Integrated Water Resource Plan

Water and Sewer Board Update

August 17, 2022

City of Greeley Colorado

Stantec

Shift in Planning Methodology

Past Approach:

Predicating a single future demand and firm yield

- Single expected future condition
- Last Water Master Plan completed 2003, did not consider Terry Ranch

Current Approach:

Incorporates risk and uncertainty

- Multiple future conditions

What is an Integrated Water Resource Plan?

- Planning-level study focused on Greeley's water resources system
- Evaluates long-term water supply sustainability
- Develops road map to Buildout
- Identifies near-term Capital Improvement Plan components

IWRP Objectives

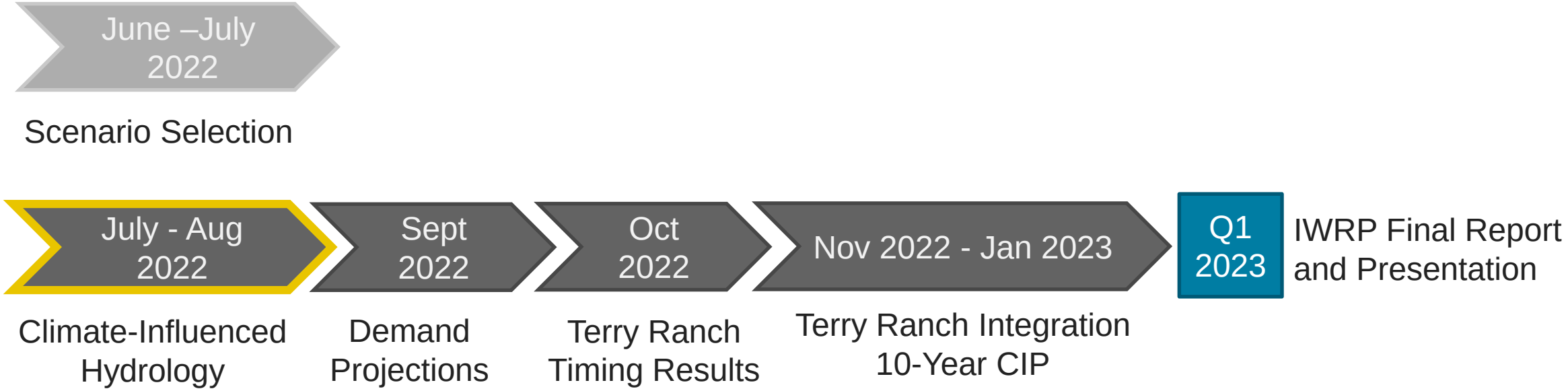
Create a long-term adaptive planning document that:

- Develops a suite of planning scenarios that explore future risks and uncertainties
- Investigates Greeley's ability to meet Level of Service Goals in an uncertain future
- Identifies an actionable water resources strategy
- Evaluates the timing and integration of Terry Ranch
- Produces a water resources CIP

IWRP Vision Statement

“An actionable and adaptive master plan for Greeley’s water resources that uses modern, defensible methods to develop a roadmap ensuring a reliable water supply for our community through an uncertain future.”

IWRP Timeline



Planning Scenario Drivers

Water Rights Competition and Administration

- Yields could be reduced due to competition and changes in administration/regulation

Water Demands

- Growth rate and per capita water use uncertain

Future Climate Conditions

- Variety of long-term changes in average temperature and precipitation possible

System Risks

- Colorado River Basin yields could be impacted several ways
- Other water providers could see water supply failures

Initial Planning Scenarios

Planning Scenario	Description
High Bookend	A hot and dry future in which Greeley grows at a rate faster than expected. Greeley's water right yields are reduced overall and are impacted by Colorado River Basin issues, wildfires, and regional water issues.
Median	A warmer future in which Greeley grows as expected, water supply yields are reduced and source water threats like Colorado River Basin issues and wildfires occur.
Low Bookend	A warmer and wetter future in which Greeley grows at a rate slower than expected. However, issues within the Colorado River Basin impact Greeley’s yields.
No Climate Change	Greeley grows as expected with climate reflective of historical conditions. Source water threats like Colorado River Basin issues and wildfires occur.
Mix and Match	A hot and wet future in which Greeley grows as expected. Greeley's water right yields are reduced overall and are impacted by Colorado River Basin issues, wildfires, and regional water issues

