City Council
Water Committee

Meeting Agenda

Friday, July 8, 2016
ADMINSTRATION BUILDING, SID COPELAND WATER TREATMENT PLANT
1955 Washington Avenue Louisville, CO 80027
7:30-10:00 am

I. Call to Order

II. Roll Call

III. Approval of Agenda

IV. Approval of Minutes from February 19, 2016

V. Public Comments on Items Not on the Agenda

VI. Committee Operations

- Future Committee meeting schedule: 3rd Quarter Meeting: August, 2016. 4th Quarter Meeting: November 2016.

VII. Update – Water Resources (Cory Peterson)

- Water Supply Update
- Windy Gap Firming Project Update (dates provided by NCWCD)
  - i. 404 Permit – 2016
  - ii. Water Rights Decree – 2016
  - iii. Design Consultant Selection

VIII. Update – CIP Projects (Cory Peterson)

- Wastewater Treatment Plant Upgrades
  - i. Status: Under construction (MHW)
  - ii. Contract cost: $31.2 million
  - iii. Estimated completion: July 2017
- Louisville/Lafayette Drainageway Improvements
  - i. Status: Under construction (Concrete Express- Phase 1, Redpoint-Phase 2)
  - ii. Engineer's estimate: $9 million total cost before UDFCD & City of Lafayette contributions

iii. Estimated completion: August 2016-Phase 2, September 2016-Phase 1

- Louisville/Superior Interconnect
  i. Status: Project Closeout (Redpoint)
  ii. Contract cost: $547,884
  iii. Budget: $600,000 (1/2 from Superior)
- Eldorado Intake Reconstruction
  i. Status: Project Closeout (Glacier)
  ii. Contract cost: $1.5 million
  iii. Budget : $1.5 million
- Sid Copeland WTP Contact Tank
  i. Status: Project Closeout (Glacier)
  ii. Contract cost: $406,413
  iii. Budget: $424,000
- Sid Copeland WTP Pump Station
  i. Status: Design (Hatch Mott MacDonald)
  ii. Design Cost: $237,000
  iii. Budget: $2.4 million (includes construction)

IX. 2017 Water Utility Rates

X. Tap Fee
- Update Tap Fee (Oct 1st)
- Review of Live/Work

XI. Raw Water Master Plan Update (Cory Peterson/Paul Flack)

XII. Update – Legal (Alan Hill)
- Eldora
- Harper Diligence
- Other Water Court Cases

XIII. Conservation Program (Cory Peterson)

XIV. Boulder County Open Space Pond (Kurt Kowar)

XV. Upcoming Projects and Council Action
- SCWTP Drying Beds Design – July/August
- Pipeline Assessment - July/August

- Plant Security Upgrades - July/August
- SCWTP Pump Station Construction - Fall

XVI. Agenda Items and Date for Next Meeting

XVII. Water Plant Tour: 9:30 to 10:00 am

XVIII. Adjourn 9:30 am

Attachments: 2016-02-19 Meeting Minutes
Project Pictures
Live/Work Tap Fee Background
Tap Fee Public Notice
Draft Water Resources Masterplan
Media material for Conservation Program
Boulder County Open Space Pond

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City Council
Water Committee

Draft - Meeting Minutes

Friday, February 19, 2016
***ADMINSTRATION BUILDING*, WASTEWATER TREATMENT PLANT**
1555 Empire Road Louisville, CO 80027

I. **Call to Order** – Jay Keany called the meeting to order at 7:40.

II. **Roll Call** was taken and the following members were present:

City Council: Jay Keany, Robert Muckle, Jeff Lipton

Absent:

Staff Present: *Malcolm Fleming, Kurt Kowar, Cory Peterson, Graham Clark, Kevin Watson, Alan Hill (Yates Law Firm), Paul Flack (RBI)*

Public: None

III. ***Approval of Agenda:*** Agenda approved.

IV. ***Approval of the Minutes***: The meeting minutes from November 13th were approval as written.

V. **PUBLIC COMMENTS ON ITEMS NOT ON THE AGENDA:**

None

VI. **Update – Water Resources (Cory Peterson/Paul Flack)**

- Water Supply Update

  Snowpack conditions for February are above average. Storage levels are recovering from the Community Ditch shutdown and should be normal for 2016. Forecasts predict normal to above normal precipitation moving into fall and winter.

- Windy Gap Firming Project Update

Council approved the 5th Interim agreement for the Windy Gap Firming Project on February 16th. NCWCD continues to work on obtaining the final 401 and 404 permits. NCWCD is planning on soliciting for a design consultant to start work in 2016. Current estimates have design taking two years and construction another three to four years.

VII. Update – CIP Projects (Cory Peterson)

- Wastewater Treatment Plant Upgrades
    i. Status: Under construction (contractor: MHW)
    ii. Contract Cost: $31.2 million.
    iii. Estimated completion: July 2017

    Mr. Peterson described the recent activity performed by MHW with the major concrete placements wrapping up this quarter. The process piping has started along with many of the other building foundations. In general, the pace of construction is proceeding satisfactorily.

- Louisville/Lafayette Drainageway Improvements
    i. Status: Under construction (Concrete Express- Phase 1, Redpoint-Phase 2).
    ii. Engineer's estimate: $9 million total cost before UDFCD & City of Lafayette contributions
    iii. Estimated completion: August 2016-Phase 2, September 2016-Phase 1

    Mr. Kowar and Mr. Peterson provide and update on the both phases of the project. Specific information on the impacts of construction to Highway 42 was discussed.

- Louisville/Superior Interconnect
    i. Status: Under construction (Redpoint)
    ii. Contract Cost: $537,000

    Mr. Peterson stated that construction was nearing completion with the final tie-in to occur within the month. Redpoint will start final site cleanup and reseed as weather permits.

- Eldorado Intake Reconstruction
    i. Status: Under construction (Glacier)
    ii. Contract cost: $1.5 million

    Mr. Peterson explained that project is going well and has handled the challenge with the weather and location. Staff continues to work through the FEMA process in hopes that it will be resolved soon.

iv. Community Ditch Reconstruction Project

Mr. Peterson outlined that the Community Ditch project reached substantial completion and has started deliveries again.

- Sid Copeland WTP Contact Tank

  Status: Construction Contract Council 2/16/16.

  Proposed Contract: $424,000

  Mr. Peterson discussed the pending schedule for this improvement project following the Council approval on Tuesday. Project is anticipated to be complete by May.

- Sid Copeland WTP Pump Station

  i. Status: Project scheduled for 2016

  ii. Engineer's estimate: $2.4 million

  Mr. Peterson provided a brief overview of project as a look ahead to 2016.

VIII. 2016 Utility Rates Update

Mr. Kowar and Mr. Peterson provided a revised outlined for the proposed 2016 utility rate analysis. An extensive discussion related to rate impacts and the debt coverages was conducted. The water committee was in favor of the smoothing option and was ready to move forward to a Council presentation.

XI. Update – Legal (Alan Hill)

- Eldorado Springs

  Mr. Hill stated that there were some preliminary discussions on modification to Eldorado Spring's use of the pipeline and is awaiting a formal proposal.

- SWSP

  Mr. Hill explained that the SWSP was used for a couple weeks and is no longer needed with the completion of Community Ditch Project

- Other Water Court Cases

  Mr. Hill outlined Eldora plans for a new change case on the Howard Ditch and will be reviewed once it is filed within the month.

IX. Tap Fee

Mr. Kowar explained that recent analysis of tap fees shows a lagging in the fee structure with the most significantly in the water resources component. An increase in tap fees is proposed. A schedule for this increase will be brought to the next water committee.

XVII. Adjourn

The meeting was adjourned at 9:45 am by Mr. Keany and seconded by Mr. Muckle.

The Remaining items were tabled due to time constraints

X. Raw Water Master Plan Update

XII. Conservation Rebate Program (Kurt Kowar/Cory Peterson)

XIII. Upcoming Projects and Council Action

XIV. Committee Operations

XV. Agenda Items and Date for Next Meeting

XVI. Wastewater Plant Tour and Staff Introductions

Photo 1 – WWTP

Photo 2 – Intake

Background on Live Work Tap Fee

The City's policy regarding tap fees requires that a separate premise (two different buildings) are required to have separate services and pay separate tap fees. This policy was reviewed with the City Council on July 28, 2015 and Council considered a proposed Ordinance to amend sections of the LMC to provide for a new water tap fee for Live-Work Land Uses. The City Council voted 4-2 (Dalton and Stolzmann voting "No" with Keany absent) to continue the matter to the September 15th Council meeting to allow the Water Committee to consider the matter further and make a recommendation to the City Council. The discussion details on the matter are in the minutes for the July 28, 2015 meeting which can be found starting on page 23.

On September 15, 2015 the Water Committee reviewed the policy and reviewed examples of case study on how live work may or may not be considered for a separate tap fee structure. The Water Committee provided clear direction that the existing tap fee policy is adequate and that no modifications would be supported for the tap fee structure for the Live-Work use. The Water Committee did agree that the Public Works Director could allow the use of a single service line to two premises on a Live-Work property to allow a construction savings (perhaps as much as $10,000) for modifications or building new Live-Work uses. The Water Committee also requested additional information.

As a result of the Water Committee's direction on September 15, 2015, the City Council continued consideration of the proposed Ordinance until October 6, 2015. Because of difficulty scheduling the Water Committee to consider the matter further, the matter was continued again on October 6th, then again on November 2nd. On December 15, staff requested that Council take no further action until the Water Committee is ready to move forward. The most recent and complete information on the issue can be found in the November 2, 2015 City Council packet. The matter was scheduled for discussion during the Water Committee's February 19, 2016 meeting, but the Committee ran out of time to consider the matter further.

Unless the Water Committee recommends differently and Council then votes in favor of an ordinance to change the Code, all live/work projects must pay separate tap fees for the residential and commercial units.

Background on Live Work Project at 927 Main

927 Main is a Live Work development approved by the City Council in 2014 (see page 163 of the Council packet and page 3 of the Meeting Minutes for more information). Under the current Code and Tap Fee Schedule, the 927 Main development is required to pay a tap fee of $25,900 at the time a new Single Family Residential Unit connects to the system. However, the Public Works Director has the authority to allow a single service line, which in round numbers could reduce installation costs by as much as $10,000. This is comparable to the tap fee savings associated with the proposed ordinance Council considered, and declined to pass, in July 2015. The Zaremba team has shown that the existing 1" meter and water line is adequate to serve the flow for a new single family residential unit and the existing commercial unit. Their calculations

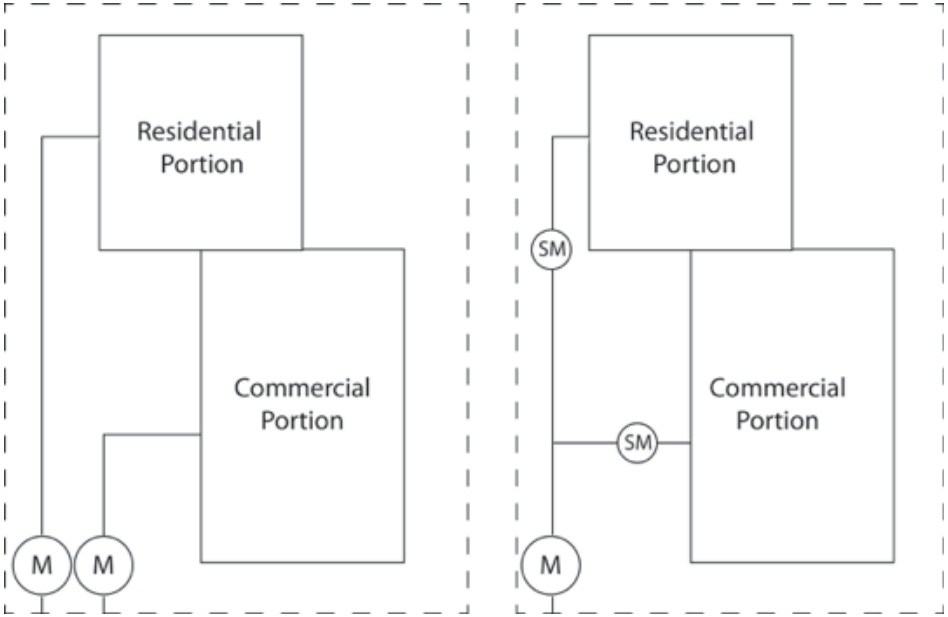
did not include irrigation or fire suppression calculations. It's likely the 1" is fine but the Zaremba team of engineers should review and cover these scenarios.

The Zaremba team has communicated they either felt they weren't made aware a separate tap fee would be required or that they were led to believe it wouldn't be required due to ongoing policy discussions with the City Council. Former Planning and Building Safety Director Troy Russ stated that he told Zaremba team members that Council would have to change the existing Code provisions to provide any change in the requirement for each unit (commercial and residential) to pay the tap fee. According to Kurt, Public Works was not involved with any direct conversations regarding expectations that there would not be a tap fee charged

Scenario Discussion

Live Work Scenarios	New 3/4"	New 1"	New Sewer	Service Lines	Total	Difference
Existing Location 3/4" Tap w/o Live Work Tap	$ 25,900	$ -	$ 4,500	$ 21,000	**$ 51,400**	
Existing Location 3/4" Tap w/ Live Work Tap	$ 25,900	$ -	$ 4,500	$ 9,000	**$ 39,400**	**$ 12,000**
Existing Location 1" Tap w/o Live Work Tap	$ 25,900	$ -	$ 4,500	$ 21,000	**$ 51,400**	
Existing Location 1" Tap w/ Live Work Tap	$ -	$ -	$ -	$ -	**$ -**	**$ 51,400**
New Location w/o Live Work Tap	$ 51,800	$ -	$ 9,000	$ 42,000	**$102,800**	
New Location w/ Live Work Tap	$ -	$ 46,200	$ 7,900	$ 21,000	**$ 75,100**	**$ 27,700**

Note: By Ordinance existing locations receive a credit for existing taps in the amount of the original tap cash purchase.



Tap Size	Allocated Water Budget (gallons)	Cost of Distribution Pipes in Tap Fee
3/4”	117,000	$3,718
1”	208,260	$6,619
2 x 3/4”	234,000	$7,436

* This discussion is specific to one time tap fees. Monthly Billing is proposed to be Residential and Commercial not a new distinct customer class.

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Water and Sewer Tap Fee Increase
Effective October 1, 2016

Effective October 1, 2016 water and sewer tap fees will be increasing for all new construction. If you have a building project in process, please contact Cory Peterson at (303) 335-4610 to discuss how this change might impact your project.

