confluence on Solomon (at Niles)*
        - *There is a chance of being cut off due to MDS if upstream of MDS gage unless a water right is bought with a priority date prior to 1984, which is when the MDS gages went into effect*
        - *Minimum flows (environmental flows) – lawsuits in west for keeping water in streams and they are winning*
        - *Inflow reductions due to land treatment impacts*
    - iii. Water Assurance Districts
        - *Study done in early 1990s that looked at WAD for Abilene, Lindsborg and Salina for Kanopolis Reservoir*
        - *WAD includes municipal and industrial water right holders downstream of a reservoir – they pool together to buy storage*
        - *The municipal and industrial users must vote to become part of WAD*
        - *There has been essentially no interest except for at Kanopolis*
        - *WAD not needed if flow is available in the river most of the time*
        - *Costs of storage for individual reservoirs would not be pooled like the Water Marketing Program*
- f. Reservoir Construction
    - *Gypsum Creek floods a lot*
    - *A water structures permit would be needed from DWR*
    - *Still need a water right*
    - *An off-site reservoir for peak flows is permittable and then bleed flows back to river*
    - *Permitting is more complicated for an in-stream reservoir*
    - *Gypsum & Mulberry may have bypass requirements*
    - *USACE is looking at new reservoir site – need to research further*
    - *There may have been sites the COE look at previously that were deauthorized*

Steve Spaulding (COE) gave a presentation on Kanopolis Lake

- Water Management Office – regulates 18 COE lakes and 11 Bureau lakes
- Planning office – studies related to future projects, operation scenarios
- Storage began at Kanopolis on Feb 17, 1948
- Multipurpose pool was filled July 19, 1948
- The COE is finding that some lakes are filling in with sediment at a slower rate than expected
- Looking at optimizing minimum releases – could do releases and then cut off when out of water, or redo the minimum release schedule
- There is substantial evaporation in the Lake
- It is difficult to make changes to the water control manual as it requires 3 levels of approval
- Permanent changes to the lake regulation manual are coordinated with the Corps regulations and National Environmental Policy Act (NEPA).
- A deviation in the releases would be a temporary measure for 1-3 years, after 3 years it would need to be permanently changed in the manual

Appendix E

Drought Contingency Plan Calculations

City of Salina
Raw Water Supply Study
Water Conservation Plan - Drought Response Plan
Winter (October - May) Conditions

Assumptions:
1. Assume no irrigation demands
2. No water lost or gained to the river from the aquifer (flow at Mentor = flow at Salina)
3. The City's water right is 15.5 cfs, however, not all of water rights are needed for demand

Watch - flows in the river are declining to low levels

Warning - flows in the river are declining to low levels

Emergency - just enough flow in river to meet demands

EMERGENCY - critical level where regulation of water use is required

	15.5	cfs	needed at Salina river intake
	15.5	cfs	needed at Mentor gage

Approximately 15 cfs needed at Mentor gage for Emergency condition
Corresponds with 99.9% exceedence (see figure 4-2)

WARNING - enough flow in river to meet demands

Choose flow exceeded 99% of the time (see figure 4-2)

	20	cfs	flow at Mentor gage
-	15.5	cfs	needed at Salina river intake
	4.5	cfs	excess flow for Warning condition

WATCH - enough flow in river to meet demands

Choose flow exceeded 85% of the time (see figure 4-2)

	30	cfs	flow at Mentor gage
-	15.5	cfs	needed at Salina river intake
	14.5	cfs	excess flow for Watch condition

City of Salina
Raw Water Supply Study
Water Conservation Plan - Drought Response Plan
Summer (June - September) Conditions

Assumptions:
1. 12.15 cfs of senior water rights between Mentor gage and Salina river intake
2. 25% water loss from the river to the aquifer between Mentor gage and Salina river intake during the summer period
3. The City's water right is 15.5 cfs

Watch - flows in the river are declining to low levels and may reach the point where reduction of demand is needed

Warning - flows in the river are just enough to meet demands but are continually declining

Emergency - the flow in the river is not sufficient to meet demands (assume meets 50%)

WARNING - critical level where regulation of water use is required

	15.5	cfs	needed at Salina river intake
+	3.9	cfs	0.25*15.5 cfs water lost to aquifer
+	12.15	cfs	needed for senior irrigation water rigths
	31.5	cfs	needed at Mentor gage

Approximately 30 cfs needed at Mentor gage for Warning condition
Corresponds with 80% exceedence (see figure 4-1)

EMERGENCY - need to meet 50% of demands

	7.25	cfs	needed at Salina river intake
+	1.8	cfs	0.25*15.5 cfs water lost to aquifer
+	12.15	cfs	needed for senior irrigation water rigths
	21.2	cfs	needed at Mentor gage

Approximately 20 cfs needed at Mentor gage for Emergency condition
Corresponds with 95% exceedence (see figure 4-1)

WATCH - enough flow in river to meet demands

Choose flow exceeded 75% of the time (see figure 4-1)

	40	cfs	flow at Mentor gage
-	15.5	cfs	needed at Salina river intake
-	3.9	cfs	0.25*15.5 cfs water lost to aquifer
-	12.15	cfs	needed for senior irrigation water rigths
	8.5	cfs	excess flow for Watch condition

Appendix F

Water Conservation Plan – Revised September 2009

MUNICIPAL WATER CONSERVATION PLAN

FOR

CITY OF SALINA, KANSAS

OCTOBER 1997
Revised SEPTEMBER 2009

Original Plan in BLACK
All Proposed Revisions in RED

City to review and approve of revisions. Once finalized need to remove the strikethrough text and make all text black. Then submit to KWO and DWR for approval.

PREPARED BY
HDR
and
WILSON & COMPANY

MUNICIPAL WATER CONSERVATION PLAN FOR CITY OF SALINA

TABLE OF CONTENTS

BACKGROUND INFORMATION

Under K.S.A. 82a-733, passed by the 1991 Kansas Legislature, “The Chief Engineer [of the Kansas Department of Agriculture Division of Water Resources] may require an applicant for a permit to appropriate water for beneficial use or the owner of a water right or permit to appropriate water for beneficial use to adopt and implement water conservation plans and practices.” Other Kansas Statutes require water conservation plans for anyone: (1) purchasing water from the State Water Marketing Program (K.S.A. 82a-1311a); (2) participating in the Water Assurance District Program (K.S.A. 82a-1348); (3) sponsoring or purchasing the public water supply portion of a Multipurpose Small Lakes Program project (K.S.A. 82a-1608); (4) transferring water under the Water Transfers Act (K.S.A. 82a-1502); or (5) applying for a loan from the State Revolving Fund (K.S.A. 65-163g). All public water suppliers on the drought vulnerable list, which is a list maintained by the Kansas Department of Health and Environment and the Kansas Water Office, are encouraged to develop and implement a municipal water conservation plan and to resolve the limitations underlying their vulnerability. According to the 2006 Kansas Drought Vulnerable List, the City of Salina’s public water supply is considered to be drought vulnerable because the primary raw water source is particularly sensitive to drought as evidenced by depleted streamflow, depleted reservoir inflow and storage, or by declining water levels in wells. The Kansas Water Office reviews and recommends all water conservation plans and the Division of Water Resources approves all water conservation plans.

The original Water Conservation Plan for the City of Salina was completed and adopted in October 1997 when the City applied for a loan from the State Revolving Fund for Water Treatment Plant improvements project. The original Water Conservation Plan was updated and revised in September 2009 in accordance with the 2007 Kansas Municipal Water Conservation Plan Guidelines published by the Kansas Water Office.

IMPORTANCE OF WATER CONSERVATION

Historically, water conservation measures have typically been invoked only during times of drought or other emergency water shortage. However, as Kansas water supplies continue to diminish, this view of water conservation is changing. Like many other public water suppliers, the City of Salina is looking to water conservation as a viable long-term supply option, helping to avert water and wastewater system expansions which results in significant savings in capital and operating costs. Ultimately, water conservation must be a shared responsibility between the City and all its water customers.

INTRODUCTION

The City of Salina obtains raw water from two sources: groundwater (wells) and surface water (Smoky Hill River).

The City of Salina has undertaken a number of steps to ensure a dependable water supply for our customers through the years. The original water treatment plant was constructed in the late 1950's with a major upgrade and expansion completed in 2001. ~~Construction of a water treatment plant was completed in the late 1950's. It~~ The treatment plant ~~currently~~ provides for partial water softening of the groundwater and surface water sources, as well as filtration and disinfection as required to meet current federal and state drinking water standards. ~~While several improvements have been made to the water treatment facility over the years, some key treatment processes and equipment have reached the extent of their useful life and need to be renovated. A water treatment plant improvement project will begin construction in 1998 and is scheduled for completion in 2000.~~ The current conjunctive use of surface water and groundwater as sources of water supply allows the City some redundancy for their source of supply. However, the wells that provide the City their groundwater supply are connected to the river flows in the Smoky Hill River and when the City experiences a significant drought period, both supply sources are strained.

The Salina water supply, water treatment plant, and distribution system ~~now~~ have ample capacity to meet current customers' demands under normal conditions. The ~~scheduled~~ 2001 plant improvements ~~will~~ increased the production capacity to 20 million gallons per day (MGD) and should meet future projected demands for several years~~, except during drought periods~~. However, with continuing business and commercial and population growth expected, a concerted effort on water conservation planning can help ensure customers of a dependable water supply in future years.

The City of Salina believes that the Municipal Water Conservation Plan represents an additional major step in ensuring our customers of a dependable water supply in future years. ~~This water conservation plan was developed to meet the guidelines of the Kansas Water Office.~~ The plan includes a water use conservation goal, a long-term water use efficiency plan, a drought/emergency ~~contingency~~ response plan, and provisions for monitoring, evaluating, and revising the plan.

MUNICIPAL WATER CONSERVATION PLAN

The primary objectives of the Water Conservation Plan for the City of Salina are to develop long-term water conservation plans (Long-Term Water Use Efficiency Section) and short-term water emergency plans (Drought/Emergency ~~Contingency~~ Response Section) to assure the City customers of an adequate water supply to meet their needs. The efficient use of water also has the beneficial effect of limiting or postponing additional water ~~distribution~~ system expansion and thus limiting or postponing the resultant increases in costs, in addition to conserving the limited water resources of the State of Kansas.

LONG-TERM WATER USE EFFICIENCY

WATER USE CONSERVATION GOALS

The City of Salina used ~~119~~ 116 gallons per ~~person~~ capita per day (gpcd) in ~~1995~~ 2007. Over a five year period ~~(1991-1995)~~ (2003-2007) Salina used an average of ~~125~~ 124 gpcd. The gpcd figure includes:

a) water sold to residential and commercial customers;
b) water distributed for free public services (fire protection, street cleaning, etc.); and
c) water lost by leaks in the water distribution system.

However, the gpcd figure does not include municipally supplied industrial water for industries that use over 200,000 gallons per year. According to ~~Figure 1~~ Table 9, shown in the ~~1995 Kansas Municipalities Water Use Publication~~ Kansas Municipal Water Use 2007 Publication, Salina is a large public water supplier located in Region 7. From this publication it was determined that Salina's ~~1995~~ 2007 water use was 14 percent below the Region 7 large supplier average of ~~139~~ 135 gpcd. Over a five year period ~~(1991-1995)~~ (2003-2007), Salina's water use was 124 gpcd which is 12 percent below the Region 7 large supplier region average of ~~141~~ 142 gpcd. The City desires to set a water conservation goal not to exceed ~~140~~ 116 gpcd, which is believed to be sustainable based on water usage during the drought of 2000 through 2006 and implementation of conservation practices outlined in this plan. The City anticipates not exceeding this goal by carrying out the specific water conservation practices that are outlined in our plan.