IWRP Team

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Neil Stewart (Project Manger)

Stantec

- Aurora Water 2017 IWMP
- Aurora Water IWMP2 (In-Progress)
- Aurora Water Lower S. Platte Master Plan
- Colorado Springs Utilities IWRP
- Colorado Springs Utilities On-Going Water Planning
- Ft. Collins Water Supply Vulnerability Study
- Water Research Foundation Planning Projects

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Core Team

Michelle Johnson

Martin & Wood

- History of water rights analysis and cases for Greeley

Mary Presecan

LRE Water

- Aurora Water Lower S. Platte Master Plan
- South Platte Basin Planning

Cortney Brand

LRE Water

- Terry Ranch Feasibility

Brett Gracely

LRE Water

- Colorado Springs Utilities IWRP

CLIMATE-INFLUENCED HYDROLOGY

Climate-Influenced Hydrology Purpose

- Planning-level evaluation
- Hydrology dataset for assessing change impacts on Greeley's water supplies and identify mitigation strategies
- Comparative evaluation of how climate change impacts water systems differently

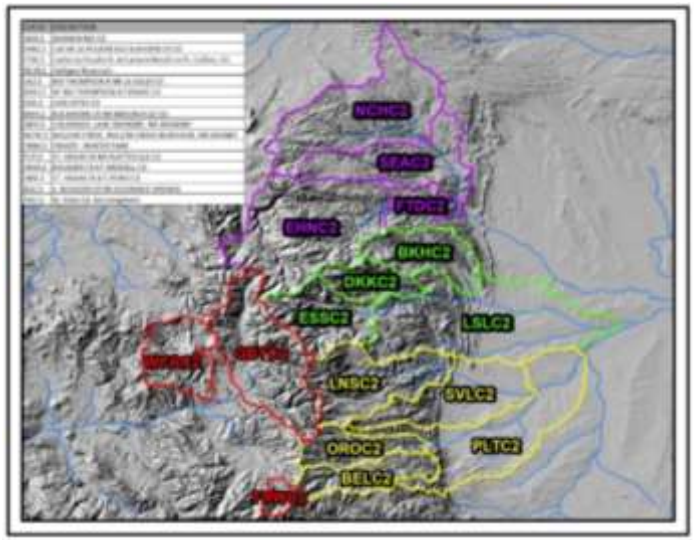
Generating Climate-Influenced Hydrology

1

Research Identified potential changes in average Temperature and Precipitation (T&P)

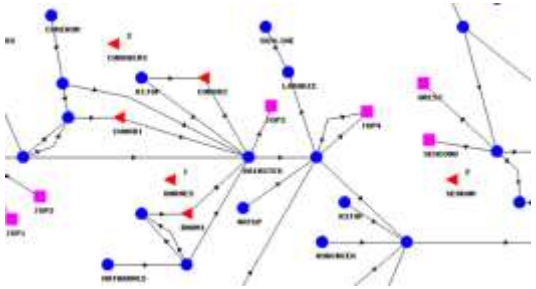
2

Joint Front Range Climate Vulnerability Study Hydrology Model Simulated Flows in the Basin



3

Apply Existing Big Thompson, Poudre Basin, and C-BT Project Models to develop water available to Greeley