Tap fees are required to be paid at the time a building construction permit is issued

The City of Louisville charges Development Tap fees for new construction to cover growth related costs and construction impact on City utilities.

Louisville's water and sewer tap fees include a Facility or Infrastructure Investment Fee which is set to recover an equitable portion of the value of the City's infrastructure required to meet the new demand of the customer on the utility system. The infrastructure includes all components required to divert, distribute and treat water to/from customers.

Periodically the City reviews the cost of the infrastructure portion of the tap fees to ensure new users are paying an equitable portion of the overall costs to maintain and improve the utility system. A recent evaluation determined the infrastructure portion of the water and sewer tap fees should be increased to address the utility system's replacement cost. This is based on the value of the improvements made to the system and the replacement costs for the rest of the system since the infrastructure fee was previously set.

In addition to the Facility Fee, the water tap fee has a Water Resources Fee set to recover the value of the City's raw water supplies purchased to meet the demand of the new customer. The water resources portion is based on the current market value of the water resources owned by the City. Recent water purchases are used as a basis for determining the current market value. Water purchases are valued in terms of the cost per acre foot (AF) of reliable annual water delivery. Louisville relies upon the value of a unit of the Colorado Big Thompson Project commonly referred to as a CB-T unit. A single CB-T unit provides 0.6 AF of water supply. The market for water rights in Colorado has become even more competitive in recent years and the current market value of CB-T water has reached a price range of up to $25,000 per unit or $41,667 per AF. Louisville has chosen a water resources value of $40,000 per AF to base the water resources component of water tap fees on.

Effective October 1, 2016. Tap fees will increase as outlined in the table of fees below as a result of the increase in the cost of water to the City and the increase in the value of the City's water infrastructure since 2014 (the last time water tap fees were adjusted based on system value and current costs).

Table 1: Schedule of Water System Development Charges

		Proposed		
Meter Size	**Existing**	**Facilities**	**Water Resource**	**Total**
3/4	$ 25,900	$ 13,100	$ 17,400	$ 30,500
1	$ 46,200	$ 23,400	$ 31,000	$ 54,400
1 1/2	$ 103,600	$ 52,400	$ 69,600	$ 122,000

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2	$ 184,300	$ 93,200	$ 123,800	$ 217,000
3	$ 414,400	$ 209,600	$ 278,400	$ 488,000
4	$ 736,700	$ 372,600	$ 494,900	$ 867,500

Table 2: Schedule of Wastewater System Development Charges

Meter Size	Existing	Equivalent Ratio	Proposed Total
3/4	$ 4,500	1.00	$ 4,600
1	$ 7,900	1.78	$ 8,200
1 1/2	$ 17,600	4.00	$ 18,400
2	$ 31,300	7.11	$ 32,800
3	$ 70,400	16.00	$ 73,600
4	$ 125,200	28.44	$ 130,900

Tap fees are subject to future increases from the rate listed on this notice.

DRAFT- 7/1/16

Municipal Water Management Plan

For the City of Louisville, Colorado

Prepared by

RESOURCE BASED INTERNATIONAL

In Collaboration with
Spronk Water Engineers, Inc

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1. South Boulder Creek Straightline Map
2. Louisville Firm Yield Scenarios Graph
3. Possible Buildout Demands Graph

INTRODUCTION

This Water Management Plan ("Plan") is recognized as part of the City of Louisville's ("City") continuing long range water resource planning process. The Plan's purpose is to keep the planning process updated using current water related data. This Plan is also recognized as a continuation of previous "Raw Water Master Plans" prepared for the City in 1993, 1998, and 2003. This previous planning and foresight has resulted in the development of varied water resources sufficient to supply the City's current water needs through drought periods.

The purpose of this report, however, varies in context from previous studies with regard to the following topics: water supply operations, historical trends, drought management planning, climate change implications, and future water acquisitions. The basis of this difference is found in the report's structure to provide practical alternatives for each of these components, rather than solely identifying technical results. This report also includes the additional consideration that such alternatives will need to be reviewed and modified on a regular basis, especially as further hydrological information becomes available.

This report is categorized into the five sections mentioned above. The overall methodology used in developing the report was to initially establish a comprehensive scientific data base - using the study period of 2003-2015, adding to the previous City Raw Water Master Plan data base (1950 - 2002). Data from the previous Raw Water Management Plan was updated through 2015. Subsequently, the updated data base provided the necessary information to perform the other analyses described within this report. The other categories were identified and selected because of their importance in providing the City's staff the necessary information to proceed with its water resource project planning, budget development, city-wide water operations enhancements, and proposed water right acquisitions.

This report also provides practical City-wide alternatives to improve overall efficiency and maximize Louisville's annual water supplies. These comments are based on Resource Based International's ("RBI") past five years of administering the City's water rights and, during that time, recognizing and addressing operational constraints. This practical approach precluded the need to do City-wide operational modeling. This report does address areas of management that may require further modeling efforts, but these future efforts need to be strategic in purpose and address only a few operational scenarios rather than reexamine entire City-wide operations.

A new addition to the City's water resource planning is the evaluation of potential climate change impacts on the City's water rights and raw water operations. Climate change impacts were evaluated using the results of previous regional climate studies to project potential effects on Louisville's water operations and infrastructure. The purpose of the climate change evaluation was to: (1) focus on possible changes related to the City's water supplies and demands; (2) determine climate change effects on the City's current drought management strategies; and (3) adjust the City's long term water supply planning to adapt to climate change effects within the South Boulder Creek watershed.

The report concludes with a summary of the study's findings and a list of alternatives for continuing to optimize the City's water resources. RBI recommends updating or supplementing this report as needed based on further information.

LOUISVILLE'S WATER SUPPLY SYSTEM OPERATIONS

The City of Louisville's water supply system is supplied with diversions from South Boulder Creek through two diversion structures: the Louisville Pipeline and the Community Ditch. South Boulder Creek diversions can be conveyed directly to the City's water treatment plants - Sid Copeland Water Treatment Plant ("SCWTP") and the Howard Berry Water Treatment Plant ("HBWTP") – or stored for later use in the City's storage facilities. The City's water system is supplemented with deliveries of water from the Colorado Big Thompson Project via a pipeline to the SCWTP. Future deliveries from the Windy Gap Firming Project will also supplement the City's water supply. A map of the City's water supply is attached as Figure 1.

The following discussion provides a background description of the City's raw water supply systems/ operations and identifies the existing constraints within the system.

Water Supplies

South Boulder Creek Water Rights

Diversions

Louisville has forty-four combined direct flow and storage water rights, from thirteen ditch companies that are administered on a daily basis on South Boulder Creek. The majority of Louisville's water rights are direct flow rights that are available only during the irrigation season (April through October) and can be used for direct use at the treatment plants, or stored in Harper, Louisville, or Marshall Reservoirs. Louisville also has storage water rights, which are available only in the non-irrigation season (November – March), that are typically diverted at the Louisville Pipeline and stored in Louisville or Harper Reservoirs until the following spring. To the extent possible, Louisville historically stored this water prior to delivery to the treatments plants to obtain the highest possible level of water quality.

Water rights are administered on hydrological and legal considerations by the State of Colorado and are allocated pursuant to the Prior Appropriation Doctrine: first in time, first in use. Water rights are characterized as having "senior" to "junior" status; in times of water shortage, senior rights are allowed to divert their full entitlement water before any junior rights are allowed to divert. The City operates its water rights on a daily basis depending on: (1) water availability in South Boulder Creek; (2) legal and administrative constraints associated with each right; (3) delivery rate limits related to pipelines and treatment capacities; and (4) daily City water demands. The City's most senior rights are available in all years, whereas the junior rights typically are available in only average to above average runoff years (Table 1). Operations and diversions are also determined by the City's daily municipal water demands and the delivery system capacities of the treatment plants.

Table 1
Summary of Louisville's Direct Flow Water Rights

	NAME	CASE	PRIORITY			START DATE		END DATE	
			MON	DAY	YR	MO	DAY	MON	DAY
Senior Rights	HOWARD DIVERSION	(W-8500-77)	4	1	1850	4	1	10	31
	HOWARD CU	(W-8500-77)	4	1	1860	4	1	10	31
	HOWARD CU 2	99CW230	4	1	1860	4	1	10	31
	HOWARD .65	(21299)	4	1	1860	4	2	10	30
	HOWARD	(10904 & 12698)	4	1	1860	4	1	10	31
	McGINN DITCH	87-CW-327	5	1	1860	4	1	10	31
	EAST BOULDER	(82CW305)	4	1	1862	4	1	10	31
	COTTONWOOD #2	(W-9193-78)	4	15	1863	5	1	8	31
	COTTONWOOD No. 2	99CW230	4	15	1863	5	1	8	31
Mixed Rights	DRY CREEK DAVIDSON	(12698)	5	1	1863	4	1	10	31
	DRY CREEK #2	(21299)	5	1	1864	4	2	10	30
	DRY CREEK NO. 2	(W-8500-77)	5	1	1864	4	15	10	1
	DRY CREEK No. 2 CU	99CW230	5	1	1864	4	15	10	1
	ENTERPRISE	(21299)	2	1	1865	4	2	10	30
	ENTERPRISE	(82-CW-305)	2	1	1865	4	15	9	15
	LEYNER COTTONWOOD S	87-CW-327	4	1	1865	4	15	9	15
	McGINN DITCH	87-CW-327	6	1	1865	4	25	8	31
	MARSHALLVILLE DITCH	87-CW-327	6	1	1865	4	25	8	31
	LEYNER COTTONWOOD M	87-CW-327	4	1	1866	4	15	9	15
	LEYNER COTTONWOOD J	87-CW-327	10	1	1870	4	11	9	24
Junior Rights	DAVIDSON DITCH	(83-CW-319)	4	15	1872	4	25	8	31
	S BOULDER & COAL CREEK	(21299)	6	1	1872	4	2	10	30
	S.B.C.C. (DIRECT)		6	1	1872	5	1	8	31
	GOODHUE DITCH	(83-CW-319)	5	1	1873	4	25	8	31
	MARSHALLVILLE DITCH	87-CW-327	6	30	1878	5	15	7	12
	COMMUNITY DIRECT		6	6	1885	5	1	7	25
	LOUIS. PIPELINE	(83CW318)	6	18	1983	11	1	10	31
	GOLF COURSE DIRECT	88-CW-172	9	20	1988	11	1	10	31

South Boulder Creek water rights are generally categorized into three groups: Marshall Lake shares; South Boulder and Coal Creek Ditch shares; and all other South Boulder Creek water rights

- *Marshall Lake Shares* – Marshall Lake is owned and operated by Farmers Reservoir and Irrigation Company ("FRICO"). FRICO diverts water from South Boulder Creek under a number of winter storage rights for the benefit of their shareholders. At the end of the winter storage season, FRICO allocates the water in storage at Marshall Lake to its shareholders. The City receives a pro-rata portion of the allocation which becomes available for use in the City's water system. The primary Marshall Lake storage rights are senior to all other winter storage rights on the South Platte.

  The Marshall Lake summer direct flow rights are generally available to divert during May 15 - July 15. Marshall Lake direct flow rights yield water to the City in average to above average streamflow years. As a result, these direct rights do not contribute to dry-year supplies ("firm yield") unless they were stored the previous year.

- *South Boulder and Coal Creek Ditch Shares ("SBCC")* - The SBCC ditch originally had its own headgate on South Boulder Creek. In 1940, after a flood, the ditch company legally changed the

point of diversion location downstream to the Community Ditch. Accordingly, the South Boulder and Coal Creek Ditch currently delivers water diverted, pursuant to its decrees, to company's shareholders via the Community Ditch and through Marshall Lake. Louisville is the majority owner of SBCC shares which consist of direct flow and storage rights.

- *Other South Boulder Creek Water* ("Other SBC") - All other water diverted from South Boulder Creek that is not associated with the Marshall Lake or SBCC shares is referred to Other South Boulder Creek Water. When this water is diverted through FRICO facilities, Community Ditch and Marshall Lake, it is referred to as Foreign Water. Other SBC water is comprised of both direct flow and storage water rights. The direct flow rights were originally irrigation rights but have subsequently been acquired and transferred through water court by the City for municipal use. This category of water rights constitutes 36 of the 44 South Boulder Creek water rights owned by Louisville. These supplies include a range of senior to junior water rights, with the majority of the rights available during May-June each year. All of these rights are decreed for diversion at the Community Ditch, the Louisville Pipeline, or both.

Return Flow Obligations

Many of the transferred water rights (from agricultural to municipal use) purchased by the City have two components: consumptive use credits and return flow obligations. The consumptive use credit is that portion of the water right that was historically consumed by the crop; the return flow obligation is that portion that represents surface and groundwater runoff resulting from historical irrigation practices. The City is entitled to use its entire share of consumptive use credits but must replace the return flow component back to stream system.

Return flow obligations usually represent about 20-25% of the water diverted from South Boulder Creek with some variability based on individual water rights. Some water rights have a higher percentage than others while many of the older water right transfer cases decreed by the City did not have any return flow component. Further, return flow obligations are separated into surface return flows and groundwater return flows. Surface return flows are returned to South Boulder Creek at the time the specific water right is diverted; groundwater return flows are lagged to simulate the historical groundwater travel time to reach the creek. Lagged groundwater return flow obligations are returned as specified in the various water right decrees.

City Reuse Potential

Only Marshall Lake shares and SBCC rights can be utilized by the City for reuse under current conditions; these rights have specified reuse terms in their decrees allowing the City to 'recycle' the water and send it to the City's reuse water system. This water is defined as reusable water and these "credits" are available to the City for other uses, including replacing return flow obligations discharged from the wastewater treatment plant. All other South Boulder Creek water rights with potential return flow credits require future water court action for reuse approval. Windy Gap Firming water, outlined below, will also be reusable within the City's system once available.

A prior analysis was performed by RBI to determine the of amount reuse water that was available during a study period of 2004-2014. The results indicated that Louisville annually averages approximately 1,100 acre-feet ("AF") of reusable water. Historically, replacing the required daily return flow requirements was the first priority for which this reusable water was used.

The second use of reusable credits is supplemental irrigation supplies at the Coal Creek Golf Course ("golf course") and the City parks. Historically, when excess reusable water was available, the golf course and parks received deliveries from July-October.

Study results indicate that while there are sufficient reusable water supplies in average and above average years for use in the City, reusable supplies are available in amounts only sufficient to meet return flow obligations after the first year of a drought. During the second year of a drought, the City's return flow obligations dominate the use of the reusable water. As the City seeks to refill Marshall Reservoir as expediently as possible, increased diversions magnify the return flow obligations that are typically spread over the entire diversion season. As a result of these increased return flow obligations incurred while filling Marshall Reservoir, no reuse water is available to supply water for any other uses. Further, because reuse supplies and return flow obligations are essentially the same during droughts, reuse water does not contribute to the City's firm yield supplies.