WATER CONSERVATION PRACTICES

The City's conservation practices include actions that will reduce overall demand for water, diminish water usage at peak demand time, improve efficiency in water use, and reduce water losses and waste. This section of the plan summarizes the current and proposed education, management, and regulation efforts that relate to the long-term conservation of water in the City of Salina. Specific practices that will be undertaken to conserve water are listed and a target date to begin each practice is also shown.

Education

The following is a list of current and proposed water use efficiency education practices:

1. The City makes available information on water conserving landscape practices through publications, local news media, seminars or other appropriate means.

2. Water bills show the amount of water used in cubic feet during the billing period and the number of cubic feet used last year during the same billing period.

3. Water conservation tips are provided with the monthly water bills during the summer months.

4. Information is provided to the general public on lawn water requirements on a regular basis during the summer months.

5. Water bills will show the amount of water used in gallons and the cost of water.
   Target Date: 1 January 2011

6. Water bills will show the amount of water used in gallons during this billing period and the number of gallons used last year during the same billing period.
   Target Date: 1 January 2011

7. Water conservation classes will be offered by the City to teach customers about water conservation.
   Target Date: 1 January 2011

8. The Board of Education and teachers will be encouraged to become involved in water conservation through classroom lectures and incentives for children to conduct home checks.
   Target Date: 1 January 2011

Management

The following is a list of current and proposed water use efficiency management practices:

1. All raw water intakes have meters installed and the meters are repaired or replaced promptly. Raw water meters are tested for accuracy at least once every three years. Each meter is repaired or replaced if its test measurements are not within two percent of the actual volume of water passing through the meter.

2. All raw water meters and individual service connections are read at least on a monthly basis.

3. The City currently conducts a water management review, which results in a specified change in water management practices or implementation of a leak detection and repair program or plan, whenever the amount of unsold water exceeds 20 percent of the total raw water ~~intake~~ diverted for a four month time period.

4. Water sales are based on the amount of water used.

5. Meters are installed at all residential service connections and at all other service connections, including separate meters for municipally owned irrigation systems.

6. Meters at each individual service connection (one inch or less) are replaced on a regular basis, at least once every ~~10~~ 15 to 20 years.

7. The current water rate structure, adopted in June 2008, is an excess use rate where the unit price for water increases after a specified volume consumed is exceeded. The City's excess use rate structure is based around average winter consumption in order to promote water conservation.

8. The City's water distribution system is divided into five pressure zones. The pressure zones have been established to provide adequate water pressure to customers. Water pressure is monitored daily at each of the City's pumping facilities. Water pressure at the customers' premises is checked at the customer's request.

9. Individual service connection meters between one inch and six inches will be tested for accuracy at least once every five years and meters six inches and above will be tested on at least an annual basis. Each meter will be repaired or replaced if its test measurements are not within two percent of the actual volume of water passing through the meter.
   Target Date: 1 January 2011

10. Develop and implement a water conservation rebate program for high efficiency/low flow toilets for residences and commercial businesses and high efficiency clothes washers for residences.
    Target Date: 1 January 2011

11. Develop and implement a rain sensor rebate program for rain sensors that automatically shut off automatic sprinkler systems during and after rain events and allow the system to go back to normal cycle when the sensors dry out.
    Target Date: 1 January 2011

Regulation

The following is a list of current and proposed water use efficiency regulation practices:

1. All new or renovated construction requires toilets that use ~~3.5~~ 1.6 gallons per flush or less and low flow shower heads that use 2.5 gallons per minute or less.

2. An ordinance was adopted in June 2008 which prohibits waste of water.

3. An ordinance was adopted in June 2008 which prohibits outdoor watering between the hours of 10:00am and 6:00pm effective between June 1 and September 30.

4. An ordinance was adopted in June 2008 which allows the governing body of the City to adopt or amend a water conservation rebate program.

5. The ordinance for restricting outdoor watering between the hours of 10:00am and 6:00pm effective between June 1 and September 30 will be revised to include all private domestic wells within the City limits, not just the customers of the water distribution system.
   Target Date: 1 June 2010

6. Develop and implement a program or ordinance to incorporate water conserving landscape principles into future landscape development projects, including renovation of existing landscapes.
   Target Date: 1 January 2011

DROUGHT/EMERGENCY ~~CONTINGENCY~~ RESPONSE

The Drought/Emergency Response applies to all persons, customers, and property served by the City of Salina. All entities that purchase water from the City of Salina will be required to follow the same reductions in water use as the City of Salina.

The Drought/Emergency Response also applies to private domestic well owners within the city limits. Under K.S.A. 82a-733(a) the Chief Engineer of the Kansas Department of Agriculture Division of Water Resources (whom approves water conservation plans) has the authority to require the owner of a water right or a permit to appropriate water for beneficial use to adopt and implement conservation plans and practices. Under K.S.A. 82a-733(i) the Chief Engineer of the Kansas Department of Agriculture Division of Water Resources can require private domestic well owners to implement water conservation practices so they are compliant with the cities' water conservation plan. Conditions under which private domestic well owners may be required to implement water conservation measures include (1) when impairment to senior water rights is occurring, (2) when a municipality with a common source of supply is experiencing a period of drought, and water watches, warnings or emergencies are in place, and (3) when the waste of water is occurring.

The City of Salina shall regulate the private domestic wells based on conditions two and three above. According to a publication by the Kansas State University Extension Service (*Watering Your Lawn* by Matthew J. Fagerness), the morning is the most efficient time to water lawns and gardens because it is cooler and less evaporation occurs. Wind is also less likely to be a problem during the early morning hours. Watering during the afternoon hours when high evaporation, low humidity, and high winds occur is considered waste of water because during these times the water applied has a higher percentage of loss than that actually put to beneficial use. On the basis of waste of water and per state statutes and the 2007 Municipal Water Conservation Plan Guidelines the City will prohibit outdoor watering during the hours of 10:00 AM to 6:00 PM between June 1 through September 30 of each year for all customers of the water distribution system and all private domestic wells within the city limits.

The City of Salina addresses its short-term water shortage problems through a series of stages based on conditions of supply and demand with accompanying triggers, goals, and actions. Each stage is more stringent in water use than the previous stage since water supply conditions are more deteriorated. The water shortage may be the result of a drought or a system failure. A drought may deplete the available water supplies or place stress on the City's ability to deliver water. A system failure could occur that would threaten the City's ability to deliver water to the entire service area.

The declaration of the beginning and end of a water watch, water warning, or water emergency shall be effective upon their publication in the official city newspaper. The City Manager is authorized by ordinance to implement the appropriate conservation measures. A copy of the Water Conservation Ordinance is included in Appendix A.

STAGE 1: WATER WATCH

<u>Triggers</u>

This stage is triggered by any one of the following conditions:

1. Treatment plant operations are at <u>75 percent</u> capacity or more for <u>three consecutive days</u>, or
2. ~~Groundwater levels have fallen 5 feet below the normal seasonal level~~ When groundwater is the only source and groundwater levels at Oakdale Monitoring Well have fallen below a saturated aquifer thickness of <u>29 feet</u>, or
3. Smoky Hill River levels are below ~~45~~ <u>40 cfs</u> at the Mentor Gage during the months of June through September and the river flow has been in a declining trend for at least <u>seven consecutive days</u>, or
4. Smoky Hill River levels are below <u>30 cfs</u> at the Mentor Gage during the months of October through May and the river flow has been in a declining trend for at least <u>seven consecutive days</u>, or
5. Emergency conditions related to repairs or water quality.

Goals

The goals of this stage are to heighten awareness of the public on water conditions, ~~and~~ to maintain the integrity of the water supply system, and to ask for voluntary reductions in water use to avoid having to implement mandatory restrictions.

Education Actions

1. The City will make occasional news releases to the local media describing present conditions and indicating the water supply outlook for the upcoming season.
2. Previous months summaries of precipitation, temperature, and water levels will be made public at the beginning of each month.

Management Actions

1. Leaks will be repaired within 8 hours of detection.
2. The City will monitor its use of water and will curtail activities such as hydrant flushing and street cleaning, including watering of City grounds and washing of vehicles.

Regulation Actions

1. The public will be asked to curtail some outdoor water use and to make efficient use of indoor water, i.e. wash full loads, take short showers, don't let faucets run, etc.
2. Any other action deemed appropriate by the City Manager.

Requirements for Termination of WATER WATCH

The WATER WATCH will be terminated following consideration of the following information:

- Have Treatment Plant operations been below 75 percent operating capacity for three consecutive days?
- When groundwater is the only source, have groundwater levels at the Oakdale Monitoring Well risen above a saturated aquifer thickness of 29 feet?
- Are the Smoky Hill River levels above 40 cfs at the Mentor Gage during the months of June through September and the river flow has not declined for seven consecutive days?
- Are the Smoky Hill River levels above 30 cfs at the Mentor Gage during the months of October through May and the river flow has not declined for seven consecutive days?
- Are there any emergency conditions related to repairs or water quality?
- What is the current and projected length of the drought?
- What is the short and long range precipitation forecast?
- What are the current and future releases from the Kanopolis Reservoir?

The City will continue to promote wise outdoor watering throughout the summer months.

STAGE 2: WATER WARNING

Triggers

This stage is triggered by any one of the following conditions:

1. Treatment plant operations are at 90 percent capacity or more for three consecutive days, or
2. ~~Groundwater levels have fallen 10 feet below the normal seasonal level~~ When groundwater is the only source and groundwater levels at Oakdale Monitoring Well have fallen below a saturated aquifer thickness of 27 feet, or
3. Smoky Hill River levels are below 30 cfs at the Mentor Gage during the months of June through September and the river flow has been in a declining mode for at least five consecutive days, or
4. Smoky Hill River levels are below 20 cfs at the Mentor Gage during the months of October through May and the river flow has been in a declining mode for at least five consecutive days, or
5. Emergency conditions related to repairs or water quality.

Goals

The goals of this stage are to reduce peak demands by 20%, ~~and~~ to reduce overall weekly consumption by 10%, and to decrease the impact on the sources of supply.

Education Actions

1. The City will make weekly news releases to the local media describing present conditions and indicating the water supply outlook for the upcoming week.
2. Previous week summaries of precipitation, temperature, and water levels will be made public each Thursday.
3. Water conservation articles will be provided to the local newspaper.