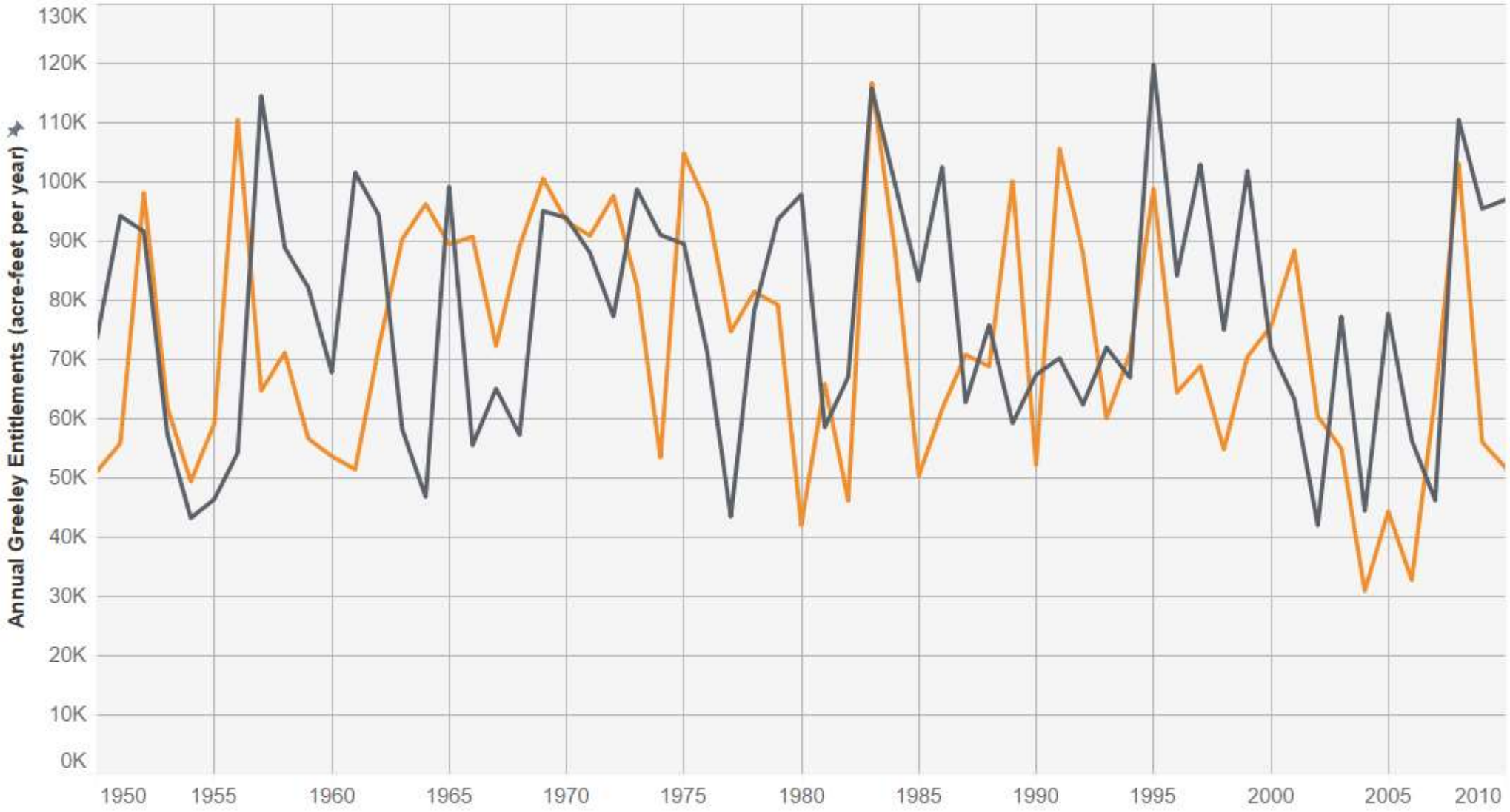


Leveraged existing data, models, and process data from Fort Collins' Water Supply Vulnerability Study