Colorado – Big Thompson Units (C-BT)

A significant supplemental supply source for the City is C-BT units that are derived from the Northern Colorado Water Conservancy District ("NCWCD") storage and delivery system. The C-BT system collects water from the Colorado River headwaters, on the West Slope, and diverts it through a series of tunnels to the Eastern Slope. C-BT water (and future Windy Gap water) is then delivered to the City via the Southern Water Supply Project ("SWSP") pipeline. C-BT units have been considered a primary option for meeting future demands and local drought protection (C-BT's source of supply is located on the west slope). Purchase and use of C-BT units are not subject to the usually required water court transaction associated with South Boulder Creek rights. C-BT units are legally available for municipal use at the time of purchase, thereby making these units a viable water source for the future. Louisville owns 2,067 C-BT units which yield an average of 0.70 AF/unit of water annually. C-BT units are comprised of "one-time" use water only, and therefore, cannot be reused within the City's system.

Windy Gap Firming Project (Windy Gap Firming)

The Windy Gap Firming Project is an ongoing project of the Northern Water Municipal Subdistrict to divert and store west slope water supplies in the yet-to-be-built eastern slope storage - Chimney Hollow Reservoir.

Windy Gap Firming Project supplies have also been considered a viable water source for the same reasons as C-BT units. However, for planning purposes, Windy Gap Firming water has been considered drought protection rather than an average year water supply, based on costs and operations. Windy Gap Firming water rights are subject to transaction constraints similar to C-BT units. Further, Windy Gap Firming's west slope rights are junior and can be diverted to east slope reservoirs only during times of water and storage availability on the west slope. As a result, and until such time Chimney Hollow Reservoir is constructed, the junior priority of the Windy Gap Firming water rights does not provide a significant benefit to the City (Louisville has not utilized Windy Gap water supplies).

Upon completion of the reservoir, the Windy Gap Firming Project will divert water from the West Slope in times of sufficient supply, store the water in the newly completed reservoir, and then release this water to the City in times of water shortage (dry years and droughts). Through Louisville's ownership of 9 units of Windy Gap water supplies, the City is entitled to 2,700 AF in Chimney Hollow Reservoir and the guaranteed firm water yield is anticipated to average 600 AF per year. Windy Gap Firming water is reusable, however acquisition costs are substantially higher than C-BT units.

Louisville Water Facilities

Water operations at the City of Louisville involve the following components: raw water diversions and deliveries to storage facilities, distributions to the treatment plants, reuse from the wastewater treatment plant, and deliveries to the golf course and parks to the extent water is available. This section describes each phase of the operations system.

Ditches and Pipelines

Louisville has three main conveyance structures from which the City obtains its raw water supplies: Community Ditch, Louisville Pipeline, and the Southern Water Supply Project pipeline. An ancillary structure is the Louisville Lateral, the predecessor to the Louisville Pipeline.

Community Ditch

The Community Ditch, the City's primary diversion structure on South Boulder Creek, is located near Eldorado Springs. The ditch diverts the both storage (winter) and direct flow (summer) water rights and has a maximum capacity of approximately at 250 cubic feet per second (cfs). The Community Ditch can be used to divert the City's Marshall Lake share water (direct flow and storage), the City's SBCC share water, and the City's Other SBC water.

The Community Ditch is owned and operated FRICO and Louisville is allowed to use the ditch pursuant to several FRICO/Louisville agreements, the latest signed in 1992. The City's diversions are coordinated on a daily basis with FRICO and water commissioner to divert the City's water entitlements.

Louisville Pipeline

The Louisville Pipeline also diverts from South Boulder Creek near Eldorado Springs and can deliver water to the SCWTP, Harper Reservoir, Louisville Reservoir, HBWTP, or Marshall Reservoir. It is owned solely by the City. The design capacity of the pipeline is 7.7 cfs, but recent diversions have been closer to 5.0 cfs. The Louisville Pipeline can be used to divert the City's Marshall Lake share water (direct flow and storage), the City's SBCC share water, and the City's Other SBC water.

Typically, the pipeline operates year round delivering direct flow water rights in the summer and Louisville Reservoir storage rights in the winter. Pursuant to the reservoir's storage decree, Louisville is allowed store up to 210 AF annually during dry years winter periods. Most of Louisville's senior water rights are entitled to divert at the Louisville pipeline and/or the Community Ditch. Therefore, especially during drought periods, the pipeline offers the City a primary diversion point that increases yield to the city at a rate up to 10 AF per day.

Additionally, Louisville has an agreement with the Town of Eldorado Springs that allows the Town to use a small portion of the pipeline capacity for its water rights' operations. This agreement does not impair Louisville's ability to fully utilize the capacity of the pipeline, but it does provide Eldorado Springs the required infrastructure to operate its water system in compliance with its water court decree.

SWSP Pipeline

The SWSP delivers C-BT/Windy Gap supplemental water directly to the SCWTP or to Louisville Reservoir. The pipeline's capacity is 4.2 cfs. In the summer months, the SWSP cannot fully meet the SCWTP demands, and therefore a combination of SWSP deliveries and diversions from the Louisville Pipeline, Harper Reservoir, or Marshall Lake releases are required.

Louisville Storage Facilities

The City has access to four reservoirs to store its raw water supplies: Marshall Lake, Harper Reservoir, Louisville Reservoir, and McKay Reservoir. Marshall Lake and McKay Reservoir are owned and operated by FRICO. Harper and Louisville Reservoirs are owned by the City. The following is a brief description of the operation for each storage facility and its role within the City-wide water storage system.

Marshall Lake

Marshall Lake is the primary storage facility for the City with a storage capacity of 9,655 AF; Louisville's pro-rata portion is approximately one-third of the total capacity. Use and operation of the reservoir is primarily shared between other FRICO shareholders (irrigation use) and the City (municipal use). In addition to Marshall Lake share water, the City can store Other SBC Water (Foreign Water) in the reservoir. Louisville's use of Marshall Lake shares are subject to the terms of the 1992 FRICO/Louisville Agreement.

There are two basic operational scenarios related to City operations:

Scenario 1: Marshall Lake fills to full capacity in April-May

Scenario 2: Marshall Reservoir does not fill to capacity during the year

If the Marshall Lake fills to capacity, Other SBC Water/Foreign Water stored in the reservoir during the prior water year is "spilled" / booked over to make storage space available for Marshall Lake share water. Once the irrigation releases from the reservoir begin, usually in late-July, storage space becomes available in Marshall Lake. At that time, Louisville is then entitled to store its Other SBC/Foreign Water supplies in the "excess" storage space created by these irrigation releases from FRICO storage.

In those years that the reservoir does not fill during the preceding winter storage season, Louisville's prior water year Other SBC / Foreign Water does not spill and the City is typically able to store current water year Other SBC / Foreign Water in Marshall Lake's excess space beginning in April. Factors that determine whether Marshall Lake fills each year is a function of the previous year's carry-over in the reservoir, winter snowpack, and springtime runoff flows in South Boulder Creek. Releases from Louisville's account in Marshall Lake supply the HBWTP demands; Marshall Reservoir can also deliver water to the SCWTP and the golf course, but only through the Louisville Lateral.

Harper Reservoir

Harper Reservoir is a secondary storage site for Louisville and has a capacity of approximately 750 AF. Harper Reservoir is supplied by the Louisville Pipeline or Louisville Lateral. Water delivered from Harper Reservoir can be stored in Louisville Reservoir or used directly at the SCWTP.

Louisville Reservoir

Louisville Reservoir is operated as a "forebay" to the North Plant. Its purpose is to supply water directly to the SCWTP, which is located adjacent to the reservoir. The reservoir has a capacity of 210 AF and is rarely lowered below 190 AF. Water deliveries to the reservoir are made through the Louisville Lateral, the Louisville Pipeline, or the SWSP Pipeline.

McKay Reservoir

McKay Reservoir is located in the Big Dry Creek basin outside of the City's water delivery system and, therefore, does not directly contribute to City's raw water supply. Instead, McKay Reservoir can be used to fulfill certain legal requirements associated with the City's Marshall Lake Division's direct and storage rights. As a result, McKay Reservoir serves a solely administrative function for the City. However, recent court cases involving Marshall shares from the Big Dry Creek basin have required return flow obligations to be released to the Big Dry basin to maintain the historical flow patterns of the creek. City water stored in McKay Reservoir can potentially be released to fulfill these obligations. Further, it is anticipated that future Marshall Lake shares acquired by the City - or any other municipality - and transferred to municipal use will have similar return flow obligations to Big Dry Creek. As a result, the future use of McKay Reservoir is expected to integrate more fully into the City-wide operations and have an increasing level of use to meet Louisville's Big Dry Creek return flow obligations.

System Constraints

In Louisville's collection and distribution system, not all available water supplies can be utilized at their maximum levels due to constraints involving pipeline capacity, storage capacity, timing of available supplies, and timing of City's daily municipal demand. As a result, water supplies have historically been diverted at lower rates than the City's maximum legal entitlement because of these constraints.

Many of the constraints listed below occur in only extreme conditions: drought or high flows. However, many other constraints are chronic issues that occur irrelevant of the annual streamflow or supply source. While these constraints are limiting factors affecting the City's water supply system and subsequent delivery to the treatment plants or reservoirs, modifications to specific system operations can be made to address these constraints and minimize their effects.

Three issues are directly or indirectly related to the potential use of the Louisville pipeline: pipeline capacity, timely head gate operations, and a lack of available City storage during April 15 - July 15.

Constraint No. 1 – Louisville Pipeline

The Louisville pipeline has a design capacity of 7.7 cfs, but typically operates in the range of 2.0 - 5.0 cfs to ensure pipe pressures do not stress the system. Throughout the study period, South Boulder Creek

records indicate that streamflows in excess of the pipeline flow capacity were available at various times to divert at the pipeline. Consequently, the records consistently demonstrate that water which could have been diverted to the City's treatment plants and reservoirs, was instead bypassed at the intake on South Boulder Creek. For example, in 2014-2015, 82 AF of water was not diverted at the pipeline at times that demand and/or storage was available but pipeline capacity was limited.

Lack of timely head gate operations also limits the use of the pipeline. Daily water rights administration can dramatically change during the summer months due to rainstorms. Subsequent storm water runoff becomes available at the pipeline for short periods of time (1-3 days) as the storm surge moves downstream. However, time constraints related to shifting manpower duties, required travel distance to the pipeline headgate, and daily (even hourly) communication requirements between staff members cause much of this available storm water to bypass the pipeline intake before the adjustments can be completed. Historically, on average, 155-180 AF per year has not been diverted due to operational constraints. However, it is anticipated that recent (2016) repairs and projected improvements at the pipeline intake will address the majority of these operational issues of the past.

Constraint No. 2 – System-Wide Storage Capacity

Storage space is a limiting constraint to optimize water yields from Louisville's water rights portfolio. At times during the study period, Louisville had more water yield than available space to store it. For example, on years that Marshall Lake fills to capacity (63% of the time), an average of 680 AF of foreign water stored in Marshall Lake the previous year by Louisville is "spilled" from the reservoir - pursuant to the FRICO/Louisville Agreement - to make space for water diverted under FRICO's Marshall Lake Division storage rights. (This water is not physically spilled from the reservoir but rather "booked" from the Louisville account over to the FRICO account in Marshall Reservoir.) When Marshall Reservoir spills occur, up to approximately 33% of this water is lost from Louisville's system and cannot be recaptured by the City. The remaining 66% amount is redistributed to the City through its ownership of its Marshall Division shares.

Some water rights were not diverted during many years of the study period due to lack of existing daily demand levels and/or storage space. This was anticipated in Louisville's earlier Raw Water Management Plans with the understanding that many of the rights would be primarily used for the following purposes:

- Drought protection, and thus not diverted during average years;
- Refill of the City's storage facilities following a drought;
- Meeting the City's future demands up to build-out levels.

Storage limitations also have a significant impact on South Boulder Creek diversions. At certain times during the year (April-July) in which Louisville is entitled to divert, the system-wide storage capacity often has no excess capacity to store potential diversions. As a result, the only option is to bypass the flow at the Community Ditch headgate and/or the Louisville Pipeline intake. On average, system-wide storage constraints decrease diversions at the pipeline by 300 AF per year.

Constraint No. 3 – SWSP Pipeline Capacity

C-BT water deliveries to the City from the SWSP are currently limited to a 4.2 cfs flow rate because of pipeline capacity limitations (Louisville has the ability to increase the pipeline capacity to 7.2 cfs ,

effectively improving the City's firm yield during droughts). While the 4.2 cfs flow rate is adequate for wintertime deliveries, the SCWTP summertime demands exceed this flow rate. Therefore, historically during the summer months, C-BT units have been considered supplemental supplies for use at the SCWTP. The reasons for this were two-fold: (1) South Boulder Creek supplies are less expensive to deliver to the treatment plants (gravity flow); and (2) flow restrictions associated with the SWSP. These restrictions preclude higher C-BT delivery rates during summer peak demands and prolonged drought periods, resulting in larger releases from Marshall, Harper, or Louisville Reservoir. These releases from the City's storage facilities may cause implementation of Louisville's Drought Plan, despite adequate stored C-BT's supplies within the NCWCD system.

Because of operational costs (pumping costs and annual assessments) it is more economical for the City to use its C-BT annual allocations prior to any use of Windy Gap Firming diversions. Because the City has sufficient C-BT water supply in average runoff years, Windy Gap Firming water would be used during only drought periods. However, until the Windy Gap Firming Project is completed with east slope storage, the water supply is not considered a viable water supply source in dry year periods.

Additionally, the lack of capacity in the SWSP also limits the City's ability to deliver Windy Gap Firming water. Firm yield analysis results show that for Louisville to reach the maximum firm yield levels with its current water supplies, C-BT and Windy Gap Firming supplies need to be diverted simultaneously to the SCWTP.

Constraint No. 4 – Louisville Lateral

Use of the Louisville Lateral was limited during the study period due to conveyance and maintenance issues related to the structure. Only two short-term releases were made from Marshall Lake to the lateral in 2007 and 2008. Therefore, it's generally recognized that during the study period there was no demand for the lateral's use - given that the SCWTP demands were met through the Louisville Pipeline.

Expected future use of the Lateral is related to the SCWTP water deliveries at times when demands exceed the Louisville Pipeline capacity. At such times preserving C-BT water sources is possible and desirable, the lateral could be operated simultaneously with the pipeline to maximize South Boulder Creek water deliveries to: (1) Louisville Reservoir for later diversion into the SCWTP; or (2) Harper Reservoir for subsequent delivery to Louisville Reservoir.