Management Actions

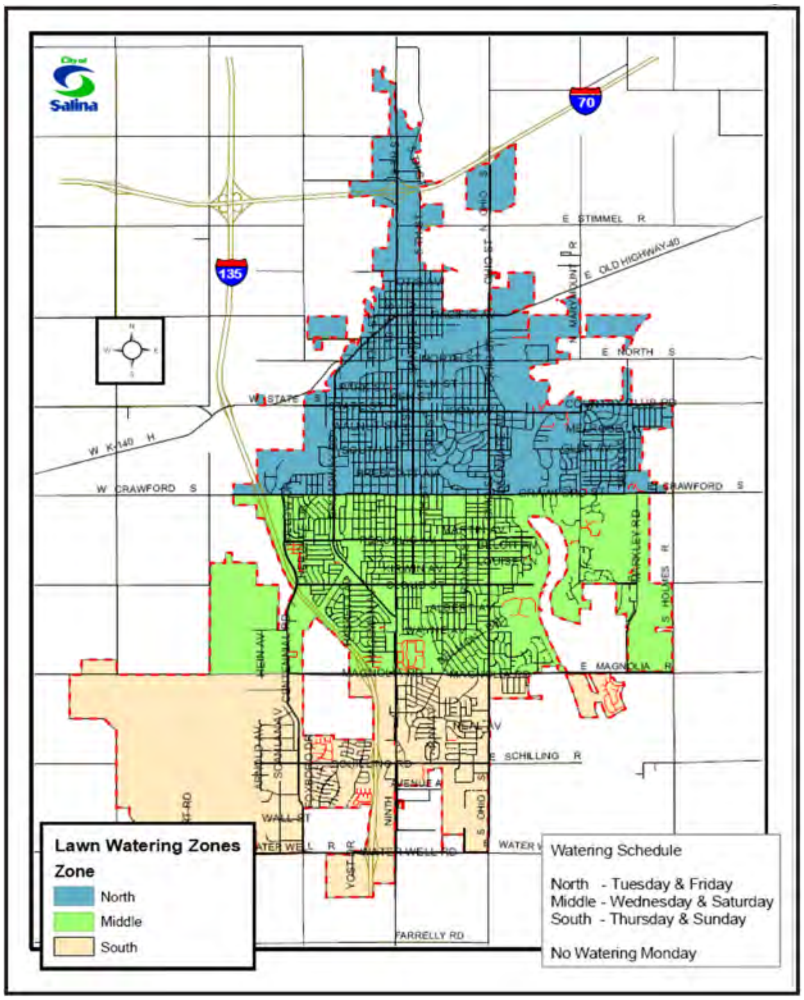
1. The City's water supplies will be monitored daily.
2. Leaks will be repaired within 8 hours of detection.
3. ~~Standby (Schilling) wells~~ Emergency water supplies will be prepared for contingency operation.
4. The City will curtail its water usage, including watering of City grounds and washing of vehicles.

Regulation Actions

1. The City at their option, based on current staffing and system operational considerations, will implement one of the lawn watering systems below:

   - An odd/even lawn watering system ~~will~~ may be imposed on City residents. Residents with odd-numbered addresses will water on odd days, and even addresses will water on even days.
   - A zoned lawn watering system will be imposed on all water customers. Customers will be allowed to water twice per week based upon three geographical zones as follows:

     North Zone: North Salina to Crawford – Tuesday and Friday
     Middle Zone: Crawford to Magnolia – Wednesday and Saturday
     South Zone: Magnolia to South Salina – Thursday and Sunday
     (No lawn watering is allowed on Monday)



2. Commercial/Industrial owners will be allowed to preserve vegetation required by the City's landscaping ordinance.
~~2. Outdoor water use, including lawn watering and car washing will be restricted to before 10:00am and after 9:00pm.~~
3. Refilling of swimming pools will be allowed one day a week after sunset.
~~4. Excess water use charges for usage of water over the amount used in the winter~~
4. Waste of water will be prohibited
5. Home outdoor washing of vehicles will be restricted to once per week on Saturdays only.
6. Restrictions will be imposed on all City residents (including private domestic well users, if authority is delegated by the Chief Engineer under K.S.A. 82a-733(i)).
7. Any other action deemed appropriate by the City Manager.

Requirements for Termination of WATER WARNING

The WATER WARNING will be terminated following consideration of the following information:

- Have Treatment Plant operations been below 90 percent operating capacity for three consecutive days?
- When groundwater is the only source, have groundwater levels at the Oakdale Monitoring Well risen above a saturated aquifer thickness of 27 feet?
- Are the Smoky Hill River levels above 30 cfs at the Mentor Gage during the months of June through September and the river flow has not declined for five consecutive days?
- Are the Smoky Hill River levels above 20 cfs at the Mentor Gage during the months of October through May and the river flow has not declined for five consecutive days?
- Are there any emergency conditions related to repairs or water quality?
- What is the current and projected length of the drought?
- What is the short and long range precipitation forecast?
- What are the current and future releases from the Kanopolis Reservoir?

Upon termination of a WATER WARNING, a WATER WATCH becomes operative.

STAGE 3: WATER EMERGENCY

Triggers

This stage is triggered by any one of the following conditions:

1. Treatment plant operations are at 100 percent capacity or more for three consecutive days, or

2. ~~Groundwater levels have fallen 15 feet below the normal seasonal level~~ When groundwater is the only source and groundwater levels at Oakdale Monitoring Well have fallen below a saturated aquifer thickness of 25 feet, or
3. Smoky Hill River levels are below ~~15~~ 20 cfs at the Mentor Gage during the months of June through September and the river flow has been in a declining mode for at least three consecutive days, or
4. Smoky Hill River levels are below 15 cfs at the Mentor Gage during the months of October through May and the river flow has been in a declining mode for at least three consecutive days, or
5. Emergency conditions related to repairs or water quality.

Goals

The goals of this stage are to reduce peak demands by 50%, ~~and~~ to reduce overall weekly consumption by 25%, and to decrease the impact on the sources of supply.

Education Actions

1. The City will make daily news releases to the local media describing present conditions and indicating the water supply outlook for the next day.
2. Previous days summaries of precipitation, temperature, and water levels will be made public each day.
3. The City will hold public meetings to discuss the emergency, the status of the City's water supply and further actions which need to be taken.

Management Actions

1. The City's water supplies will be monitored daily.
2. Leaks will be repaired within 8 hours of detection.
3. ~~Standby (Schilling) wells~~ Emergency water supplies will be prepared for contingency operation.
4. The City will seek additional emergency water supplies from state or federal agencies.

Regulation Actions

1. Outdoor water use will be banned.
2. Waste of water will be prohibited.
3. Restrictions will be imposed on all City residents (including private domestic well users, if authority is delegated by the Chief Engineer under K.S.A. 82a-733(i)).
4. Any other action deemed appropriate by the City Manager.

Requirements for Termination of WATER EMERGENCY

The WATER EMERGENCY will be terminated following consideration of the following information:

- Have Treatment Plant operations been below 100 percent operating capacity for three consecutive days?
- When groundwater is the only source, have groundwater levels at the Oakdale Monitoring Well risen above a saturated aquifer thickness of 25 feet?
- Are the Smoky Hill River levels above 20 cfs at the Mentor Gage during the months of June through September and the river flow has not declined for three consecutive days?
- Are the Smoky Hill River levels above 15 cfs at the Mentor Gage during the months of October through May and the river flow has not declined for three consecutive days?
- Are there any emergency conditions related to repairs or water quality?
- What is the current and projected length of the drought?
- What is the short and long range precipitation forecast?
- What are the current and future releases from the Kanopolis Reservoir?

Upon termination of a WATER EMERGENCY, a WATER WARNING becomes operative.

PLAN REVISION, MONITORING, AND EVALUATION

The City of Salina reviews monthly totals for water production, residential sales, commercial sales, water used for line flushing and fire protection, and water lost through system leaks. Problems noted during the monthly review will be solved as soon as possible.

The City of Salina Municipal Water Conservation Plan will be reviewed during the month of April each year and on a more frequent basis during drought or other water shortage conditions. If the water conservation gpcd goals for the previous year are not met, then the City will review the data collected from the previous year in relationship to the status and effectiveness of the conservation practices that are outlined in our plan and will provide a status report to the Division of Water Resources (or whatever state agency is responsible for approving and monitoring our plan), which will also include any additional water conservation practices that may need to be taken in order for the City to achieve and maintain its water use conservation gpcd goals.

APPENDIX A

Water Conservation Ordinance

APPENDIX A

DIVISION 3. WATER CONSERVATION

Sec. 41-60. Purpose.

The purpose of this division is to conserve the water supply of the city, to meet the needs and demands of the citizens, to eliminate waste in the use of such water, and provide for the declaration of a water watch, water warning or a water supply emergency and the implementation of voluntary and mandatory water conservation measures throughout the city in the event such a watch, warning or emergency is declared.

(Ord. No. 89-9341, § 2, 9-11-89; Ord. No. 97-9833, § 1, 10-27-97, Ord. No. 08-10451, § 1, 6-9-08)

Sec. 41-61. Definitions and classes of usage established.

(a) *Definitions.* The following definitions shall apply in the interpretation, implementation and enforcement of this division:

(1) *Water,* as the term is used in this division, shall mean water available to the City of Salina for treatment by virtue of its water rights or any treated water introduced by the city into its water distribution system, including water offered for sale at any coin-operated site.

(2) *Customer,* as the term is used in this division, shall mean the customer of record using water for any purpose from the city's water distribution system and for which either a regular charge is made or, in the case of coin sales, a cash charge is made at the site of delivery.

(3) *Waste of water,* as the term is used in this division, includes, but is not limited to, permitting substantial amounts of water to escape down a gutter, ditch or other surface drain or failure to repair a controllable leak of water due to defective plumbing.

(4) *Outdoor watering,* as the term is used in this division, shall mean the irrigation with potable water of lawns, shrubs, flowers, trees, gardens and other outdoor vegetation for personal, private, commercial, or governmental purposes.

(b) *Classes of usage.* The following classes of uses of water are established:

Class 1

Water used for outdoor watering, either public or private, for gardens, lawns, trees, shrubs, plants, parks, golf courses, playing fields, swimming pools or other recreational areas, or the washing of motor vehicles, boats, trailers or the exterior of any building or structure.

Class 2

Water used for commercial or industrial, including agricultural, purposes, except water actually necessary to maintain the health and personal hygiene of bona fide employees while such employees are engaged in the performance of their duties at their place of employment.

Class 3

Domestic usage, other than that which would be included in either classes 1 or 2.

Class 4

Water necessary only to sustain human life and the lives of domestic pets and maintain standards of hygiene and sanitation.

(Ord. No. 89-9341, § 2, 9-11-89; Ord. No. 08-10451, § 1, 6-9-08)

Sec. 41-61.1. Regulation of use.

(a) Outdoor watering with potable water, shall be prohibited between the hours of 10:00 a.m. and 6:00 p.m., effective between June 1 and September 30. Upon application, a special permit shall be issued by the Director of Utilities to allow watering newly seeded lawns between the hours of 10:00 a.m. and 6:00 p.m., effective June 1 through September 30.

(b) No customer shall allow substantial amounts of water to escape or drain from private property onto public property, including, but not limited to, public sidewalks, rights-of-way, streets, alleys, and highways; provided that the term “substantial” shall mean an amount sufficient to cause a discernible flow of water reaching the street, gutter or other drainage system.

(Ord. No. 08-10451, § 2, 6-9-08)

Sec. 41-62. Declaration of a water watch, water warning, or water emergency.

(a) *Declaration of water watch.* Whenever the city manager finds that conditions indicate that the probability of a drought or some other condition causing a major water supply shortage is rising, the city manager shall be empowered to declare, that a water watch exists and shall take steps to inform the public and ask for voluntary reductions in water use. Such a watch shall be deemed to continue until it is declared by the city manager to have ended. The city manager's determination that a water watch exists shall be subject to review by the governing body at its next regular or special meeting.

(b) *Declaration of water warning.* Whenever the city manager finds that drought conditions or some other condition causing a major water supply shortage are present and supplies are starting to decline, the city manager shall be empowered to declare that a water warning exists and will recommend, to the governing body, restrictions on nonessential uses during the period of warning. Such a warning shall be deemed to continue until it is declared by the city manager to have ended. The city manager's determination that a water warning exists and the recommended restrictions shall be subject to review by the governing body at its next regular or special meeting.

(c) *Declaration of water emergency.* Whenever the city manager finds that an emergency exists by reason of a shortage of water supply needed for essential uses, the city manager shall be empowered to declare that a water supply emergency exists and will impose mandatory restrictions on water use during the period of the emergency. Such an emergency shall be deemed to continue until it is declared by the city manager to have ended. The city manager's determination that a water emergency exists and the restrictions imposed shall be subject to review by the governing body at its next regular or special meeting.

(Ord. No. 89-9341, § 2, 9-11-89; Ord. No. 97-9833, § 1, 10-27-97; Ord. 07-10397, § 1, 7-16-07)

Sec. 41-63. Voluntary conservation measures.