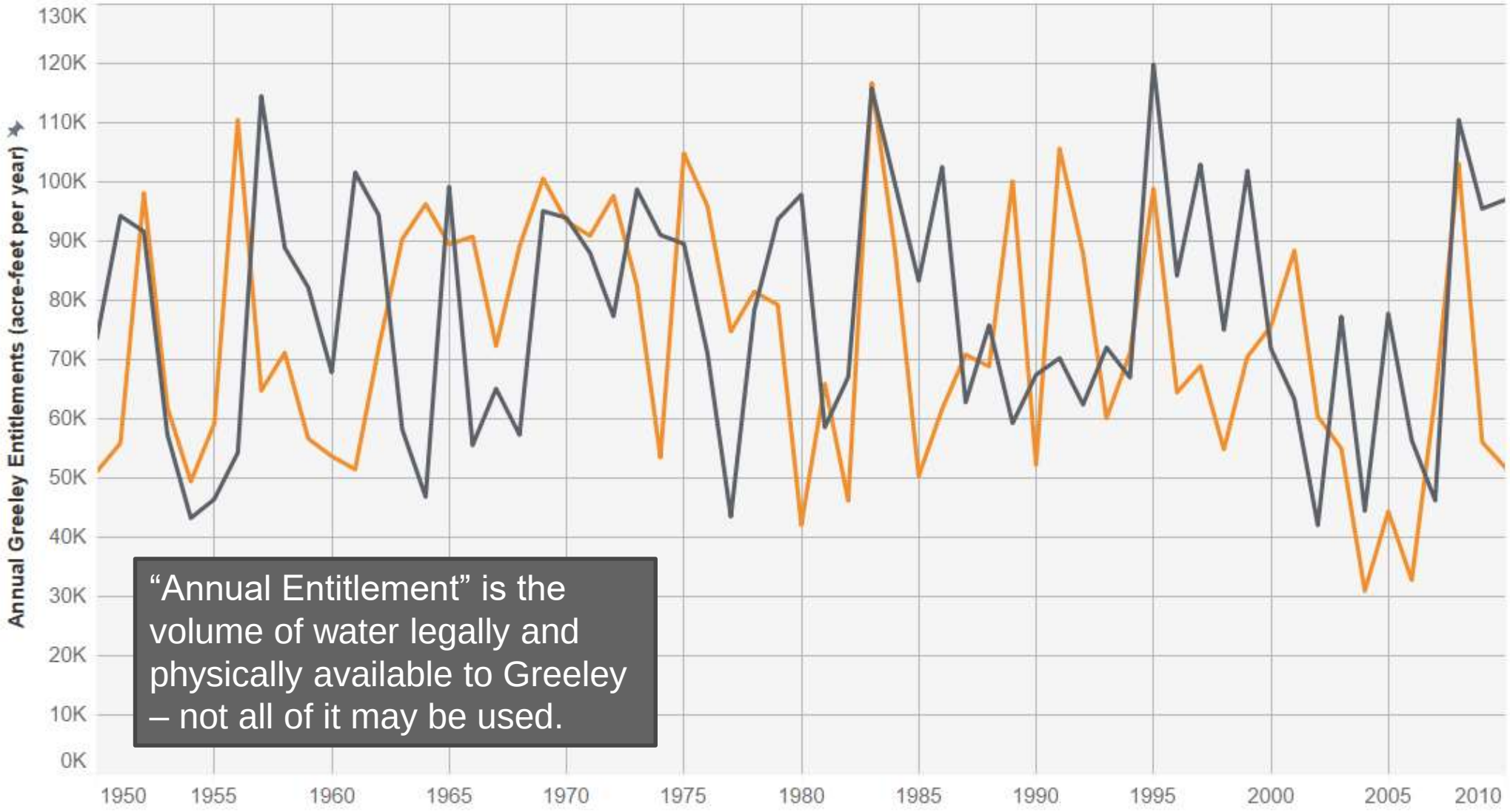
Short-Term Climate Variability

- Resequence historical data, creating new droughts possible under current climate
- Six “Timeseries” of droughts selected for IWRP

Timeseries	Drought Characterization
A	Same 10-year Cycle, greater severity
B	4 2002’s in 10-year Period
C	Similar to Historical
D	Back-to-Back-to-Back 2002s
E	Severe 5-year Drought
F	Drought and Aridification



Timeseries of Greeley's annual entitlements under historical hydrology and a the new timeseries "D"



"Annual Entitlement" is the volume of water legally and physically available to Greeley – not all of it may be used.