Constraint No. 5 - South Boulder Creek's Instream Flow

The Colorado Water Conservation Board ("CWCB") filed an instream flow water right below the reach of South Boulder Creek from which Louisville diverts at the Community Ditch and the Louisville Pipeline. The purpose of the instream flow right is to protect the fishery and riparian habitat from low streamflow conditions. The filing was made in December, 1980 for 15 cfs minimum flow rate in the summer and 2 cfs in the winter. For a variety of legal reasons specific to in stream flow rights, the CWCB water right is administered as a "senior" right to approximately 82% of Louisville's South Boulder Creek water rights. Therefore, at times the instream flow water right is the calling right on South Boulder, Louisville must curtail a majority of its diversions.

DATA COLLECTION AND HISTORICAL TRENDS

Previous water planning reports conducted for the City utilized sophisticated computer modeling techniques to assess current and future water operations. RBI used the results of these modeling efforts, extended the previous master plan database, and then combined them with the practical experience of operating Louisville's water rights system to provide: (1) a description of the ongoing management practices; and (2) changes to the current system and evaluate future operation alternatives.

Period of Record

The study period for this report's data base was 2004-2015. The data base included available information related the City's water demands and supplies during these specific years. Once developed, the 2004-2015 data based was integrated with the 2003 Raw Water Master Plan's data base to create a continuum of data through 2015. The City's "water supply" was calculated using the historical daily, monthly, and annual amounts of water diverted and stored. Conversely, treatment plant records, golf course irrigation use, and other reuse needs comprised the City's overall "water demand" amounts.

The period of record also reflects conservation measures implemented by the City, recent system-wide improvements, and all additional water right acquisitions since 2003.

Diversion Records

Diversion records were obtained from the City's historical monthly and annual accounting reports submitted during the study periods to the following agencies: (1) the State Engineer's office; (2) FRICO; and 3) South Boulder – Coal Creek Ditch Company. Data for years 2000-2003 were derived from the Louisville's 2003 Raw Water Master Plan. Additionally, the City's internal accounting software records were used to supplement missing data. If there was discrepancy between the various data bases, the lowest and most conservative recorded values were used in the analysis. Total diversions from the City's various water supply sources are listed in the table below for each month of the study period.

Table 2
City Louisville Historical Water Diversions
(acre-feet)

Water Year	Marshall Storage	Marshall Directs	Other SBC Water	C-BT	Windy Gap	Total
2000	1746	1022	2973	---	0	5741
2001	1940	6938	4514	521	0	13913
2002	645	0	2222	722	0	3589
2003	1179	1309	1422	256	0	4166
2004	1129	1660	1790	0	0	4579
2005	1613	1205	1998	30	0	4846
2006	968	2106	2008	66	0	5148
2007	1613	1317	1640	21	0	4591
2008	968	2190	2153	0	0	5311
2009	1779	280	1725	28	0	3812
2010	1779	1379	1050	80	0	4288
2011	1456	1658	1289	160	0	4563
2012	1203	0	2229	991	0	4423
2013	1492	742	1778	967	0	4979
2014	1497	1809	3880	637	0	7823
2015	1520	3501	1858	1031	0	7910
Ave	1408	1695	2158	367	0	5605

Note: Other SBC Water is referred to as Foreign Water when diverted in FRICO's facilities

The results indicate that diversions during the 2000-2015 study period are consistent with the trends reported in the earlier master plan reports (1992, 1998, and 2003), including the typical annual variations reflected in South Boulder Creek diversions and C-BT allocations. No significant changes from previous reports (and study periods) were identified during this study period.

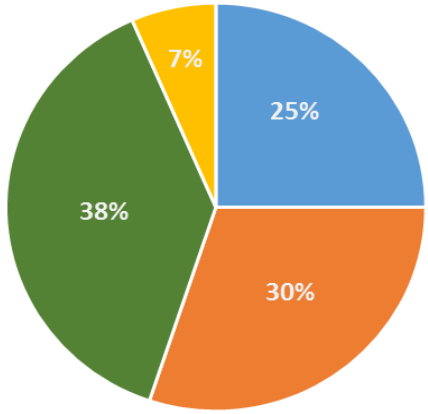
For future consideration, it is not anticipated that hydrological conditions will change significantly in the short term, but long term, climate change impacts may alter historical flow conditions – most notably in the timing of the runoff season.

Nevertheless, this historical trend analysis provided the baseline data to investigate the City's current water supplies (yields) and the foundation to assess existing and future city-wide operations.

Average Distribution of Supplies

The average annual allocation of supplies from each of the City's water sources during the 2000-2014 study period is illustrated in Figure 2.

Figure 2
Allocation of Raw Water Supplies



Precentages based on 2000-2015 average historical water diversions

Marshall Storage Marshall Directs Other SBC Water C-BT

Historical Demands

Total treatment plant production at the HBWTP and SCWTP was summarized to develop a baseline monthly and annual demand for raw water during the study period. Production numbers varied widely and the historical data reflected conservation measures implemented by the City in times of supply shortages. Annual demands are shown in Table 2.

Table 3
City of Louisville Raw Water Demands
(acre-feet)

Month	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Total
2000	247	205	197	188	220	326	602	749	792	738	554	308	5126
2001	192	202	210	178	206	247	443	716	776	721	575	354	4820
2002	215	197	196	187	213	369	453	387	448	393	318	225	3601
2003	153	169	172	154	153	168	347	478	701	627	408	345	3875
2004	162	163	175	163	188	186	390	446	479	457	412	220	3441
2005	163	170	175	149	171	195	353	496	731	582	522	241	3948
2006	191	174	174	166	175	303	574	702	643	618	442	257	4419
2007	157	174	176	157	182	200	376	623	743	632	509	296	4225
2008	173	166	170	164	174	210	410	591	797	665	443	252	4215
2009	179	175	179	161	193	192	383	388	550	585	512	216	3713
2010	167	175	170	170	158	185	301	497	577	591	535	308	3834
2011	171	184	180	164	179	226	345	546	550	655	493	304	3997
2012	158	173	169	155	196	309	493	672	649	672	491	233	4370
2013	177	181	181	151	162	158	311	590	649	592	344	189	3685
2014	159	163	168	150	171	203	353	544	617	530	377	234	3669
2015	155	169	166	143	163	207	234	375	481	606	563	409	3671
Ave	176	177	179	163	181	230	398	550	636	604	469	274	4038

Note: The Coal Creek Golf Course average annual total demand is an additional 210 AF.

DROUGHT MANAGEMENT PLANNING

Design Drought Determination

Previous raw water master plans included an analysis of historical flow records on South Boulder Creek to identify past droughts with respect to duration, severity, and frequency of re-occurrence. The purpose of the analysis was to determine the type of drought ("design drought") for which Louisville should use for planning and management strategies. From the design-drought analysis, the City's water supplies and demands are compared to identify any water shortages. The amount of Louisville's water supply during all years including a drought is commonly referred to as "firm yield" which is generally derived from the City's more senior water rights. In previous water planning reports, the 24-month period from March-1963 to February-1965 was selected as the "design-drought" for the City's future water supply planning.

These previous design drought analyses were reexamined for accuracy and to assess the feasibility of replacing the previous 1963-1965 design-drought with a more predictive period. The 2003 Raw Water Master Plan's hydrological records were updated through 2015 and then used to determine the need for a new design-drought. The result of this re-examination was that the criteria for using the 1963-1965 drought period continues to be applicable and provide the most representative design period for City-wide drought planning.

To project drought impacts to the City, the 1960's drought represents the unique set of circumstances and factors that most significantly affect the City's raw water supply. The 2002 drought is the most significant drought year during the study period, but the one year duration allowed City-wide storage to substantially refill in 2003. Further, while the drought of 1952-1957 was more severe in terms of low streamflow records on South Boulder Creek, using the 1960's drought-design period produces more significant drawdown in storage, and consequently, has a higher level of impact on developing and implementing drought management actions.

Therefore, in the case of Louisville, categorizing drought events only by its associated reoccurrence level (example: 1-in-50 years) has been determined to be inappropriate. A more important parameter with selection the proper design drought is the duration of the drought and its impacts on storage levels. The duration is an important because: (1) extended droughts generally do not occur frequently enough to justify the expense to protect against them in the future; (2) extended droughts are generally less severe in any given year but occur for longer periods, and (3) short-term (18 months or less) droughts do not fully impact City-wide storage for long periods and therefore have much less significant impacts on water operations. For Louisville, the 2-year duration of the 1960's design-drought was selected because of its critical impacts on City storage levels.

The key factor in assessing drought actions for Louisville is associated with the drawdown of City-wide storage levels during the first two years of the drought. The City currently has a two-year storage buffer available for the design-drought periods. During the first year of the design drought, water storage levels are drawn below average end-of-water year (November 15th) recorded levels. During the second year, the City is reliant on its carry-over from the previous year and the firm yield amount of water supplied in the second year. If the storage drawdown rate is significantly higher than previous (typical) years during the first year of the drought, then the City must rely on its firm yield water supplies and,

simultaneously, implement management strategies to address drought conditions and reduce City-wide water demands throughout the second year.

For these reasons, the design drought for this analysis was selected as the 2-year, 1963-1965 hydrological period on South Boulder Creek. The results from this analysis indicate that the City has a firm yield approximately 6,500 AF annually. Firm yield sources include senior South Boulder Creek water rights, City-wide winter storage, Colorado-Big Thompson and Windy Gap Firming water supplies.

Implementing Drought Management Restrictions

A critical component to properly manage the City's water resources during drought periods is to identify the appropriate time to implement the Drought Plan. Implementing the drought plan too early results in supplies exceeding demands, negating the need for outdoor water restrictions. Contrarily, implementing restrictions too slowly results in drawing City-wide storage levels significantly below average, causing the City to reduce its carry-over supplies for subsequent use if drought conditions continue.

The time of year in which drought management restriction are determined will depend on a variety of hydrological factors: winter snowpack within the South Boulder Creek, projected C-BT's west slope deliveries, Marshall Lake carry-over storage supplies, and the City's March-April water usage. At times snowpack levels are significantly below-average within the South Boulder Creek drainage (e.g. 2002), it is reasonable to anticipate water restrictions during April-October. However, at times when snowpack levels are only marginally below average, timing the drought management actions becomes more difficult. Historically, during times of low spring snowpack within the basin, the City relied more heavily and earlier on C-BT supplies prior to implementing outdoor watering restrictions. By doing so, the City prevented the need to impose drought restrictions too early in the summer irrigation season, but risked the need to implement the same restrictions later in the summer (July-August) or the following spring.

Outdoor watering restrictions need to be consistently implemented only at times they are determined to be season-long actions (as a minimum). Public perception is important to obtain compliance with watering restrictions, and inconsistency and/or "false alarms" associated with the timing of watering restrictions erodes public confidence and compliance with the City's drought rules and management. Generally, a high level of consistency can be achieved by assessing the City's water supplies by May 1 (or earlier) of each year. For example, during the first year of the design-drought period used in this study, watering restrictions would be unlikely. However, by May 1 of the second drought year, indicators (snowpack/runoff predictions, Marshall Lake carry-over storage, recorded City demands, and projected C-BT deliveries) are anticipated to indicate the need and level of watering restrictions to match estimated water supplies.

CLIMATE CHANGE

Climate Change Modeling Review

RBI has reviewed climate change modeling results that apply to the South Boulder Creek, Boulder Creek, and the South Platte River to assess potential long term impacts on the regional hydrology, water rights

administration, and city water operations. Because of the wide variations and uncertainty in the modeling results, only general conclusions are offered below. As Louisville proceeds with future water resource management planning and as additional modeling results become refined, it is recommended that the City review these findings and make appropriated modifications as necessary.

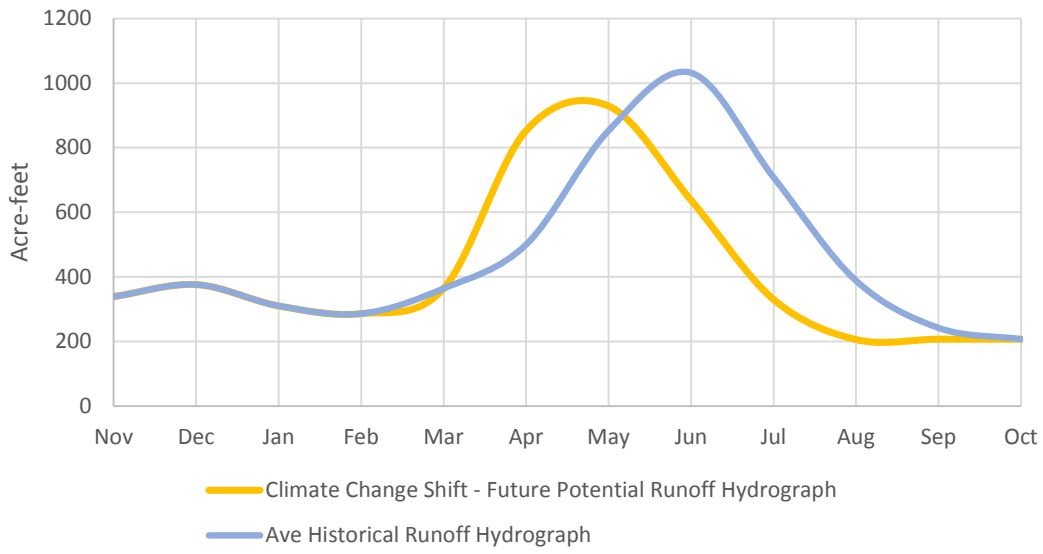
Predicted Result – No. 1: Hydrology

The consensus of the models reviewed (Colorado Water Conservation Board, Boulder Climate Change Study (2009)), Joint Front Range Climate Change Vulnerability Study (2012), Colorado State University Technical Report 12-203(a) indicates the following:

- The runoff period on South Boulder Creek will gradually shift 20-45 days earlier from May 20 – June 22 to April 20 – May 22

Figure 3

Potential Runoff Timing Shift



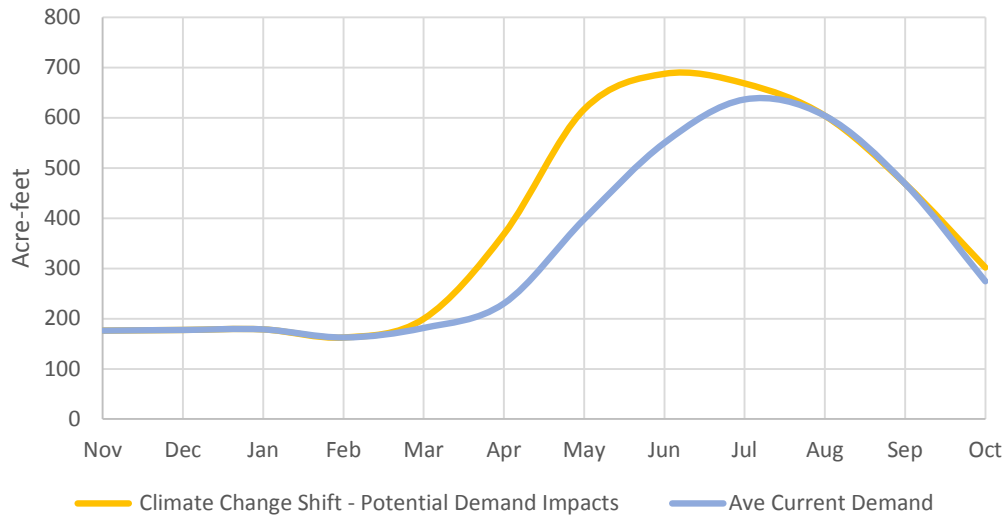
Other climate change assumptions to also be considered with runoff shift effects:

- Winter precipitation will increase 10-20%; summer precipitation will decrease 5-15%
- Annual runoff and stream flow volumes will be reduced up to 10%
- Late summer stream flows will decrease 8-10 %
- Extreme climate conditions (droughts and floods) will increase in frequency and duration.