Upon the declaration of a water watch as provided in section 41-62(a), the city manager is authorized to call on all water consumers to employ voluntary water conservation measures to limit or eliminate nonessential water uses, included, but not limited to, limitations on the following uses:

(1) Sprinkling of water on lawns, shrubs or trees (including golf courses).

(2) Washing of motor vehicles.

(3) Use of water in swimming pools, fountains and evaporative air conditioning systems.

(4) Waste of water.

(Ord. No. 89-9341, § 2, 9-11-89; Ord. No. 97-9833, § 1, 10-27-97; Ord. No. 07-10397, § 1, 7-16-07)

Sec. 41-64. Mandatory conservation measures.

A. Upon the declaration of a water supply warning as provided by sections 41-62(b), the governing body is authorized to implement certain mandatory water conservation measures, including, but not limited to, the following:

   (1) Suspension of new connections to the city's water distribution system, except connections of fire hydrants and those made pursuant to agreements entered into by the city prior to the effective date of the declaration of the emergency;

   (2) Restrictions on the uses of water in one (1) or more classes of water uses, wholly or in part;

   (3) Restrictions on the sales of water at coin-operated facilities or sites;

   (4) The imposition of water rationing based on any reasonable formula, including, but not limited to, the percentage of normal use and per capita or per consumer restrictions;

   (5) Complete or partial bans on the waste of water; and

   (6) Any combination of the foregoing measures.

B. Upon the declaration of a water supply emergency as provided by sections 41-62(c), the city manager is authorized to implement certain mandatory water conservation measures, including, but not limited to, the following:

   (1) Suspension of new connections to the city’s water distribution system, except connections of fire hydrants and those made pursuant to agreements entered into by the city prior to the effective date of the declaration of the emergency;

   (2) Restrictions on the uses of water in one (1) or more classes of water uses, wholly or in part;

   (3) Restrictions on the sales of water at coin-operated facilities or sites;

   (4) The imposition of water rationing based on any reasonable formula, including, but not limited to, the percentage of normal use and per capita or per consumer restrictions;

   (5) Complete or partial bans on the waste of water; and

   (6) Any combination of the foregoing measures

   (7) The city manager’s determination that a water emergency exists and the restrictions imposed shall be subject to review by the governing body at its next regular or special meeting.

(Ord. No. 89-9341, § 2, 9-11-89; Ord. No. 07-10397, § 1, 7-16-07)

Sec. 41-65. Emergency water rates.

Upon the declaration of a water supply emergency as provided in section 42-62, the governing body of the city shall have the power to adopt emergency water rates by resolution designed to conserve water supplies. Such emergency rates may provide for, but are not limited to:

(1) Higher charges for increasing usage per unit of use (increasing block rates);

(2) Uniform charges for water usage per unit of use (uniform unit rate); or

(3) Extra charges in excess of a specified level of water use (excess demand surcharge).

(Ord. No. 89-9341, § 2, 9-11-89)

Sec. 41-66. Regulations.

During the effective period of any water supply emergency as provided for in section 41-62(c), the city manager is empowered to promulgate such regulations as may be necessary to carry out the provisions of this division, any water supply emergency resolution, or emergency water rate resolution. Such regulations shall be subject to the approval of the governing body at its next regular or special meeting.

(Ord. No. 89-9341, § 2, 9-11-89; Ord. No. 07-10397, § 2, 7-16-07)

Sec. 41-67. Violations, disconnections and penalties.

(a) If the city manager, director of utilities, or other city official or officials charged with implementation and enforcement of this division or a water supply emergency resolution learn of any violation of any water use restrictions imposed pursuant to sections 41-61.1, 41-62, 41-64 or 41-66 of this division, the customer of record and the owner, lessee, tenant, or occupant known to the city to be responsible for the violation shall be provided with either actual or mailed notice of the violation.

(b) Prior to disconnection of water service, the customer of record and the owner, lessee, tenant, or occupant known to the city to be responsible for the violation or its correction shall be provided with either actual or mailed notice of the violation. Said notice shall describe the violation and order that it be corrected, cured or abated immediately or within such specified time as the city determines reasonable under the circumstances. If the order is not complied with, the city may terminate water service to the customer subject to the following procedures:

(1) The city shall give the customer notice by mail or actual notice that water service will be discontinued within a specified time due to the violation and that the customer will have an opportunity to appeal the termination by requesting a hearing scheduled before a city official designated as a hearing officer by the city manager;

(2) If such hearing is requested by the customer charged with the violation, he or she shall be given a full opportunity to be heard before termination is ordered; and

(3) The hearing officer shall make findings of fact and order whether service should continue or be terminated.

(4) A fee of fifty dollars ($50.00) shall be paid for the reconnection of any water service terminated pursuant to subsection (a). In the event of subsequent violations, the reconnection fee shall be two hundred dollars ($200.00) for the second violation and three hundred dollars ($300.00) for any additional reconnections.

(c) Violations of this division shall be a municipal offense and may be prosecuted in municipal court. Any person so charged and found guilty in municipal court of violating the provisions of this division shall be guilty of a municipal offense. Each day's violation shall constitute a separate offense. The penalty for an initial violation shall be a mandatory fine of one hundred dollars ($100.00). The penalty for a second or subsequent conviction shall be a mandatory fine of two hundred dollars ($200.00).

(Ord. No. 89-9341, § 2, 9-11-89, Ord. No. 07-10397, § 2, 7-16-07, Ord. No. 08-10451, § 3, 6-9-08)

Sec. 41-68. Emergency termination.

Nothing in this division shall limit the ability of any properly authorized city official from terminating the supply of water to any or all customers upon the determination of such city official that emergency termination of water service is required to protect the health and safety of the public.
(Ord. No. 89-9341, § 2, 9-11-89)

Sec. 41-69. Water conservation rebate program.

In order to promote water conservation, the governing body of the city may by resolution adopt or amend a water conservation rebate program.
(Ord. No. 89-9341, § 2, 9-11-89, Ord. No. 08-10451, § 4, 6-9-08)
Editor's Note: Former § 41-69 pertained to the severability and repealed by Ord. No. 08-10451.

Appendix G

Potential Water Conservation Measures

POTENTIAL WATER CONSERVATION MEASURES

Water conservation can yield many benefits for the municipal water and wastewater utility, environment, and community. Some of these benefits include reduced energy and chemical use for water treatment, downsized or postponed expansions of water treatment facilities, and reduced costs and impacts on wastewater collection and treatment facilities. Common water conservation measures include customer education, water-efficient fixtures, water-efficient landscaping, economic incentives, and water-use restriction ordinances.

In order to select which potential conservation measures should be implemented the following evaluation criteria should be considered:

- ☑ Program costs, Cost-effectiveness, Budgetary considerations
- ☑ Ease of implementation
- ☑ Staff resources and capability
- ☑ Legal issues or constraints
- ☑ Regulatory approvals
- ☑ Public acceptance
- ☑ Environmental impacts
- ☑ Timeliness of water savings
- ☑ Ratepayer impacts
- ☑ Environmental and social injustice
- ☑ Consistency with other programs

The following is a list consisting of a wide range of potential water conservation measures for review. Included in the list is a brief description, and pros and cons of each potential item. There are a few items that are already implemented by the City but in order to not skew results during the rating process these are not specifically identified.

SYSTEM MEASURES TO REDUCE NON-REVENUE WATER (WATER LOSS)

1. *Water Meter Maintenance Program*
   Description: Program that includes scheduled testing, repair, and replacement of customer water meters and source water meters.
   Pros: Increased accountability of water use
   Cons: Cost of new meters
2. *Water Loss Control Program*
   Description: This type of program includes data collection of the existing distribution system to determine where water loss is occurring and then implementing the necessary measures to help in the reduction of water loss in the distribution system. These measures could include leak detection program, valve maintenance program, pressure management program, infrastructure replacement program, etc.
   Pros: Water loss can be reduced and controlled by these measures; Actual water savings can be determined
   Cons: City must consistently follow program to see water savings; City must re-evaluate data on a regular basis to determine best measure to implement; Cost to implement program(s)
3. *Hydrant Locking Devices*
   Description: A variety of simple locking devices exist to secure the square operating nut on top of hydrants
   Pros: Reduces unauthorized use of fire hydrants
   Cons: Cost of locking devices; Fire Dept and Water Dept must have multiple unlocking devices to utilize fire hydrants during a fire, flushing of mains, and hydrant flow testing; Could add to fire response time if hydrants can't be easily unlocked during a fire (i.e. they don't have the right equipment to unlock, the lock is rusted, etc.)
   Comments: Is there really an issue with water loss through unauthorized use of fire hydrants?

<u>OUTREACH AND EDUCATION ACTIVITIES</u> – Can produce water savings when customers change water use habits but the savings can be difficult to estimate. Informative and educational measures can enhance the other more direct measures such as rebates, etc.

4. *Understandable and Informative Water Bill*
   <u>Description:</u> Going above and beyond the basic water bill and making sure customers are able to easily read and understand their water bill by identifying volume of usage (in gallons preferably), rates and charges, and other relevant information. For example, a bar graph showing the entire last years monthly consumption would allow customers to easily see their seasonal water usage habits.
   <u>Pros:</u> Provided to all customers; May reduce questions pertaining to water bills
   <u>Cons:</u> Costs involved with modifying the billing software
5. *Water Conservation Classes*
   <u>Description:</u> Water conservation classes are offered to teach customers how to irrigate efficiently, to share information on low water use plants, and to discuss the City's water situation. Customers who participate in the class could be given a free rain barrel, a coupon to purchase low water use plants, free water conservation irrigation products, etc.
   <u>Pros:</u> Size of program controlled by City—limited to a certain number and size of classes and can be easily budgeted for; Could team with local irrigation specialists rather than utilizing only City staff
   <u>Cons:</u> Labor cost to conduct classes; Classes should be on weekends or after hours
6. *Indoor/Outdoor Water Audits*
   <u>Description</u>: Each month a total of ten customers with the highest usage in their classification are selected to receive a contact letter and a water use questionnaire. (More often should try to target actual high inefficiency rather than just overall high water use—i.e. look for seasonal peaks which may mean inefficient outdoor watering, look for a drastic difference in water use which may mean leak, faulty meter, erroneous meter reading, etc.) Those who respond and request information, receive a customized packet of water conservation information and a follow-up letter offering a free water audit of their property. A water audit would consist of an inventory of indoor and outdoor fixtures, checking for visible leaks, assessing current water use and irrigation habits, education on possible water conservation measures.
   <u>Pros</u>: Size of program controlled by City—limited to a certain number of customers and can be easily budgeted for; Not much time and costs spent on customers if they don't respond; One-on-one time with customers; Costly water audits only completed upon request
   <u>Cons</u>: Labor cost to conduct water audits
7. *Self-Water Audit Kit Giveaway*
   <u>Description</u>: Provide a guide and kit to assist customers in doing their own water audit. The kit could contain self-audit instructions, drip cup, shower flow bag, vegetable dye tablets, etc. Kits could be given to certain customers such as high use customers, customers living in older homes, etc.
   <u>Pros</u>: City staff not needed to complete audits, Size of program controlled by City—limited to a certain number of customers and can be easily budgeted for
   <u>Cons</u>: Cost to provide and distribute kits; Customers are on their own to complete correctly
8. *Conservation packets, brochures, newsletter articles*
   <u>Description</u>: Providing written literature about various water conservation ideas.
   <u>Pros</u>: Easily provide info to all customers with water bill inserts which could minimize customer calls; Not effective unless literature is distributed to customers
   <u>Cons</u>: Cost to print and distribute
9. *Booths at Local Events (i.e. local festivals, county fair, etc.)*
   <u>Description</u>: Set up informational booth with free literature, show-and-tell objects, etc.
   <u>Pros</u>: One-on-one time with customers; Hands-on information
   <u>Cons</u>: Cost to set up booth and accessories; Cost of labor during weekends or after hours

10. *Educational Tours of Water Treatment Plant*
    Description: Provide educational tours of the water treatment plant to kids and/or adults. These tours would educate the public on where their water comes from and what it takes to properly treat with the emphasis on water conservation.
    Pros: Public sees and learns first hand about the water treatment process
    Cons: Not all water treatment facilities are handicap accessible; Cost of labor to conduct tours; Health and safety risks
11. *Water Conservation Garden*
    Description: A City owned and maintained garden/landscaping area that shows citizens an example of how to landscape utilizing water conservation measures.
    Pros: City leads by example; Visible example for customers
    Cons: Cost to install and maintain
12. *Teaching Water Conservation in Schools*
    Description: Provide board of education with simple and quick lessons to teach in classes (Refer to EPA WaterSense example lessons attached)
    Pros: Helps new generation become water conservation oriented; Kids could help to change water use practices at the family level
    Cons: Need approval of and cooperation of board of education; Good lessons include homework and assistance of parents
13. *Water Festival*
    Description: Typically a one day festival with numerous hands-on activities for kids and/or adults (water Pictionary, water trivia, edible aquifer, etc.)
    Pros: Most people learn better from hands-on activities or games rather than just literature
    Cons: Cost to run a separate festival; Cost of labor during weekends or after hours
14. *High Use Notifications*
    Description: Provide letter notification to those users that have increased high usage.
    Pros: Targeted program (high users); Individual customers become aware of high use which could be caused by leaky fixtures, service line, etc.
    Cons: City staff would have to monitor individual use to determine high use; Some customers know they have high use for irrigation purposes and don't care or don't want it to be pointed out
15. *Water Conservation Website*
    Description: Provide water conservation information on City's existing website
    Pros: Literature provided without printing and distribution costs
    Cons: Limited to customers with internet access; Need to update periodically
16. *Bill Inserts – Monthly Water Saving Tips*
    Description: Provide water conservation information either on the water bills or an insert with the water bills.
    Pros: All customers are provided with the information
    Cons: Cost to print and distribute; Sometimes only the 'bill payer' reads the information
17. *Local Newspaper Ads*
    Description: Submit written newspaper advertisements on water conservation.
    Pros: Local newspaper has a wide subscription customer base
    Cons: Cost of advertisement; Limited to customers with newspaper subscription
18. *Local Television Ads*
    Description: Submit television advertisements on water conservation.
    Pros: Local television channels have a large audience base
    Cons: Cost of advertisement; Limited audience (must be watching when ad is shown)

DISTRIBUTION OF PLUMBING HARDWARE TARGETING SPECIFIC CUSTOMER CATEGORIES – Customer categories could include all residential users, high water users, older residential areas, low-income users, etc.

19. *Showerhead Giveaway*
    Description: Provide a free water efficient showerhead to specific customer categories. (Showerheads account for approximately 17 percent of residential indoor water use.)
    Pros: Giveaways easier to implement than rebates
    Cons: Some customers may not like or even install the free showerhead chosen by the City; Cost of providing showerheads
20. *Faucet Aerator Giveaway*
    Description: Aerators increase the rinsing power of water by adding air and concentrating flow, thus reducing the amount of water used. Provide a free water efficient faucet aerator to specific customer categories. (Faucets account for approximately 15 percent of residential indoor water use.)
    Pros: Giveaways easier to implement than rebates
    Cons: Some customers may not like or even install the free faucet aerator chosen by the City; Cost of providing faucet aerators
21. *Plumbing Retrofit Kit Giveaway*
    Description: A kit containing multiple items that will promote water conservation. Items such as the following may be included: low flow shower head with sealant tape, toilet dam to partition off part of the toilet tank, toilet tummy (another type of toilet displacement device), faucet aerators, leak detection tablets, and instructions.
    Pros: Giveaways easier to implement than rebates
    Cons: Not all customers may have a use for all the items; Cost of providing the kit

REBATE PROGRAMS

22. *High Efficiency Clothes Washer Rebate*
    Description: Provide a rebate on ENERGY STAR labeled clothes washers with a maximum water factor of 7.0 or lower.
    Pros: Open to all customers but City could control rebate program by time period or number of rebates
    Cons: City staff may have to provide on-site inspection to verify installation; Cost of providing rebate (City could ask Westar Energy and/or Kansas Gas to team with the City to provide these rebates)
23. *High-Efficiency or Low Flow Toilets Rebate*
    Description: Provide a rebate on high-efficiency or low flow toilets. (Toilets account for approximately 30 percent of residential water use. Toilets also happen to be a major source of wasted water due to leaks and/or inefficiency.)
    Pros: Open to all customers but City could control rebate program by time period or number of rebates
    Cons: City staff may have to provide on-site inspection to verify installation; Cost of providing rebate
24. *Evapotranspiration (ET) Irrigation Controllers Rebate*
    Description: ET irrigation controllers re-adjust themselves automatically as often as needed without manual reprogramming by using three sources of information: 1. Solar radiation values by postal zip code or latitude 2. Entered data about each zone to be watered: soil type, plant type, irrigation type (sprinklers or drip), and slope. 3. Real-time weather data from on-site sensors or wireless data service. (ET controllers can reduce water usage by 20 to 50 percent.)
    Pros: City could control rebate program by time period or number of rebates; Reduces irrigation water use which is largest use
    Cons: Targets only customers with irrigation systems

25. *Rain Sensors Rebate*
    Description: Rain sensors/soil moisture sensor devices automatically shut off automatic sprinkler systems during and after rain events and allow the system to go back to normal cycle when the sensor dries out.
    Pros: City could control rebate program by time period or number of rebates; Reduces irrigation water use which is largest use
    Cons: Targets only customers with irrigation systems
26. *Wireless Rain Sensors Rebate*
    Description: Wireless rain sensors/soil moisture sensor devices automatically shut off automatic sprinkler systems during and after rain events and allow the system to go back to normal cycle when the sensor dries out.
    Pros: City could control rebate program by time period or number of rebates; Reduces irrigation water use which is largest use
    Cons: Targets only customers with irrigation systems
27. *Greywater and Water Harvesting System Rebate*
    Description: Greywater is a valuable resource as it makes double use of water that otherwise goes down the drain. Greywater systems divert some interior water from clothes washers, bathtubs, showers or bathroom sinks (but not from a kitchen sink, dishwasher or toilet) for use in outdoor irrigation. (On average a family of four will use about 100 gallons per day of re-usable water.)
    Pros: Reduces water use and wastewater flows;
    Cons: Cost to customer to install system (~$300-3,000); Cost of providing rebate; Need approval from regulators first; Not all water may be suitable for irrigation due to soaps and detergents
28. *Hot Water Recirculator Rebate*
    Description: Hot water recirculators help save the cold water which initially comes out of the hot water taps when first turned on. Recirculators redirect the cold water in the hot water pipes back into the household water supply until hot.
    Pros: Reduces water use and wastewater flows;
    Cons: Cost to customer to install (~$500); Cost of providing rebate; Local availability of hot water recirculators?
29. *Rain Barrels Rebate*
    Description: A barrel for rain water, particularly a barrel placed so as to catch water dripping from eaves of a house or other buildings.
    Pros: Provides a cheap source of water for irrigating plants (water is ‘free’, barrels cost between $60-$100)
    Cons: Only relatively small quantities of water can be collected, which doesn’t eliminate much tap water use; Water collected is non-potable and is primarily useful for hand watering of plants; Cost of providing rebate

ORDINANCES

30. *Xeriscape Ordinance*
    Description: Xeriscaping is a systematic approach to landscaping that uses plants selected for their water efficiency. Basically means planting of native and low-water-use grasses, trees, shrubs, flowers, and groundcovers to minimize the amount of irrigation that is necessary. Also, plants are grouped in the landscape area according to their different water needs so they can be irrigated separately and efficiently. Ordinance could just encourage xeriscape landscaping or could actually put a limitation on amount of water intensive landscape/turf area for certain customer classes.
    Pros: Substantial irrigation cost savings
    Cons: It’s a totally different way to landscape; People aren’t accustomed to the look of a xeriscape; Costs involved with replacing existing landscaping
31. *Water Waste Ordinance*
    Description: An ordinance that defines waste of water with consequences if violation occurs.
    Pros: City has authority to enforce; Pertains to all customers
    Cons: City must consistently enforce to be viable

32. *Irrigation Ordinance*
    Description: Irrigation is limited to certain time of the day through a City ordinance and there are consequences if violation occurs. (i.e. 1st violation = warning, 2nd violation = $50 fine, 3rd violation = $100 fine, Continued violations can result in suspension of service)
    Pros: City has authority to enforce; Pertains to all customers
    Cons: City must consistently enforce to be viable; City relies heavily on public to turn in violators
33. *Plumbing Fixture Retrofit Ordinance*
    Description: Upon resale of an older home the inefficient plumbing fixtures must be retrofitted with water efficient plumbing fixtures.
    Pros: Targeted program (older neighborhoods)
    Cons: May interfere with historical preservation; May be costly for homeowners to retrofit some fixtures
34. *Irrigation Area Ordinance*
    Description: Irrigation is limited to a certain area of land per lot. For example: Turf, high-water plantings (e.g. annuals, container plants) and water features (e.g., fountains, pools) shall all be considered high-water-uses and shall be limited to not more than 40% of the lot's landscaped area if non-drought resistant cool season grass is used, and to no more than 50% of the landscaped area if drought resistant cool-season grass or warm-season grass is used.
    Pros: Substantial irrigation cost savings
    Cons: Tough to enforce; Tough to calculate the specific areas; Many existing lots already irrigate more than 50% of their lot.

RATE STRUCTURES TO ENCOURAGE WATER SAVINGS

35. *Conservation Based Water Rate Structure*
    Description: A water rate structure that charges for the amount of water used and charge a higher rate for consumption above a certain level (or during a certain period of time) to encourage customers to use water efficiently. A portion of the revenue from the excess use rate could be allocated to the water conservation program with a large portion returned to customers through rebates and other incentives.
    Pros: Customers respond to price; Includes all customers; When based upon individual winter consumption averages the conservation rates are fair and equitable to all classes of customers
    Cons: Takes time for customers to become accustomed to after so many years of a decreasing block rate (the more water used the cheaper it is); Costs involved with modifying the billing software
36. *Water Emergency Water Rates*
    Description: A water rate that is charged to all customers during a Water Emergency. This could simply be two times the current rates.
    Pros: Customers respond to price; Includes all customers; Dramatic reduction in water use is absolutely necessary during a Water Emergency
    Cons: Costs involved with modifying the billing software for a short period of time (Can current software be easily adapted to a Water Emergency water rate?)

*COMMERCIAL AND INDUSTRIAL INCENTIVE PROGRAM (*No pros or cons given for these)

37. *Water Savings Project Program:* Commercial or industrial customers can receive up to $40,000 for improving the efficiency of their processes (see Denver example)
38. *High Efficiency Urinal Rebate Program:* Offer a $50 rebate for each high efficiency urinal installed. High efficiency urinals include both flushing and non-water urinals.