Predicted Result – No. 2: Water Demands

- City demands will shift from April – September to March – October

Figure 4
Potential City Demand Shift



Other climate change assumptions to also be considered with potential City demand shift effects:

- Annual irrigation demand volumes are projected to increase 5-15% without City imposed limitations
- Daily temperature increases will also increase daily evaporative reservoir losses at Marshall, Harper, McKay and Louisville Reservoirs, decreasing the potential annual yield released from each.

Predicted Result – No. 3: Operational Changes

- Marshall Reservoir will fill to capacity less frequently
- Junior water rights (foreign water) will be diverted more frequently in March and April
- Total peak runoff diversions will decrease
- Post-peak junior diversions will increase
- Senior rights will be used in June-October period rather than July- September
- Decreed monthly and annual volumetric limits will be reached more frequently for all of Louisville water rights, but most notably for the City's senior water rights
- Higher evaporative loses from the City's reservoirs.

Predicted Result - No. 4: Colorado River Compact

- More frequent and longer droughts are anticipated to reduce flows within the Colorado River basin
- River flows are reduced over time, and the associated storage levels within the basin are reduced to prolonged drought

- The likelihood of a Colorado River Compact call being placed on the Colorado River increases from "unlikely" to "possible" (some models show "probable").
- A compact call will reduce or eliminate delivers from C-BT and Windy Gap water supplies
- Specific impacts to the Louisville's water supplies based on a Colorado River call would require specific system wide modeling for the City's delivery system.

Watershed Protection

- Increased wildfire danger - increase frequency and duration
- Increased runoff due to extreme thunderstorm events
- Increased flash-flooding - local tributary capacities exceeded (Dowdy Hollow).

ALTERNATIVES

The City has adopted many of the recommendations provided in the 2003 Raw Water Management Plan. Consequently, an updated evaluation of the raw water supply system now includes these previous recommendations, and as result, the current baseline has been established against which to compare other future alternatives.

Current Water Supply and Demand

Louisville's average annual demand currently is 4,250 af/year. The City's firm yield is also currently estimated at 5,000 af/year. This is based on data for water treatment plant deliveries (demand) and the historical South Boulder Creek diversions and SWSP deliveries to SCWTP (supply). Therefore, based on the current level of demand, the City has sufficient supplies to meet average demands without imposing watering restrictions.

However, it is anticipated that future demands will increase; at time of this report the City's build-out demand is somewhat uncertain. RBI was provided three likely demand levels at the time the City's build-out occurs:

- 6,100 AF per year – (estimate provided by Louisville's Water Efficiency Plan)
- 6,500 AF per year – (estimate provided by the draft Drought Management Plan)
- 7,120 AF per year (this estimated demand at build-out listed in the 2003 Raw Water Master Plan Report 2003).

For each of these build-out demand levels, the difference between build-out demand and current water supply systems was analyzed to determine:

- The amount of water supply shortfall based on the future firm yield estimates
- The adequacy of current drought management practices to address these shortfalls
- List alternative actions the City may consider reducing overall City demand during drought periods
- List alternative actions the City may consider increasing its water rights portfolio and drought water supplies.

The results of this particular analysis are provided below. Costs for the alternatives are estimated, although the water markets' volatility in northern Colorado is a consideration for any future water acquisition.

No Action

Most City-wide planning documents include a "No Action" alternative addressing the current situation and impacts in the future. For this report, the recommendations listed in the 2003 Raw Water Management Report adopted or to be adopted by the City are included in the No Action alternative (e.g. load shifting, obtain Windy Gap Firming supplies, and increase in SWSP capacity).

The No Action alternative is used to quantify the impact of using only the current City's supply system to meet future projected demands. No Action, however, does not imply that the City will not decide to improve/repair/construct its water supply infrastructure, discontinue its water leasing to other local users, or make other management decisions that will improve the efficiency of the raw water supply system.

However, No Action does accurately reflect Louisville's current water and storage supplies, and consequently, the City's sole reliance on the existing firm yield water supply during future droughts. Consequently, as build-out demands approach and potential shortfalls occur, City management may need to invoke drought management strategies earlier and more frequently if not combined with other alter-natives.

The components of the No Action alternative are listed below:

Firm Yield	(AF/yr)
Current:	5,000
Current with No Action Alternative	6,500
Demand	
Current (ave)	4,250
Build-out Scenario No. 1	6,100
Build-out Scenario No. 2	6,500
Build-out Scenario No. 3	7,120

The analysis shows that the City has sufficient water supplies to meet its near-term demands. In the future, at the three build-out demand levels, the City must implement load-shifting from the HBWTP to SCWTP , enlarge the SWSP pipeline to SCWTP (to 7.2 cfs), and utilize water conservation measures to ensure that demands do not exceed firm yield supplies. Load-shifting and a larger pipeline increases the yield to 6,500 AF per year, which meets two lesser demand scenarios. Therefore, build-out #2 scenario was selected as the "Baseline Demand" to assess the City's need to acquire additional water supplies and/or storage. If future build-out demands are less than the "Baseline Demand", future water and/or storage acquisitions may not be necessary. Conversely, to meet the build-out #3 (7,120 AF) scenario, a water acquisition plan would need to be added to the no action alternative. Additionally, in the build-out #3 scenario, load-shifting, water conservation, and watering restrictions (10-15% reduction) may be implemented to lower City-wide demands to firm yield water supply levels.

Additional Storage

The acquisition of additional storage can be achieved two ways: (1) Marshall Lake Division shares; and 2) build or acquire additional storage space. Marshall Lake Division water includes direct and storage water rights based on the City's pro rata ownership in the division. Therefore, storage in Marshall Lake is included with every purchased share. In past City water reports, acquired or constructed storage space was considered prohibitively expensive. However, while costs remain relatively expensive, alternatives exist that warrant further consideration:

Enlargement of Gross Reservoir: Add one-foot of elevation to the dam height and create an 800-1,000 AF "excess" pool. The estimated cost is $ 4-8 million. Cooperation with Denver Water, City of Boulder, and City of Lafayette would be an integral part of obtaining approval for such additional storage space in Gross Reservoir. Modifications to the reservoir inlet are also anticipated.

Enlargement of Marshall Lake: Previous reviews conducted by the City indicated that increasing Marshall Lake may be problematic because of the resulting increased footprint of the reservoir area. Increasing the dam height may cause alluvial groundwater to build-up behind the dam to levels that would have detrimental effects to the adjacent landowners (landfill) and Highway 93. While further investigation is needed, these preliminary findings reduce the viability of this storage alternative.

Marshall Lake Forebay: Construct a 600 - 1,000 AF forebay storage facility adjacent to Marshall Lake for the purpose of diverting "spill water" and in-priority junior water rights from Marshall Lake to the forebay. The initial proposed site is south of the HBWTP, property presently owned by Boulder Open Space. The estimated cost is $12-$15 million.

Storage Partnerships with Surrounding Communities: Collaboratively investigate storage opportunities with entities such as District 6 water users and the Cities of Lafayette, Superior, Firestone and Erie. Periodic meetings with participants from each entity would be conducted to identify water needs (volumes, amounts, timing) and build the framework for a storage project within the South Boulder Creek/Boulder Creek/South Platte River drainages. Partnerships with Denver Water and the Cities of Boulder and Lafayette are anticipated to proceed with Louisville's potential ability to store water at Gross Reservoir.

Dredge Marshall Lake: RBI is not aware of any updated storage-capacity curves for Marshall Lake. Without an updated curves, water elevation levels may no longer accurately represent storage volumes in the reservoir. Therefore, preferably in collaboration with FRICO, updated Marshall Lake storage capacity curves need to be developed to assess the current storage volume. Once the curves are developed, the City and FRICO can assess the amount of dredging that is needed to maximize the marginal benefits versus the marginal costs. The estimated cost is $2 million for dredging.

Excess credit leasing/trade: Develop a leasing program or partnership program (water trade) to utilize excess reuse credits in non-drought years. The available reuse water would be used at times the City's water excess credit supplies exceeds its demands. The excess water could be leased to generate revenue or traded with other entities for use of CB-T units, additional South Boulder Creek water rights, or additional Marshall Lake shares. Terms and conditions of future leases will be contingent upon future water market demands.

C-BT/Windy Gap Conveyance to HBWTP

Load-shifting has proven to be a valuable management tool to maximize Louisville's water supplies, most notably C-BT and Windy Gap sources. However, load-shifting is only from the HBWTP to SCWTP to fully utilize C-BT and Windy Gap supplies especially during winter operations. Under the current water delivery system, no C-BT/Windy Firming Gap water can be diverted to the HBWTP.

Historically, Marshall Lake has been the primary source of water for the HBWTP. Using storage at Marshall Lake to meet the plant's demands rather than C-BT/Windy Gap Firming supplies has proven a cost-effective strategy (no pumping costs) and reserves C-BT/Windy Gap Firming water for later use at the SCWTP to carry the City through the design-drought.

However, recent events have illustrated the potential need for a C-BT/Windy Gap Firming conveyance to the HBWTP. Events such as the 2013 flood effectively eliminated the use of Marshall Lake due to high turbidity levels. Additionally, in 2015, repairs to the Community Ditch required closing the head gate during the middle of the summer, thereby eliminating any additional diversions into Marshall Lake. Further, diversion from the Louisville Pipeline to the HBWTP were curtailed by repairs in 2015, again impacting water yields at Marshall Lake. Also, ongoing water quality issues have hindered the use of Louisville Reservoir in late summer, thereby increasing the treatment demands at the HBWTP. Under all of these conditions, preserving Marshall Lake water shifted to a higher priority as a result of limited storage supplies.

As a result of these events, a potential option has developed for a conveyance facility to deliver water from SWSP to the HBWTP to address times when storage becomes limiting in Marshall Reservoir. A full feasibility analysis is required to assess the design and cost of the pipeline, but estimates range from $8-20 million.

Enlargement of Louisville Pipeline

The current capacity of the pipeline is 5.0 cfs. Expanding the capacity of the line to 10 cfs increases the average South Boulder Creek yield by 400 AF; during drought years, firm yield would increase approximately 200 AF.

This updated analysis confirms the results of the 2003 Raw Water Master Plan. Given the cost of C-BT units and the uncertainty of water right transfers, optimizing infrastructure to increase water yield is an economically viable alternative. The enlarged pipeline would be designed to divert water that currently bypasses the head gate. If additional capacity existed, higher flow rates could be diverted in accordance to the City's water right entitlements.

However, the marginal benefits associated with enlarging the Louisville Pipeline are lessened by the lack of storage and seasonal demand in average years. While higher rates of diversion are possible with an enlarged pipeline capacity, storage of such water occurs only if space is available in Marshall Lake or Harper Lake. If these two reservoirs are at full capacity, maximum pipeline diversions would be limited (equal) to daily treatment plant demands. However, it is anticipated that City future demands will increase resulting in higher diversion occurring at the pipeline.

Nevertheless, additional pipeline capacity would allow the City to reserve its Marshall Lake and C-BT allocations, thereby increasing Louisville's average and the firm yield water supplies. Further, no water court action to enlarge the pipeline is required if the location of the head gate on South Boulder Creek does not substantially change (which is not anticipated). The estimated cost is $10-15 million - which converts to $25,000 - $37,500 per AF of increased yield. Currently this is comparable to the cost of Marshall Division shares ($22,000 - $27,000/AF).

Another advantage of enlarging the pipeline involves operational maintenance issues. The pipeline was constructed in the 1950's making it part of the City's aging infrastructure that will see an increase in repairs and maintenance. Rather than replace and repair the existing pipeline - with no increased capacity benefits - the City could adopt a replacement program that enlarges the pipeline to allow for future increased flows. This option gives the City the ability to maintain and repair the pipeline and simultaneously gradually increase its capacity. It is expected that if no replacement of the pipeline is undertaken by the City, the Louisville Pipeline will continue to incur significant expenses for extensive repairs based on recent use the pipeline.

Water Acquisition

The planning criteria for future water acquisitions is four-fold: (1) identify the City's projected water demands; (2) identify the City's firm yield supply amount; (3) identify shortfalls between current supplies and future demands; and (4) purchase the "type" of water that best serves the long term interest of the City.

Water Rights Considered for Purchase

Colorado's water markets have various types of rights available for purchase, including agricultural ditch rights, C-BT units, and Marshall Division shares. (Groundwater, based on earlier studies, is not considered a viable alternative water source for Louisville. Deep groundwater supplies are limited and considered not sustainable based on current ground water supply and pumping costs). Selecting the "best-fit" for Louisville requires an analysis that determines which of these three purchase options meets the City's long term needs at the most cost effective manner. This section describes the three alternatives.

Agricultural Ditch Rights - "Foreign Water"

Louisville currently has 31 agricultural ditch water rights involving 14 irrigation ditches that have been transferred through water court for use within the City's municipal system. These water rights consist of a combination of senior and junior water rights, with 80% of the City's water diverted during the months of May - July. Former agricultural rights comprise the "foreign" water classification and can be legally stored in City reservoirs or directly diverted to the treatment plants. Each of these water rights has specific terms and conditions that define the timing and amount of water the City is entitled.