39. *Restaurant Toilet Rebate Program:* Targets high-traffic, high-use toilets for replacement. Studies have shown that restaurant bathroom fixtures get much higher use than other commercial sites. To qualify for the rebate, existing toilets must use 3.5 gallons per flush or more. A $100 rebate is offered for the replacement with an approved standard 1.6 gallons per flush toilet, and $200 is offered for an approved high efficiency toilet which uses an average of 1.28 gallons per flush.
40. *Improve Single-Pass Cooling Systems:* Single-pass or once-through cooling systems can be improved to provide significant water savings. Single-pass systems dispose of cooling water down the drain after circulating it once through a piece of equipment. CAT scanners, degreasers, hydraulic equipment, condensers, air compressors, welding machines, vacuum pumps, ice machines, x-ray equipment, and air conditioners typically use single-pass cooling. Most of these types of equipment have air-cooled options available. Additional, the user can recirculate cooling water to reduce waste. Offer a $450 rebate for commercial customers that either (1) replace single-pass water cooled equipment with air-cooled options, or (2) install a closed-loop system that recycles cooling water.
41. *Car Wash Efficiency Equipment:* Car washes must be certified (see Denver example). Water savings can be achieved by installing weep management systems, to control bleed-off from nozzles during freezing weather. A rebate of $100 for installation of weep management systems.
42. *Coin-operated Laundry Equipment:* High-efficiency front-load laundry equipment offers significant water savings over their top-load counterparts. These machines save water, energy and chemicals, and they reduce wastewater costs. This incentive will target smaller-sized washers, because typically large industrial machines only come in front-loading models. Offer a $150 per machine rebate for each domestic-sized coin-operated laundry equipment.
43. *Boiler-less Steamers:* Steamers are commonly used in schools, hotels, hospitals and many restaurants for large-scale cooking of vegetables, fish, rice and steamed foods. Most food service establishments use the boiler-based atmospheric steamer. These are “zero pressure” steamers where steam is injected into the cooking chamber. Typically these units use between 20 and 40 gallons of potable water per hour while in operation. New boiler-less steamers, sometimes called connectionless steamers, are jacketed. The cooking chamber and steam chamber are separated and the condensate is returned and reused. The steamers use much less water than atmospheric steamers, typically 2-3 gallons per hour. Offer a $350 rebate per steamer for companies that replace atmospheric steamers with approved boiler-less units.
44. *Commercial Low-Flow Toilets:* Offer a $25 rebate per toilet to commercial customers who replace old high-water using toilets with qualifying low-flow toilets that use 1.6 gallons per flush or less.
45. *Commercial High-Efficiency Toilets:* Offer a $125 rebate per toilet to commercial customers who replace old high-water using toilets with high-efficiency toilets that use an average of 1.28 gallons per flush or less.
46. *Cooling Tower Conductivity Control:* Cooling towers without adequate control systems tend to be poorly operated, and they use more water than is necessary. A good conductivity control system gives building operators the tools to operate their cooling towers at higher cycles. Water meters that monitor cooling tower make-up and bleed-off also can help control efficiency in cooling towers. Offer a $500 rebate per conductivity controller for sump make-up in existing cooling towers with no conductivity controller or a malfunctioning controller. Offer a $50 rebate per water meter installed to monitor tower make-up and bleed-off.
47. *Pre-Rinse Spray Valves:* The amount of water used to pre rinse dishes is significant. Replacing old, high volume kitchen sprayers with a high-velocity, low-flow model can save water and energy. Offer a $60 rebate per spray valve to replace an inefficient model.
48. *Waterbrooms:* Save time and money when cleaning tennis courts, pool decks, kitchens, outdoor eating areas, sidewalks, and more. Waterbrooms can save 5 to 15 gallons per minutes and clean in about 75% less time. Offer $150 rebate per waterbroom.
49. *Public Awareness:* Offer free “Water Conservation” placards, stickers, etc. for commercial and industrial customers to display at their businesses.

Appendix H

Water Reuse Cost Estimates

City of Salina Raw Water Supply Study
Water Reuse for Municipal and Recreational Irrigation
Preliminary Opinion of Construction Costs
Irrigation and Industrial Uses

January, 2009

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization	1	LS	$191,000	$191,000
Supervision	1	LS	$302,000	$302,000
Temporary Facilities	1	LS	$10,000	$10,000
Temporary Utilities	1	LS	$50,000	$50,000
Equipment Rental & Misc.	1	LS	$60,000	$60,000
Total - General Requirements				**$613,000**
FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Filtration Facilities - 5 MGD				
Lift Station	1	LS	$334,000	$334,000
Gravity Filtration	1	LS	$1,310,000	$1,310,000
Backwash Facilities	1	LS	$478,000	$478,000
Subtotal				**$2,122,000**
UV Disinfection - 5 MGD				
Concrete Channel	1	LS	$324,000	$324,000
UV Equipment	1	LS	$2,093,000	$2,093,000
Electrical/Instrumentation	1	LS	$207,000	$207,000
Subtotal				**$2,624,000**
Finished Water Storage Tank & Pump Station				
1 Million Gallon Storage Tank	1	LS	$800,000	$800,000
5 MGD Pump Station	1	LS	$380,000	$380,000
Subtotal				**$1,180,000**
Dedicated Reclaimed Water Piping				
Irrigation Line - 16" installed with appurtenances	34,100	LF	$72	$2,455,000
Industrial Line - 8" installed with appurtenances	33,400	LF	$50	$1,670,000
Subtotal				**$4,125,000**
Construction Cost Subtotal				**$10,664,000**
Contingencies			**30%**	**$3,199,000**
TOTAL CONSTRUCTION COST				**$13,863,000**
Engineering, Legal, and Administrative Costs			**20%**	**$2,773,000**
TOTAL PROJECT COST				**$16,636,000**

City of Salina Raw Water Supply Study
Water Reuse for Municipal and Recreational Irrigation
Preliminary Opinion of Construction Costs
Irrigation Only

January, 2008

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization	1	LS	$135,000	$135,000
Supervision	1	LS	$213,000	$213,000
Temporary Facilities	1	LS	$7,000	$7,000
Temporary Utilities	1	LS	$35,000	$35,000
Equipment Rental & Misc.	1	LS	$43,000	$43,000
Total - General Requirements				**$433,000**
FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Filtration Facilities - 3.7 MGD				
Lift Station	1	LS	$308,000	$308,000
Gravity Filtration	1	LS	$1,089,000	$1,089,000
Backwash Facilities	1	LS	$379,000	$379,000
Subtotal				**$1,776,000**
UV Disinfection - 3.7 MGD				
Concrete Channel	1	LS	$247,000	$247,000
UV Equipment	1	LS	$1,624,000	$1,624,000
Electrical/Instrumentation	1	LS	$160,000	$160,000
Subtotal				**$2,031,000**
Finished Water Storage Tank & Pump Station				
600,000 Gallon Storage Tank	1	LS	$500,000	$500,000
3.7 MGD Pump Station	1	LS	$336,000	$336,000
Subtotal				**$836,000**
Dedicated Reclaimed Water Piping				
Irrigation Line - 16" installed with appurtenances	34,100	LF	$72	$2,455,000
Subtotal				**$2,455,000**
Construction Cost Subtotal				**$7,531,000**
Contingencies			**30%**	**$2,259,000**
TOTAL CONSTRUCTION COST				**$9,790,000**
Engineering, Legal, and Administrative Costs			**20%**	**$1,958,000**
TOTAL PROJECT COST				**$11,748,000**

City of Salina Raw Water Supply Study
Water Reuse for Municipal and Recreational Irrigation
Preliminary Opinion of Construction Costs
Irrigation of City Properties Only (excluding Soccer Complex)

January, 2009

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization	1	LS	$70,000	$70,000
Supervision	1	LS	$110,000	$110,000
Temporary Facilities	1	LS	$4,000	$4,000
Temporary Utilities	1	LS	$18,000	$18,000
Equipment Rental & Misc.	1	LS	$22,000	$22,000
Total - General Requirements				**$224,000**

FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Filtration Facilities - 1.9 MGD				
Lift Station	1	LS	$272,000	$272,000
Gravity Filtration	1	LS	$760,000	$760,000
Backwash Facilities	1	LS	$79,000	$79,000
Subtotal				**$1,111,000**
UV Disinfection - 1.9 MGD				
Concrete Channel	1	LS	$140,000	$140,000
UV Equipment	1	LS	$975,000	$975,000
Electrical/Instrumentation	1	LS	$94,000	$94,000
Subtotal				**$1,209,000**
Finished Water Storage Tank & Pump Station				
200,000 Gallon Storage Tank	1	LS	$167,000	$167,000
1.9 MGD Pump Station	1	LS	$274,000	$274,000
Subtotal				**$441,000**
Dedicated Reclaimed Water Piping				
Irrigation Line - 10" installed with appurtenances	18,000	LF	$50	$900,000
Subtotal				**$900,000**
Construction Cost Subtotal				**$3,885,000**
Contingencies			**30%**	**$1,166,000**
TOTAL CONSTRUCTION COST				**$5,051,000**
Engineering, Legal, and Administrative Costs			**20%**	**$1,010,000**
TOTAL PROJECT COST				**$6,061,000**

Appendix I

Cost Estimates of Preliminary Alternatives

City of Salina Raw Water Supply Study
Seasonal Water Right on the Smoky Hill River
Preliminary Opinion of Costs - Capital Costs

February, 2009

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization	1	LS	$58,000	$58,000
Supervision	1	LS	$92,000	$92,000
Temporary Facilities	1	LS	$3,000	$3,000
Temporary Utilities	1	LS	$15,000	$15,000
Equipment Rental & Misc.	1	LS	$18,000	$18,000
Total - General Requirements				**$186,000**
FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Surface Water Intake - 10 MGD				
River Intake	1	LS	$356,000	$356,000
Raw Water Pump Station	1	LS	$712,000	$712,000
Raw Water Piping - 24"	500	LF	$95	$48,000
Subtotal				**$1,116,000**
Treatment for Taste/Odor and Control of DBPs				
Ozone Treatment System	1	LS	$1,956,000	$1,956,000
Subtotal				**$1,956,000**
Construction Cost Subtotal				**$3,258,000**
Contingencies			**30%**	**$977,000**
TOTAL CONSTRUCTION COST				**$4,235,000**
Engineering, Legal, and Administrative Costs			**20%**	**$847,000**
TOTAL PROJECT COST				**$5,082,000**

City of Salina Raw Water Supply Study
Aquifer Recharge by Direct Recharge Wells
Preliminary Opinion of Costs - Capital Costs

February, 2009

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization	1	LS	$90,000	$90,000
Supervision	1	LS	$142,000	$142,000
Temporary Facilities	1	LS	$5,000	$5,000
Temporary Utilities	1	LS	$24,000	$24,000
Equipment Rental & Misc.	1	LS	$28,000	$28,000
Total - General Requirements				**$289,000**
FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Wellfield for Water Source				
River Bank Filtration Wells	5	LS	$250,000	$1,250,000
Raw Water Piping to Recharge Wells - 16"	10,000	LF	$72	$720,000
Subtotal				**$1,970,000**
Recharge Wellfield				
Recharge Injection Wells	11	LS	$250,000	$2,750,000
Subtotal				**$2,750,000**
Construction Cost Subtotal				**$5,009,000**
Contingencies			**30%**	**$1,503,000**
TOTAL CONSTRUCTION COST				**$6,512,000**
Engineering, Legal, and Administrative Costs			**20%**	**$1,302,000**
TOTAL PROJECT COST				**$7,814,000**

City of Salina Raw Water Supply Study
Improvements at Downtown Wellfield
Preliminary Opinion of Costs - Capital Costs