Agricultural irrigation rights within the South Boulder Creek basin generally do not have associated storage rights, but rather are solely direct flow rights that can be diverted only during the summer's irrigation season. Therefore, the value of these rights is limited at times the City's current storage facilities reach full capacity. Under these circumstances, direct flow agricultural rights can only be diverted to the treatment plants, with flow rates limited by daily city demands rather than the larger

legal entitlement. As a result, foreign water is less valuable to the City when compared with the other sources.

Current purchase costs for agricultural water rights within the South Boulder Creek basin average $25,000 -30,000/AF. However, transactions costs (engineering and legal) to transfer these rights from agricultural to municipal use in Colorado's water court averages $150,000 (2016). Comparable costs vary depending on the amount of water transferred in each water court application. Therefore, the economies of scale for the purchase and transaction of these rights would indicate that it would be beneficial to acquire a large amount of water prior to undertaking any water court action by the City.

C-BT Units

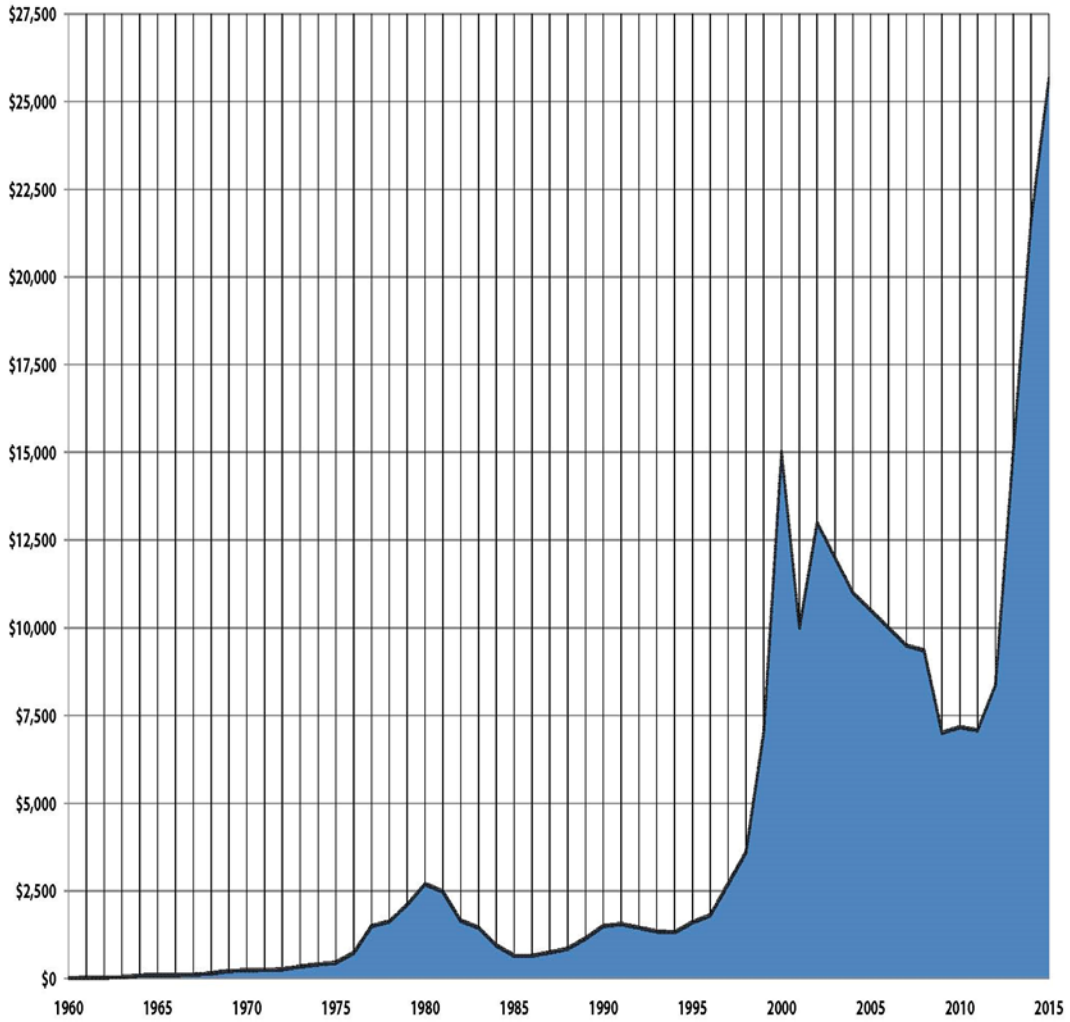
The Colorado-Big Thompson Project diverts water from the headwaters of the Colorado River and delivers this water to various east slope reservoirs. Units of C-BT water can be bought and sold on the open market. Built originally during the 1930's to serve northern Colorado agricultural communities, C-BT units have been gradually acquired by municipal and energy interests and now make up the majority of usage.

Once collected on the west slope and diverted to NCWCD's east slope storage sites, C-BT units are not subject to Colorado's legal water allocation system and therefore offer more flexibility related a unit's time of use. However, C-BT units are subject to a Colorado River Compact river call, if one was to occur in the future. On average, a single C-BT unit equals 0.7 AF of water which was used in assessing future C-BT amounts and needs. C-BT units can be used year-round because of the storage component associated with each unit. As a result, the demand for C-BT water has been increasing over the last ten years, especially due to the recent increased demand from municipal interests.

The price of C-BT water has increased dramatically since 2010. Currently, the price of C-BT water is at record levels ($23,000-$27,000 per unit). Delivery costs to the City are currently $35/unit, not including the $17/AF pumping costs. Slowing energy development may lower prices in the near-term, but municipal demand has remained constant. Historical transactions indicate that C-BT costs do not fluctuate during drought and flood periods. However, historical economic variations in housing development in northern Colorado have proven to significantly impact the C-BT market.

Figure 5

Historical Representative Market Prices Per C-BT Acre-Foot Unit [1]



[1] District allottees of C-BT Project water may transfer and sell their respective acre-foot units to other parties within Northern Water boundaries. These transactions are subject to rules and regulations of the Board. The above table represents data gathered by voluntary action and serves as an indicator of how the price of C-BT Project water has fluctuated on the open market through the years. Actual transaction prices may vary.

64 Northern Water

Windy Gap Units

Louisville owns 9 units of the Windy Gap Firming Project. Future shares of Windy Gap Firming will be associated with any acquisition of C-BT units. However, Windy Gap units may be purchased without associated C-BT units. Because of the project's junior water rights, Windy Gap Firming water cannot be diverted during low runoff years. Conversely, during wet periods, storage space in the project's west slope reservoir, Granby Lake, is not available for Windy Gap water because it has a lower "storage priority" (as determined by NCWCD) than C-BT Project water.

Chimney Hollow Reservoir will increase the Windy Gap Firming project's annual firm yield to approximately 30,000 AF. This equates to approximately 600 AF entitled to Louisville Windy Gap water, with storage, would be considered drought protection for the City. It is also the most expensive water acquisition alternative at $1.4 million per unit and an annual debt service charge of approximately $25,000/year. Delivery charges for Windy Gap Firming water to the City is currently $130/AF, plus pumping costs ($17/AF).

The expected commencement date of the Windy Gap Firming Project - and the construction of Chimney Hollow Reservoir - is currently anticipated to be mid-2018.

At the time of this report, there is potential to acquire addition Windy Gap units as several project participants have reassessed their respective positions and looking to reduce their unit total.

Marshall Division Shares

Louisville owns 381.64 shares in FRICO's Marshall Lake Division; the total number of Marshall Division shares is 1,278.979 shares. The Marshall Division water rights consist of the Marshall Lake Division direct flow priorities and the Marshall Lake and McKay Reservoir storage rights.

The storage capability in Marshall Lake differentiates Marshall Lake Division rights from other agricultural water rights within the South Boulder Creek drainage basin. As a result, the Marshall Division shares provide a higher value to the City because of the Marshall Division right's storage component. Recent sales of Marshall Division shares have averaged $23,000 - $30,000 per share, with each share averaging 4 AF/year.

South Boulder and Coal Creek Ditch Shares

Louisville owns shares of South Boulder and Coal Creek shares. Similar to Marshall Division shares, these shares also consist of a storage and direct flow water rights. No recent sales of South Boulder and Coal Creek Ditch shares have occurred. However, it is anticipated that such rights have a value comparable (if not slightly cheaper) than Marshall Division shares. Only about 12% of the company's shares are still untransferred. Prior City engineering reports indicated that Louisville's ownership in the remaining shares could assist in protecting the City's current interest in the ditch company in addition to providing additional water supply to the City.

Gross Reservoir

During the past few years, Louisville has participated in negotiations with Denver Water (owner of Gross Reservoir) and the cities of Boulder and Lafayette to assess the feasibility of acquiring additional storage in Gross Reservoir. Denver Water is undergoing a re-permitting process for the reservoir and has identified 5,000 AF of additional storage space ("Environmental Pool") in Gross Reservoir. The purpose of Environmental Pool is to store water for later release to benefit the riparian habitat along South Boulder Creek and supplement streamflows when the Colorado Water Conservation Board's instream flow is the calling right on the creek (late summer). The original proposal from the participants included storing Boulder, Lafayette's and Louisville's water in the newly available storage space each given a specific amount of storage space based on each city's ability to use its own water rights for environmental purposes.

The other parties have decreed water rights for storage in Gross Reservoir; Louisville has no such right. This lack of decreed storage space in Gross Reservoir has severely limited Louisville's participation. Without a water source to store in the reservoir, Louisville does not have the ability to meet the Environmental Pool requirements. Further, Boulder and Lafayette have the ability to release water from Gross Reservoir, shepherd the water through the instream flow reach of South Boulder Creek, and recapture the water for use in the municipal system. Louisville, however, has no ability to recapture the water from below the instream flow reach of South Boulder Creek. Louisville's water rights are diverted above the instream flow reach. Therefore, Louisville's ability to provide environmental enhancement and recapture Gross Reservoir releases for later City use has proven to be problematic.

The remaining parties continue to negotiate final terms (volume amounts and capital storage costs). Previously, Louisville has made proposals to the other parties to cost-share expenses associated with Gross Reservoir storage (since 2007), but without a legal water storage supply and identified, tangible environmental benefits, Louisville cannot meet the re-permitting requirements.

Amount of Water to Purchase

The amount of water required to adequately supply the City during the design-drought duration is contingent on: (1) risk assessment; (2) estimated costs; and (3) other adopted alternatives. Currently the City has an average demand of approximately 4,250 AF/year. Current firm yield supplies are estimated at 5,000 AF/year. Therefore, in the near-term planning period, Louisville's supply is sufficient to meet historical average demands. With load-shifting and water conservation management, the City's firm yield can be increased to 6,500 AF/year.

Based on review of historical records and City staff discussions, the 6,500 AF build-out scenario was used as the baseline annual demand for this report. At this level, the current firm yield supplies are adequate to meet the City's raw water demands with the implementation of the No Action Alternative. However, due to inherent inefficiencies in the City's raw water transmission and distribution system, it is recommended that the City consider increasing its raw water supplies and/or storage to add 200 AF of C-BT units, Windy Gap units, or Marshall Division shares.

If the build-out demand is higher than 6,500 AF then additional water supplies and/or additional storage capacity will be needed. If the City water demand reaches the 7,120 AF/year level, there is a potential shortfall of 620 AF/yr at this build-out demand level.

To cover potential future water supply deficits which would result from demands exceeding 6,500 AF/year, the City will need additional water supply (from sources listed above) and/or storage acquisition. However, the following issues should also be considered with such purchases:

- C-BT purchases are limited to 400 units without increasing our contribution to Windy Gap
- Windy Gap Firming -- is considered best suited for drought protection rather than used to increase average annual supply because of high cost of acquisition and operation
- South Boulder Creek water rights include the uncertainty related to water court proceedings, in stream flows, and other administrative constraints
- In general, without additional storage, relatively more senior rights are required to address the shortfall. However, senior water rights comprise a smaller segment of the water market

and, as a result, are relatively more expensive than other less senior (but more abundant) water rights.

- Marshall Lake shares include a storage component, increasing their value for City use
- Raw water supply needs are subject to change due to any of the following reasons: (1) future changes in water operations, (2) development of future cooperative agreements, (3) increase in city-wide storage capacity, (4) revised lower demand projections.

OTHER CONSIDERATIONS

General Cooperative Partnerships

Louisville has existing water/storage supply-related agreements with several entities including:

- Annual water supply leases - Asphalt Specialties, Three Leaf Farms
    - 2016 Lease Amount is 20 AF/yr
- Use of Louisville Pipeline for augmentation bypasses - Eldorado Springs
    - Approximately 10 AF during 2015 water year
- Use of Louisville Pipeline as an alternate point of diversion - City of Lafayette
    - Legal right, not contractual right

(* Please see the Reference section of this report for additional information for these City documents.)

The Asphalt Specialties, Three Leaf Farm, and Eldorado Springs agreements are currently under review to assess the following:

- Policy strategies for renewing lease contracts (Asphalt and Three Leaf Farm);
    - Honor existing leases
    - Add new leases only on an annual basis - to the extent water is available.
- Louisville Pipeline Use -
    - Review and revise existing terms and conditions regarding the Facility Use Agreement with Eldorado Springs.

Future partnerships are anticipated regarding potential South Boulder basin local storage, basin-wide water right administration and management, and the possibility (and feasibility) of developing South Boulder Creek cooperative opportunities. Initial discussions with local entities are needed to develop the structure and process associated with these partnerships- with a primary focus on current basin-wide issues and future planning. Potential participants in these partnerships include water users in District 6 and, to the extent necessary, the users located on the lower St. Vrain and South Platte Rivers.

McKay Reservoir Conveyance

McKay Reservoir has the potential to supply replacement water for the City's return flow obligations, including Marshall Division shares, which could alleviate the need for such replacements to be made from Marshall Lake or the City's wastewater treatment plant. However, without an approved

conveyance between the reservoir and Big Dry Creek, such replacements from McKay Reservoir are not physically possible.

Negotiations with other Big Dry Creek water users to allow for water deliveries to Big Dry Creek have been undertaken and are anticipated to continue. Discussions need to focus on Louisville's (and others) requirement to make return flow replacements to Big Dry Creek. Recent rulings from similar water court proceedings indicate that future similar requirements will be imposed on water right transfers from Big Dry Creek, most notably Marshall Lake Division shares. Current and projected terms of Big Dry Creek water supplies will create a higher demand for McKay Reservoir releases to supply municipal replacement obligations in time, place a location of the historical depletions (including Louisville's). This effectively eliminates the ability to deliver such return flows replacements from the City's wastewater treatment plant. Therefore, full compliance with Louisville's water court decrees will require a hydraulic connection between McKay Reservoir and Big Dry Creek. Final costs will depend on cost sharing arrangement with other parties involved in Big Dry Creek water supplies and the type of engineering solutions selected to allow McKay Reservoir releases.

State of Colorado Water Plan

A recently published statewide water plan, developed by the Colorado Water Conservation Board, has indicated more cooperative operations are needed to address the projected shortfall of municipal water supplies in the state. Specifically, the plan identifies the need for increased flexibility to provide municipal water supplies during droughts. This flexibility can be achieved through cooperative agreements between water users within the basin, e.g. interruptible water supplies and water banking.

The state-wide plan recommends basin-wide cooperative planning among local water users. However, currently there is no formal planning forum for South Boulder Creek water right holders. Therefore, to implement the state plan, a District 6 water forum needs to be established with representation from the various District 6 water users. The purpose of the forum would be to discuss: (1) current water supplies/storage; (2) near-term basin-wide operations; (3) future water right operations; (4) watershed protection strategies, and (5) improved communication among the participants.

State of Colorado, Division of Water Resources, Water Rights Accounting Audit

Louisville began the audit process with the Colorado Division of Water Resources in 2014 to standardize the City's accounting forms, reporting procedures, and accounting process. This audit phase currently continues revisions to the accounting forms and procedures, with review and comment from the Division 1 Engineer, and the State Engineer's Office. It is anticipated that the audit process will be completed by December, 2017.

SUMMARY

The purpose of this report was to provide Louisville with an analysis related to its current and future water supply and use. Results indicate that the City has a firm yield of 6,500 AF/yr, with a current annual demand of 4,850 AF/yr. Three projected water demand levels were used to evaluate whether

current water supplies are sufficient to meet the City's future growth. Results indicated that current raw water supplies were adequate to meet all but the highest demand level: 7,120 AF/yr.

To accurately appraise these results, several assumptions need to be identified when considering the outcomes described above:

- The modeling analysis assumed current storage capacities are an accurate representation of existing conditions.
- The Louisville Pipeline's recent maximum historical diversion rate is 5.0 cfs. This was based on typical historical use of the pipeline rather than the original design flow rate of 7.7 cfs.
- To the extent water and storage/demand was available, it was assumed in the original modeling analysis that Louisville diverted water to its fullest legal entitlement. However, in practice, full efficiency in water diversions and deliveries is unrealistic. Historical diversion/delivery records clearly indicate that there were several occasions whereby water was available but not diverted. Therefore, appropriate modifications were made to reflect practical constraints limiting the City's ability to divert at the highest rates, most notably regarding the two pipelines.
- To achieve the firm yield of 6,500 AF/yr with current water supplies it is anticipated that the City will need to increase its current level of water resource management, specifically daily administration and operations. This includes providing the capability to divert, deliver, and store all available water. As a result, higher daily management is required to achieve this level of water operations.
- Three future City-wide water demand levels were chosen for this analysis based on previous reports and estimates. Further refinement of these three City's future build-out demand estimates is warranted to specifically target the amount of any water supply shortfall.

This report identifies a variety of water resource management alternatives designed to meet all future City water demands. However, the intent was not to present these individual alternatives mutually exclusive of each other. To the contrary, it is anticipated that a combination of alternatives will be adopted to achieve the desired goals. It is also anticipated changes and modifications will be necessary to update the information contained in this report. As the City develops into its build-out scenario in 2065, review of this document is warranted on 2-5 year basis, rather than the previous 10-year review.

Table 4
Summary of Capital Improvement Alternatives

Alternative	Increased Yield (AF)	Cost/AF	Difficulty (1-5)*	Total Cost
Enlarge SWSP Pipeline Capacity	800	$10K - $18K	3	$1-3 Million
Marshall Lake Forebay	600 - 1000	$20K - $25K	5	$12-25 Million
Dredge Marshall Lake	400 *	$10K	3	$4 Million
Water Purchase	250 *	$22K - $28K	5	$4-7 Million
Gross Reservoir Storage	250 *	$10K - $20K	5+	$2.5-5 Million

* 1-5 = easy to difficult transaction level
** Estimated yield unknown - only estimates provided

RECOMMENDATIONS

After considering the information gathered, the Staff has the following specific recommendations:

- Maintain the Design Drought period of 1963-1965
- Proceed with the SWSP Transmission Capacity Project
- Continue participation in the Windy Gap Firming Project
- Develop and implement load shift operational procedures
- Maintain and expand the Water Conservation Program
- Finalize McKay Reservoir negotiation
- Perform bathometric survey of Marshall Lake
- Utilize a build-out demand projection of 6,700 acre-feet for short term acquisition strategy

Figure 1

CITY OF LOUISVILLE, COLORADO
RAW WATER SYSTEM

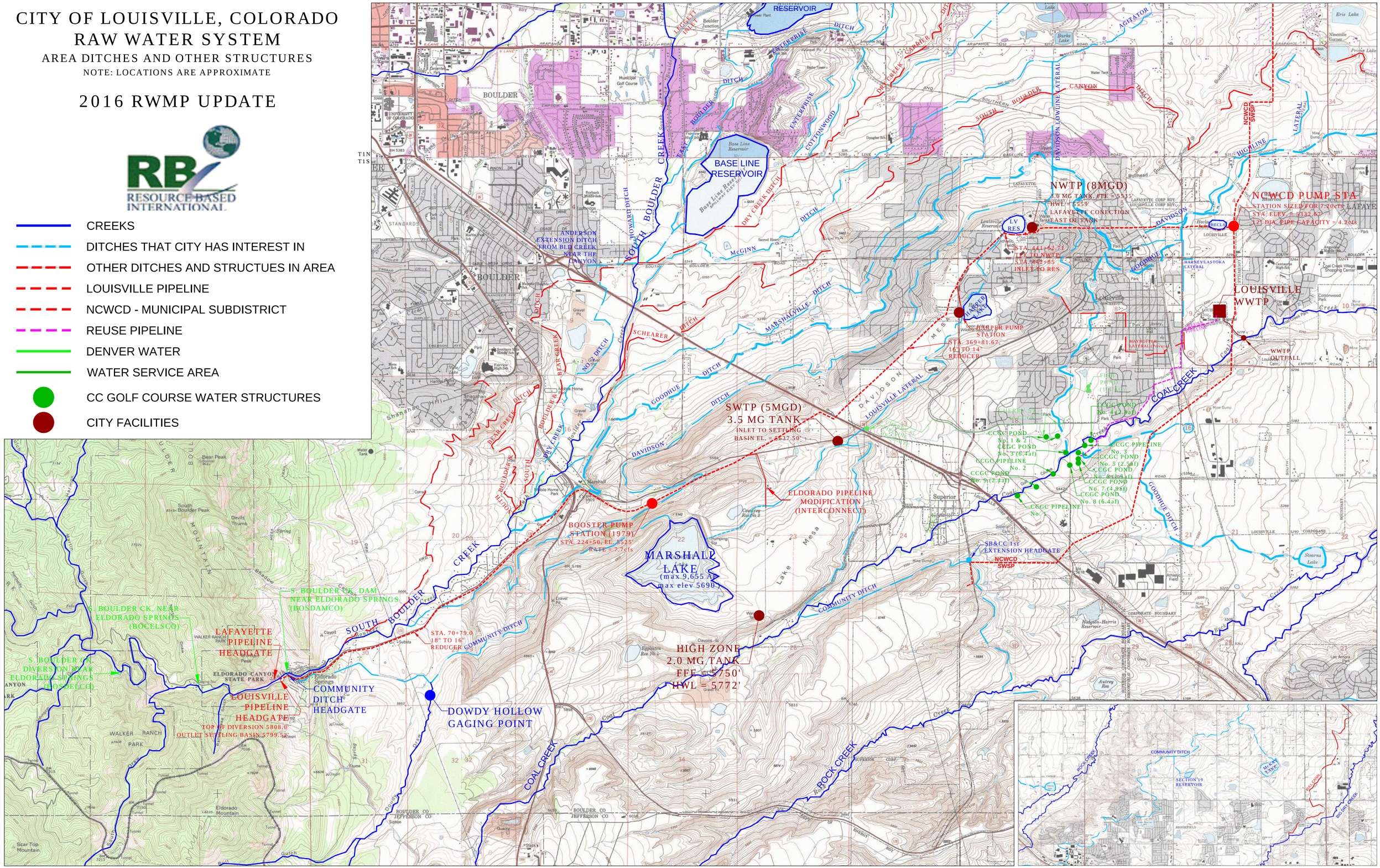
AREA DITCHES AND OTHER STRUCTURES

NOTE: LOCATIONS ARE APPROXIMATE

2016 RWMP UPDATE

RESOURCE BASED INTERNATIONAL

- CREEKS
- DITCHES THAT CITY HAS INTEREST IN
- OTHER DITCHES AND STRUCTUES IN AREA
- LOUISVILLE PIPELINE
- NCWCD - MUNICIPAL SUBDISTRICT
- REUSE PIPELINE
- DENVER WATER
- WATER SERVICE AREA
- CC GOLF COURSE WATER STRUCTURES
- CITY FACILITIES