February, 2009

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization	1	LS	$73,000	$73,000
Supervision	1	LS	$116,000	$116,000
Temporary Facilities	1	LS	$4,000	$4,000
Temporary Utilities	1	LS	$19,000	$19,000
Equipment Rental & Misc.	1	LS	$23,000	$23,000
Total - General Requirements				**$235,000**
FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Wellfield Improvements				
Plug/Abandon & Re-Drill 5 Wells	5	LS	$275,000	$1,375,000
20" Pipe Between Well No 11 and Intersection	2,640	LF	$85	$224,000
30" Pipe Between Intersection and Intersection	1,525	LF	$121	$185,000
36" Pipe Between Intersection and Equilization Basin	350	LF	$161	$56,000
Subtotal				**$1,840,000**
Optional Contamination Treatment at Wellfield				
GAC System on Combined Piping from Wells 11, 12, 15, 16	1	LS	$1,715,000	$1,715,000
Subtotal				**$1,715,000**
Increased Capacity of Air Strippers				
Blowers - 27,520 cfm	3	EA	$30,000	$90,000
Pumps - 5278 gpm ea	3	EA	$50,000	$150,000
Other Work	1	LS	$60,000	$60,000
Subtotal				**$300,000**
Construction Cost Subtotal				**$4,090,000**
Contingencies			**30%**	**$1,227,000**
TOTAL CONSTRUCTION COST				**$5,317,000**
Engineering, Legal, and Administrative Costs			**20%**	**$1,063,000**
TOTAL PROJECT COST				**$6,380,000**

City of Salina Raw Water Supply Study
Improvements at South Wellfield
Preliminary Opinion of Costs - Capital Costs

February, 2009

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization	1	LS	$174,000	$174,000
Supervision	1	LS	$275,000	$275,000
Temporary Facilities	1	LS	$9,000	$9,000
Temporary Utilities	1	LS	$46,000	$46,000
Equipment Rental & Misc.	1	LS	$55,000	$55,000
Total - General Requirements				**$559,000**
FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Wellfield Improvements				
Re-Drill Wells No. 3 & 4 - 500 gpm @ 50' Depth	2	LS	$275,000	$550,000
Observation Wells - 2" well	2	LS	$10,000	$20,000
Improvements to Raw Water Piping to Plant - 12"	8,500	LF	$56	$476,000
Subtotal				**$1,046,000**
Water Treatment Facility				
Demolition of Existing Schilling WTP	720,000	CF	$0.35	$252,000
New Lime Softening Treatment Facility - 3.7 MGD	1	LS	$7,760,000	$7,760,000
Distribution Piping	2,000	LF	$56	$112,000
Subtotal				**$8,124,000**
Construction Cost Subtotal				**$9,729,000**
Contingencies			**30%**	**$2,919,000**
TOTAL CONSTRUCTION COST				**$12,648,000**
Engineering, Legal, and Administrative Costs			**20%**	**$2,530,000**
TOTAL PROJECT COST				**$15,178,000**

City of Salina Raw Water Supply Study
Acquisition of Existing Water Rights
Preliminary Opinion of Costs - Capital Costs

February, 2009

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization	1	LS	$65,000	$65,000
Supervision	1	LS	$102,000	$102,000
Temporary Facilities	1	LS	$3,000	$3,000
Temporary Utilities	1	LS	$17,000	$17,000
Equipment Rental & Misc.	1	LS	$20,000	$20,000
Total - General Requirements				**$207,000**
FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Purchase of Water Rights - 6.67 MGD				
Purchase of Land	6,000	AC	$1,500	$9,000,000
Purchase of Water Rights	5	EA	$70,000	$350,000
Subtotal				**$9,350,000**
Wellfields and Piping - 5 MGD				
Redrill Wells	5	EA	$250,000.00	$1,250,000
Raw Water Piping - 16"	30,000	LF	$72	$2,160,000
Subtotal				**$3,410,000**
Construction Cost Subtotal				**$12,967,000**
Contingencies			**30%**	**$3,890,000**
TOTAL CONSTRUCTION COST				**$16,857,000**
Engineering, Legal, and Administrative Costs			**20%**	**$3,371,000**
TOTAL PROJECT COST				**$20,228,000**

*** Costs are highly variable based on the number of water rights aquired and the location**

City of Salina Raw Water Supply Study
Milford Reservoir
Preliminary Opinion of Costs - Capital Costs

February, 2009

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization	1	LS	$353,000	$353,000
Supervision	1	LS	$558,000	$558,000
Temporary Facilities	1	LS	$19,000	$19,000
Temporary Utilities	1	LS	$93,000	$93,000
Equipment Rental & Misc.	1	LS	$112,000	$112,000
Total - General Requirements				**$1,135,000**
FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Surface Water Intake - 5 MGD				
Lake Intake	1	LS	$238,000	$238,000
Raw Water Pump Station	1	LS	$476,000	$476,000
Subtotal				**$714,000**
Raw Water Handling				
Pumping Facilities = 5 MGD	2	LS	$387,000	$774,000
Raw Water Piping - 16"	237,600	LF	$72	$17,107,000
Subtotal				**$17,881,000**
Construction Cost Subtotal				**$19,730,000**
Contingencies			**30%**	**$5,919,000**
TOTAL CONSTRUCTION COST				**$25,649,000**
Engineering, Legal, and Administrative Costs			**20%**	**$5,130,000**
TOTAL PROJECT COST				**$30,779,000**
ANNUAL COST TO PURCHASE STORAGE (2009)	**610,000**	**1000 GAL**	**$0.18516**	**$112,948**

City of Salina Raw Water Supply Study
Dakota Aquifer
Preliminary Opinion of Costs - Capital Costs

February, 2009

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization	1	LS	$358,000	$358,000
Supervision	1	LS	$566,000	$566,000
Temporary Facilities	1	LS	$19,000	$19,000
Temporary Utilities	1	LS	$94,000	$94,000
Equipment Rental & Misc.	1	LS	$113,000	$113,000
Total - General Requirements				**$1,150,000**
FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Wellfield - 5 MGD				
Public Water Supply Wells - 100 to 300 gpm, 300' deep	24	EA	$350,000	$8,400,000
Wellfield Piping - 16"	63,360	LF	$72	$4,562,000
Subtotal				**$12,962,000**
Raw Water Handling				
Water Storage - 1 MG	1	LS	$800,000	$800,000
Pumping Facilities - 5 MGD	2	LS	$387,000	$774,000
Raw Water Piping - 16"	60,000	LF	$72	$4,320,000
Subtotal				**$5,894,000**
Construction Cost Subtotal				**$20,006,000**
Contingencies			**30%**	**$6,002,000**
TOTAL CONSTRUCTION COST				**$26,008,000**
Engineering, Legal, and Administrative Costs			**20%**	**$5,202,000**
TOTAL PROJECT COST				**$31,210,000**

*** Costs are variable based on where in the Dakota Aquifer the wellfield is located and the yield obtained**

City of Salina Raw Water Supply Study
Kanopolis Reservoir
Preliminary Opinion of Costs - Capital Costs

February, 2009

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization	1	LS	$161,000	$161,000
Supervision	1	LS	$255,000	$255,000
Temporary Facilities	1	LS	$8,000	$8,000
Temporary Utilities	1	LS	$42,000	$42,000
Equipment Rental & Misc.	1	LS	$51,000	$51,000
Total - General Requirements				**$517,000**
FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Surface Water Intake - 2 MGD				
Lake Intake	1	LS	$167,000	$167,000
Raw Water Pump Station	1	LS	$334,000	$334,000
Subtotal				**$501,000**
Raw Water Handling				
Raw Water Piping - 12"	142,560	LF	$56	$7,983,000
Subtotal				**$7,983,000**
Construction Cost Subtotal				**$9,001,000**
Contingencies			**30%**	**$2,700,000**
TOTAL CONSTRUCTION COST				**$11,701,000**
Engineering, Legal, and Administrative Costs			**20%**	**$2,340,000**
TOTAL PROJECT COST				**$14,041,000**
ANNUAL COST TO PURCHASE STORAGE (2009)	**610,000**	**1000 GAL**	**$0.18516**	**$112,948**

City of Salina Raw Water Supply Study
Saline River
Preliminary Opinion of Costs - Capital Costs

February, 2009

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization	1	LS	$474,000	$474,000
Supervision	1	LS	$748,000	$748,000
Temporary Facilities	1	LS	$25,000	$25,000
Temporary Utilities	1	LS	$125,000	$125,000
Equipment Rental & Misc.	1	LS	$150,000	$150,000
Total - General Requirements				**$1,522,000**
FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Wellfield				
Horizontal Collector Well - 80' deep with laterals	1	LS	$2,000,000	$2,000,000
Raw Water Piping to Plant - 20"	1	LF	$200,000	$200,000
Subtotal				**$2,200,000**
Reverse Osmosis Treatment Facility				
Pre-Treatment/Post-Treatment - 5.75 MGD	1	LS	$8,510,000	$8,510,000
RO Membranes - 5.75 MGD	1	LS	$8,740,000	$8,740,000
Class I Injection Wells - 0.75 MGD	1	EA	$2,000,000	$2,000,000
Subtotal				**$19,250,000**
Finished Water Handling				
Water Storage - 1 MG	1	LS	$800,000	$800,000
Pumping Facilities - 5 MGD	2	LS	$387,000	$774,000
Finished Water Piping to Salina WTP - 16"	26,400	LF	$72	$1,901,000
Subtotal				**$3,475,000**
Construction Cost Subtotal				**$26,447,000**
Contingencies			**30%**	**$7,934,000**
TOTAL CONSTRUCTION COST				**$34,381,000**
Engineering, Legal, and Administrative Costs			**20%**	**$6,876,000**
TOTAL PROJECT COST				**$41,257,000**

City of Salina Raw Water Supply Study
Confluence of Smoky Hill River and Solomon River
Preliminary Opinion of Costs - Capital Costs

February, 2009

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization	1	LS	$533,000	$533,000
Supervision	1	LS	$841,000	$841,000
Temporary Facilities	1	LS	$28,000	$28,000
Temporary Utilities	1	LS	$140,000	$140,000
Equipment Rental & Misc.	1	LS	$168,000	$168,000
Total - General Requirements				**$1,710,000**
FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Wellfield				
Horizontal Collector Well - 80' deep with laterals	1	LS	$2,000,000	$2,000,000
Raw Water Piping to Plant - 20"	1,000	LF	$85	$85,000
Subtotal				**$2,085,000**
Reverse Osmosis Treatment Facility				
Pre-Treatment/Post-Treatment - 5.75 MGD	1	LS	$8,510,000	$8,510,000
RO Membranes - 5.75 MGD	1	LS	$8,740,000	$8,740,000
Class I Injection Wells - 0.75 MGD	1	EA	$2,000,000	$2,000,000
Subtotal				**$19,250,000**
Finished Water Handling				
Water Storage - 1 MG	1	LS	$800,000	$800,000
Pumping Facilities - 5 MGD	1	LS	$387,000	$387,000
Finished Water Piping to Salina WTP - 16"	76,500	LF	$72	$5,508,000
Subtotal				**$6,695,000**
Construction Cost Subtotal				**$29,740,000**
Contingencies			**30%**	**$8,922,000**
TOTAL CONSTRUCTION COST				**$38,662,000**
Engineering, Legal, and Administrative Costs			**20%**	**$7,732,000**
TOTAL PROJECT COST				**$46,394,000**

City of Salina Raw Water Supply Study
Wilson Reservoir
Preliminary Opinion of Costs - Capital Costs