N
W E
S

0 4,300 8,600
Feet

RBI
RESOURCE BASED INTERNATIONAL

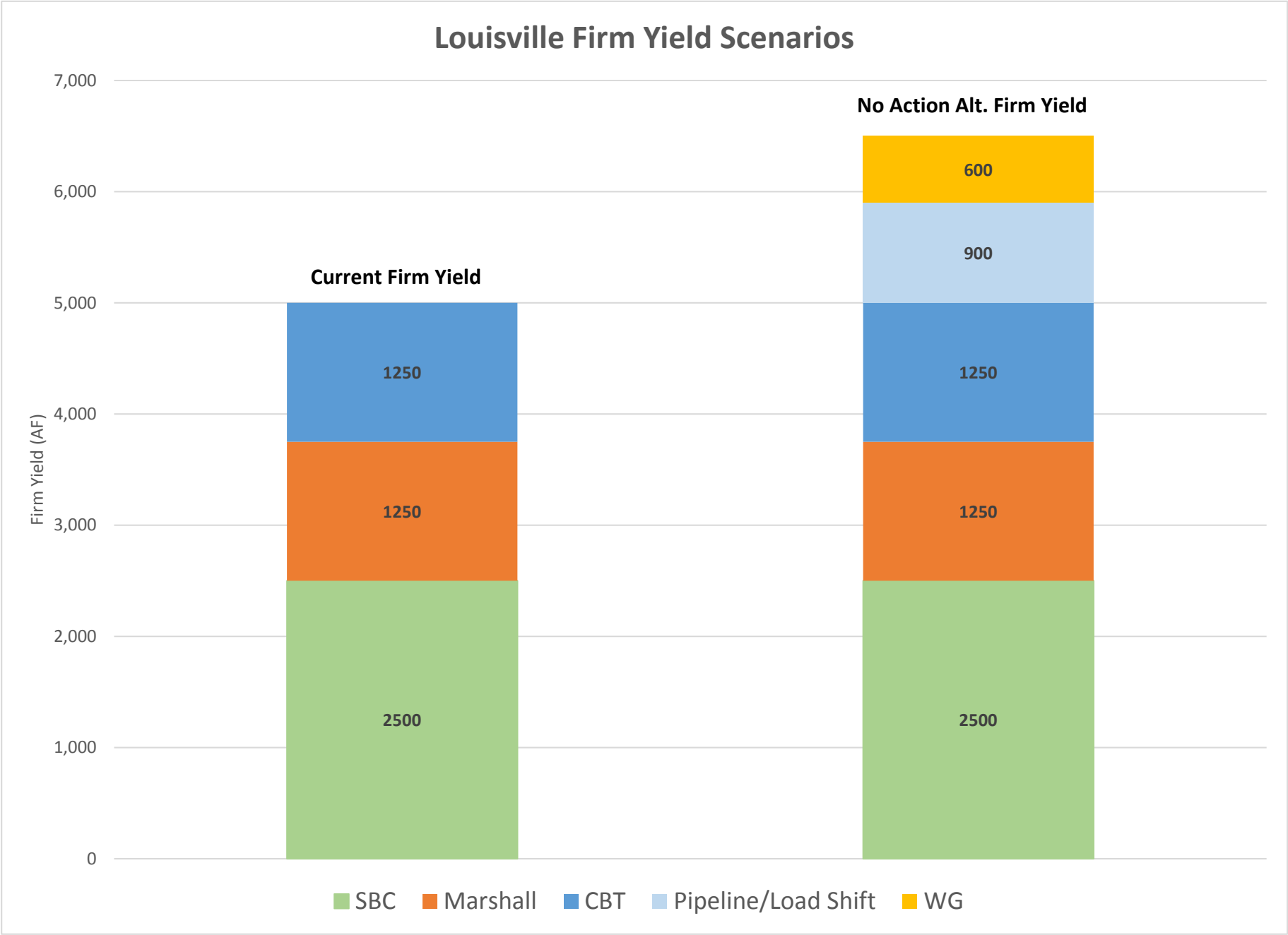
CITY OF LOUISVILLE 2016 RWMP

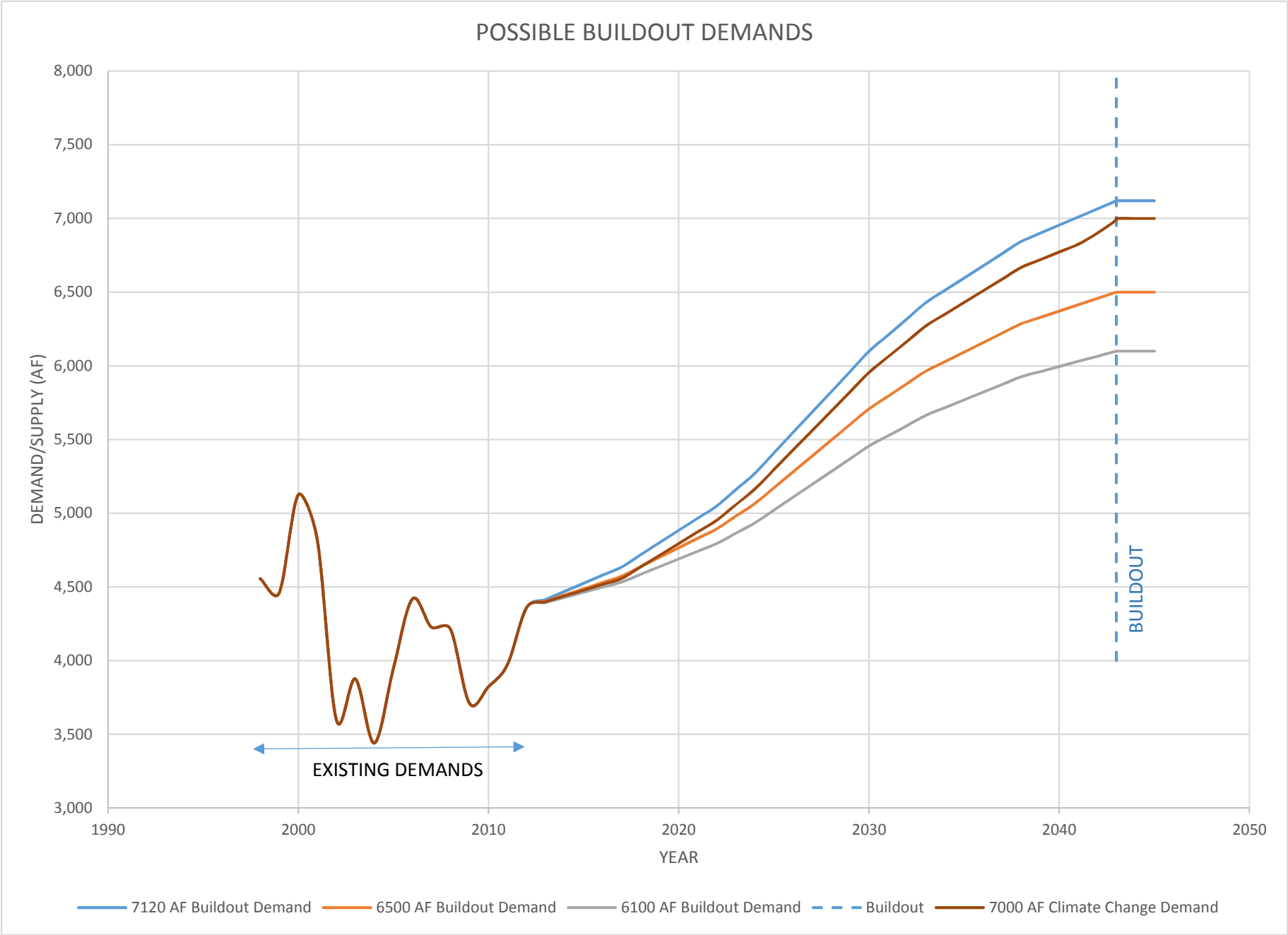
SOUTH BOULDER CREEK STRAIGHTLINE MAP

FIGURE NO. 1

DATE: 5/24/2016

SCALE: 1 inch=6,500 feet


Louisville Firm Yield Scenarios
Firm Yield (AF)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Current Firm Yield
No Action Alt. Firm Yield
1250
1250
2500
600
900
1250
1250
2500
SBC
Marshall
CBT
Pipeline/Load Shift
WG


POSSIBLE BUILDOUT DEMANDS
DEMAND/SUPPLY (AF)
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
1990
2000
2010
2020
2030
2040
2050
YEAR
EXISTING DEMANDS
BUILDOUT
7120 AF Buildout Demand
6500 AF Buildout Demand
6100 AF Buildout Demand
Buildout
7000 AF Climate Change Demand

GET A FREE SMART CONTROL CLOCK WITH YOUR SPRINKLER INSPECTION!

TAKE THE PAIN OUT OF SETTING YOUR CONTROL CLOCK AND STILL STAY GREEN!

As a resident of the City of Louisville, you may be qualified to receive a free Rachio Smart Controller! The controller will automatically adjust for weather conditions, making sure your lawn is getting just the right amount of water without wasting your money.

To qualify, you must first receive a free sprinkler inspection from the Center of ReSource Conservation. It's easy to sign-up and learn simple ways to improve your landscape health and save money on your water bill.

*Supplies are limited and will be given on a first-come, first-served basis. Provided to you at no cost through a partnership with the City of Louisville.

Sign Up Today

ConservationCenter.org/sprinkler
(303) 999-3824 to schedule by phone

CENTER FOR ReSource Conservation
Slow the Flow

City of Louisville
COLORADO • SINCE 1878

Smart Controller Mini Marketing Toolkit

Overview

This document is designed to give you all the information you'll need to promote the Smart Controller Program to your customers. In addition to the attached flyer, you will find editable text to use in any form of media, an outline of the process of the program, requirements for qualifying for the program, and what the homeowner can expect. Feel free to use the information provided in any way you see fit. I only ask that significant changes to the messaging are sent to me for review before distribution.

Editable Text

Are you baffled by your old sprinkler control clock? Or are you worried about wasting water when your sprinklers water your lawn during a rain storm? Fear not! As a resident of the City of Louisville, you qualify for a free Rachio smart control clock through a partnership with the City and the Center for ReSource Conservation. This sleek new technology automatically adjusts your sprinkler system to account for weather changes, saving you water, time, and money! It can even be programmed from your smart phone or tablet!

With the Rachio, you'll never have to worry about watering too much when its rainy, or too little when its hot and dry. Feel at ease knowing your lawn is getting just the right amount of water, keeping your grass healthy, and your water bill affordable.

Getting your free smart controller is simple. Just sign up to receive a free sprinkler inspection from the Center for ReSource Conservation, then once that has been completed, we'll send one of our trained water conservation specialists back to install your new Rachio smart control clock. To sign up for both, simply call us at 303-999-3824, and be sure to request a free smart controller.

Already signed up for a sprinkler inspection? Call us to sign up for just the smart control clock. **But act fast, supplies are limited and are given on a first-come, first-served basis.**

Important Dates

May 27, 2016: Sprinkler inspection scheduling begins

June 9, 2016: First day of sprinkler inspections.

June 27, 2016: Smart control clock scheduling begins.

Mid-July: Smart control clock installations begin

Late August: Sprinkler inspections and smart control clock installations end.

What to Expect

Once you've received a free sprinkler inspection, the Center for ReSource Conservation will schedule you for an appointment to install your new smart control clock. A friendly and trained technician will meet with you to explain the process and connect the new smart control clock to the sprinkler system. Then, with your help, the technician will program the control clock using the results from your sprinkler inspection. Finally, the technician will demonstrate the exciting features and teach you how to use your new Rachio control clock with your smart phone or tablet.

How to Qualify

In order to receive a free Rachio smart control clock from the City of Louisville and the Center for ReSource Conservation, you must meet the following prerequisites:

1. Have had a free sprinkler inspection from the Center for ReSource Conservation in 2014-2016.
2. Have a control clock that is currently connected to your sprinkler system.
3. Have a functioning home 2.4 GHz wi-fi connection that reaches your control clock.
4. Have no more than 16 zones on your irrigation system.
5. Have a smart phone or tablet running on iOS 9 or greater, or Android 4 or greater.

Measurement Location	Flow (cubic feet per second) 2 yr	5 yr	10 yr	25 yr	50 yr	100 yr	500 yr	Measured
Coal Creek at 93 (UDFCD Prop)						3,590	7,390	
Coal Creek at Dillon (UDFCD Prop)	180	330	460	1,040	1,750	3,690	7,390	
Coal Creek at Plainview (56 yr avg peak)								48
Coal Creek at Plainview (5/11/2015)								92
Coal Creek at Plainview (CWCB 2013 Estimate)								3,900

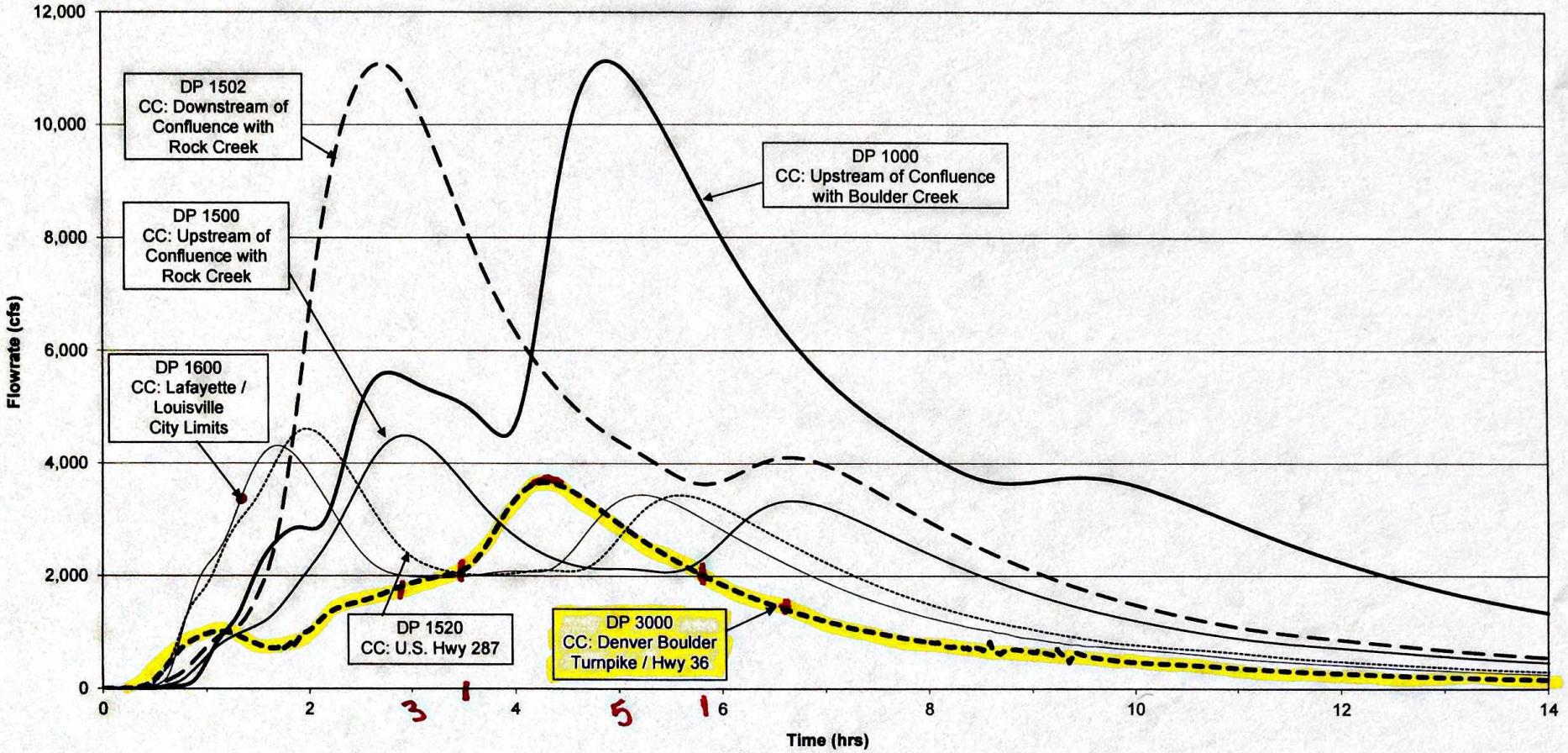
Regional Pond Napkin Analysis (Maintain 50 yr Flow during 100 yr Storm)		
Coal Creek Peak Flow Hydrograph duration above 1,750 cfs	210	minutes
Coal Creek 100 yr Flow	3,690	cfs
Coal Creek 50 yr Flow	1,750	cfs
CC Peak x 60 sec/min x Duration x 0.5 (Hydrograph Triangle)	24,444,000	cubic feet
7.48 gallons per Cubic Foot	182,841,120	gallons
325,851 gallons per Acre-Foot	563	acre-feet
Harper Lake	700	acre-feet
Marshall Lake Size	9,952	acre-feet

Regional Pond Napkin Analysis (Maintain 50 yr Flow during 500 yr Storm)		
Coal Creek Peak Flow Hydrograph duration above 1,750 cfs	420	minutes
Coal Creek 100 yr Flow	7,390	cfs
Coal Creek 50 yr Flow	1,750	cfs
CC Peak x 60 sec/min x Duration x 0.5 (Hydrograph Triangle)	142,128,000	cubic feet
7.48 gallons per Cubic Foot	1,063,117,440	gallons
325,851 gallons per Acre-Foot	3,271	acre-feet
Harper Lake	700	acre-feet
Marshall Lake Size	9,952	acre-feet

Regional Pond Napkin Analysis (Maintain 100 yr Flow during 500 yr Storm)		
Coal Creek Peak Flow Hydrograph duration above 1,750 cfs	210	minutes
Coal Creek 100 yr Flow	7,390	cfs
Coal Creek 50 yr Flow	3,690	cfs
CC Peak x 60 sec/min x Duration x 0.5 (Hydrograph Triangle)	46,620,000	cubic feet
7.48 gallons per Cubic Foot	348,717,600	gallons
325,851 gallons per Acre-Foot	1,073	acre-feet
Harper Lake	700	acre-feet
Marshall Lake Size	9,952	acre-feet

UDFCD 34.8 acre-ft Pond Construction Cost	$	21,000,000
UDFCD $/acre-ft	$	603,448.28
Core Area 2 acre-ft Pond Construction Cost	$	700,000
Core Area $/acre-ft (No Land Acquisition)	$	140,000
Total Guess Estimate on $/acre-ft	$	200,000
100 yr to 50 yr Pond	$	112,517,612
500 yr to 50 yr Pond	$	654,226,117
500 yr to 100 yr Pond	$	214,595,446

FIGURE B - 8
Coal Creek Existing Land Use Hydrograph
100-Year Baseline Hydrology



Z:\UDFCD PLANNING\Coal Creek-Rock Creek\01 HYDROLOGY\Baseline\Spreadsheets\Peak Flows\BaselineHydrographs_Existing.xls (CC Hydro)

Coal Creek and Rock Creek Flood Maps

November 2014

Instructions to print an area smaller than the full page to scale:

1. Using the "Snapshot" tool, select the desired area to print.
2. Click File>Print...
3. Select your printer from the printer dropdown menu.
4. Set the desired paper size using the printer "Properties" menu.
5. Choose the "Selected Graphic" option under "Print Range".
6. Select "None" from the "Page Scaling" dropdown menu.
7. Unselect "Choose Paper Source by PDF Page Size".
8. Click "OK" to print selection.

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(303) 300-1635 (fax)
www.respec.com

Map Legend

- HEC-RAS Cross Section
- Base Flood Elevation
- Channel Alignment
- Matchline
- Major (10 Foot)
- Minor (2 Foot)
- Separation of Flooding Source
- Bridge
- Culvert
- Irrigation
- 100-Year Floodplain (1% Annual Exceedance Probability)
- 500-Year Floodplain (0.2% Annual Exceedance Probability)
- Shallow Flooding Zone
- Floodway (0.5 Foot Rise)
- Road
- Railroad
- Recreation Path/Trail
- Canal/Ditch
- Structures in Floodplain

N

Sheet 4 of 7

0 400 800 1,600 2,400 Feet

1 inch = 200 feet