February, 2009

Item Description	Quantity	Unit	Unit Cost	Total Cost
			$	$
GENERAL REQUIREMENTS				
Mobilization	1	LS	$809,000	$809,000
Supervision	1	LS	$1,278,000	$1,278,000
Temporary Facilities	1	LS	$43,000	$43,000
Temporary Utilities	1	LS	$213,000	$213,000
Equipment Rental & Misc.	1	LS	$256,000	$256,000
Total - General Requirements				**$2,599,000**
FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Surface Water Intake - 5.75 MGD				
Lake Intake	1	LS	$255,500	$255,500
Raw Water Pump Station	1	LS	$511,000	$511,000
Raw Water Piping to Plant - 20"	1,000	LF	$85	$85,000
Subtotal				**$851,500**
Reverse Osmosis Treatment Facility				
Surface Water Pre-Treatment/Post-Treatment - 5.75 MGD	1	LS	$8,510,000	$8,510,000
RO Membranes - 5.75 MGD	1	LS	$8,740,000	$8,740,000
Class I Injection Wells - 0.75 MGD	1	EA	$2,000,000	$2,000,000
Subtotal				**$19,250,000**
Finished Water Handling				
Water Storage - 1 MG	1	LS	$800,000	$800,000
Pumping Facilities - 5 MGD	2	LS	$387,000	$774,000
Finished Water Piping to Salina WTP - 16"	290,400	LF	$72	$20,909,000
Subtotal				**$22,483,000**
Construction Cost Subtotal				**$45,183,500**
Contingencies			**30%**	**$13,555,000**
TOTAL CONSTRUCTION COST				**$58,738,500**
Engineering, Legal, and Administrative Costs			**20%**	**$11,748,000**
TOTAL PROJECT COST				**$70,486,500**
ANNUAL COST TO PURCHASE STORAGE (2009)	**610,000**	**1000 GAL**	**$0.18516**	**$112,948**

City of Salina Raw Water Supply Study
Reservoir Construction
Preliminary Opinion of Costs - Capital Costs

February, 2009

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization	1	LS	$1,864,000	$1,864,000
Supervision	1	LS	$2,944,000	$2,944,000
Temporary Facilities	1	LS	$98,000	$98,000
Temporary Utilities	1	LS	$491,000	$491,000
Equipment Rental & Misc.	1	LS	$589,000	$589,000
Total - General Requirements				**$5,986,000**
FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Reservoir Construction - 25,000 AF for 5 MGD Yield (2% Drought)				
Site Work	1	LS	$11,379,000	$11,379,000
Embankment	1	LS	$43,083,000	$43,083,000
Soil Cement	1	LS	$25,554,000	$25,554,000
Cut-Off Wall	1	LS	$3,257,000	$3,257,000
Drain	1	LS	$12,242,000	$12,242,000
Subtotal				**$95,515,000**
Surface Water Intake - 5 MGD				
Lake Intake	1	LS	$238,000	$238,000
Raw Water Pump Station	1	LS	$476,000	$476,000
Raw Water Piping to Salina - 16"	26,400	LF	$72	$1,900,800
Subtotal				**$2,614,800**
Construction Cost Subtotal				**$104,115,800**
Contingencies			**30%**	**$31,235,000**
TOTAL CONSTRUCTION COST				**$135,350,800**
Engineering, Legal, and Administrative Costs			**20%**	**$27,070,000**
TOTAL PROJECT COST				**$162,420,800**

City of Salina Raw Water Supply Study
Water Reuse for Municipal and Recreational Irrigation
Preliminary Opinion of Construction Costs
Irrigation and Industrial Uses

January, 2009

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization	1	LS	$191,000	$191,000
Supervision	1	LS	$302,000	$302,000
Temporary Facilities	1	LS	$10,000	$10,000
Temporary Utilities	1	LS	$50,000	$50,000
Equipment Rental & Misc.	1	LS	$60,000	$60,000
Total - General Requirements				**$613,000**
FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Filtration Facilities - 5 MGD				
Lift Station	1	LS	$334,000	$334,000
Gravity Filtration	1	LS	$1,310,000	$1,310,000
Backwash Facilities	1	LS	$478,000	$478,000
Subtotal				**$2,122,000**
UV Disinfection - 5 MGD				
Concrete Channel	1	LS	$324,000	$324,000
UV Equipment	1	LS	$2,093,000	$2,093,000
Electrical/Instrumentation	1	LS	$207,000	$207,000
Subtotal				**$2,624,000**
Finished Water Storage Tank & Pump Station				
1 Million Gallon Storage Tank	1	LS	$800,000	$800,000
5 MGD Pump Station	1	LS	$380,000	$380,000
Subtotal				**$1,180,000**
Dedicated Reclaimed Water Piping				
Irrigation Line - 16" installed with appurtenances	34,100	LF	$72	$2,455,000
Industrial Line - 8" installed with appurtenances	33,400	LF	$50	$1,670,000
Subtotal				**$4,125,000**
Construction Cost Subtotal				**$10,664,000**
Contingencies			**30%**	**$3,199,000**
TOTAL CONSTRUCTION COST				**$13,863,000**
Engineering, Legal, and Administrative Costs			**20%**	**$2,773,000**
TOTAL PROJECT COST				**$16,636,000**

City of Salina Raw Water Supply Study
Water Reuse for Municipal and Recreational Irrigation
Preliminary Opinion of Construction Costs
Irrigation of City Properties Only (excluding Soccer Complex)

January, 2009

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization	1	LS	$70,000	$70,000
Supervision	1	LS	$110,000	$110,000
Temporary Facilities	1	LS	$4,000	$4,000
Temporary Utilities	1	LS	$18,000	$18,000
Equipment Rental & Misc.	1	LS	$22,000	$22,000
Total - General Requirements				**$224,000**
FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Filtration Facilities - 1.9 MGD				
Lift Station	1	LS	$272,000	$272,000
Gravity Filtration	1	LS	$760,000	$760,000
Backwash Facilities	1	LS	$79,000	$79,000
Subtotal				**$1,111,000**
UV Disinfection - 1.9 MGD				
Concrete Channel	1	LS	$140,000	$140,000
UV Equipment	1	LS	$975,000	$975,000
Electrical/Instrumentation	1	LS	$94,000	$94,000
Subtotal				**$1,209,000**
Finished Water Storage Tank & Pump Station				
200,000 Gallon Storage Tank	1	LS	$167,000	$167,000
1.9 MGD Pump Station	1	LS	$274,000	$274,000
Subtotal				**$441,000**
Dedicated Reclaimed Water Piping				
Irrigation Line - 10" installed with appurtenances	18,000	LF	$50	$900,000
Subtotal				**$900,000**
Construction Cost Subtotal				**$3,885,000**
Contingencies			**30%**	**$1,166,000**
TOTAL CONSTRUCTION COST				**$5,051,000**
Engineering, Legal, and Administrative Costs			**20%**	**$1,010,000**
TOTAL PROJECT COST				**$6,061,000**

City of Salina Raw Water Supply Study
Water Reuse for Municipal and Recreational Irrigation
Preliminary Opinion of Construction Costs
Irrigation Only

January, 2008

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization	1	LS	$135,000	$135,000
Supervision	1	LS	$213,000	$213,000
Temporary Facilities	1	LS	$7,000	$7,000
Temporary Utilities	1	LS	$35,000	$35,000
Equipment Rental & Misc.	1	LS	$43,000	$43,000
Total - General Requirements				**$433,000**
FACILITIES CONSTRUCTION	Quantity	Unit	Unit Cost	Total Cost
Filtration Facilities - 3.7 MGD				
Lift Station	1	LS	$308,000	$308,000
Gravity Filtration	1	LS	$1,089,000	$1,089,000
Backwash Facilities	1	LS	$379,000	$379,000
Subtotal				**$1,776,000**
UV Disinfection - 3.7 MGD				
Concrete Channel	1	LS	$247,000	$247,000
UV Equipment	1	LS	$1,624,000	$1,624,000
Electrical/Instrumentation	1	LS	$160,000	$160,000
Subtotal				**$2,031,000**
Finished Water Storage Tank & Pump Station				
600,000 Gallon Storage Tank	1	LS	$500,000	$500,000
3.7 MGD Pump Station	1	LS	$336,000	$336,000
Subtotal				**$836,000**
Dedicated Reclaimed Water Piping				
Irrigation Line - 16" installed with appurtenances	34,100	LF	$72	$2,455,000
Subtotal				**$2,455,000**
Construction Cost Subtotal				**$7,531,000**
Contingencies			**30%**	**$2,259,000**
TOTAL CONSTRUCTION COST				**$9,790,000**
Engineering, Legal, and Administrative Costs			**20%**	**$1,958,000**
TOTAL PROJECT COST				**$11,748,000**

Appendix J

Supply Requirement Calculations

City of Salina
Source of Supply Requirments

Projected Demands						Existing Sources Yield Non-Drought			Existing Sources Yield Drought			Existing Sources Yield Annual			Supply Needs			
Year	Average Day (MGD)	Summer Average Day (MGD)	Maximum Day (MGD)	Max Annual Quantity (ac-ft)	Avg Annual Quanitity (ac-ft)	Smoky Hill River Yield (MGD)	Firm Capacity DT Wellfield Yield (MGD)	Total (MGD)	Smoky Hill River Yield (MGD)	DT Wellfield Yield (MGD)	Total (MGD)	Smoky Hill River Yield (ac-ft)	DT Wellfield Yield (ac-ft)	Total (ac-ft)	Supply Needs Non-Drought (MGD) (1)	Supply Needs Drought (MGD) (2)	Supply Needs Avg Annual (ac-ft) (3)	Supply Needs Max Annual (ac-ft) (4)
2010	8.14	12.05	15.57	10,212	9,119	10.00	9.90	19.90	0.00	8.40	8.40	5,028	4,993	10,021	0.0	7.2	0	191
2015	8.38	12.40	16.03	10,511	9,386	10.00	9.90	19.90	0.00	8.40	8.40	5,028	4,993	10,021	0.0	7.6	0	490
2020	8.62	12.76	16.48	10,810	9,653	10.00	9.90	19.90	0.00	8.40	8.40	5,028	4,993	10,021	0.0	8.1	0	789
2025	8.85	13.11	16.94	11,109	9,920	10.00	9.90	19.90	0.00	8.40	8.40	5,028	4,993	10,021	0.0	8.5	0	1088
2030	9.09	13.46	17.40	11,408	10,186	10.00	9.90	19.90	0.00	8.40	8.40	5,028	4,993	10,021	0.0	9.0	165	1387
2035	9.33	13.81	17.85	11,707	10,453	10.00	9.90	19.90	0.00	8.40	8.40	5,028	4,993	10,021	0.0	9.5	432	1686
2040	9.57	14.17	18.31	12,005	10,720	10.00	9.90	19.90	0.00	8.40	8.40	5,028	4,993	10,021	0.0	9.9	699	1984
2045	9.81	14.52	18.76	12,304	10,987	10.00	9.90	19.90	0.00	8.40	8.40	5,028	4,993	10,021	0.0	10.4	966	2283
2050	10.05	14.87	19.22	12,603	11,254	10.00	9.90	19.90	0.00	8.40	8.40	5,028	4,993	10,021	0.0	10.8	1233	2582
2055	10.28	15.23	19.67	12,902	11,521	10.00	9.90	19.90	0.00	8.40	8.40	5,028	4,993	10,021	0.0	11.3	1500	2881
2060	10.52	15.58	20.13	13,201	11,788	10.00	9.90	19.90	0.00	8.40	8.40	5,028	4,993	10,021	0.2	11.7	1767	3180

(1) Projected Maximum Day Demands minus Non-Drought Existing Sources Yield
(2) Projected Maximum Day Demands minus Drought Existing Sources Yield
(3) Projected Average Annual Quantity minus Annual Existing Sources Yield
(4) Projected Maximum Annual Quantity minus Annual Existing Sources Yield

Notes:
Only considers Downtown Wellfield and Smoky Hill River as existing sources of supply
South Wellfield not considered as existing source of supply due to the fact that the City only uses it in an emergency and would only use it regularly if it were upgraded
Downtown Wellfield currently limited to 10 MGD due to air stripper capacity
Drought considers worst case scenario that Smoky Hill River temporarily unavailable
Drought at Downtown Wellfield considers reduced yield for lower aquifer levels