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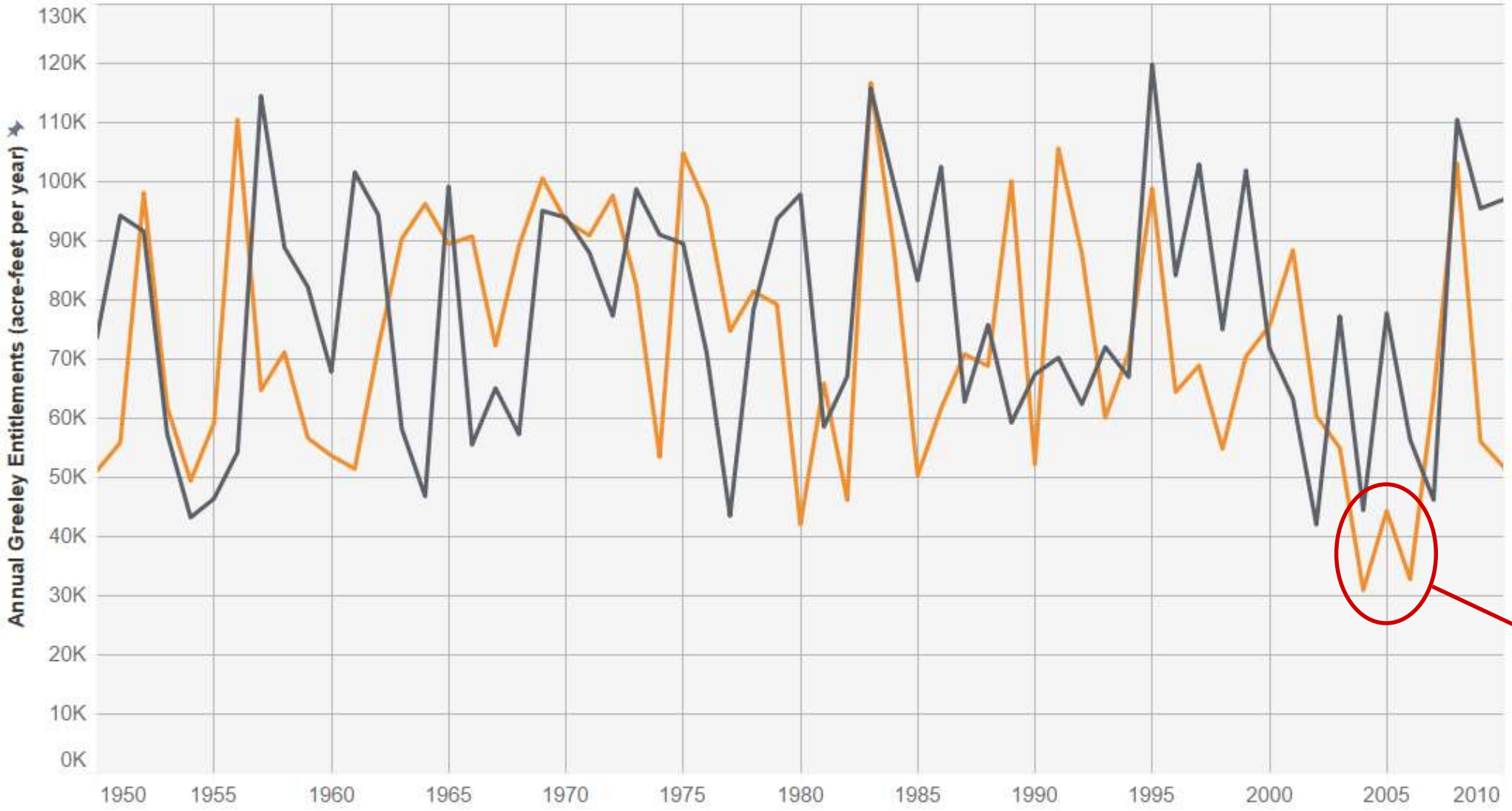


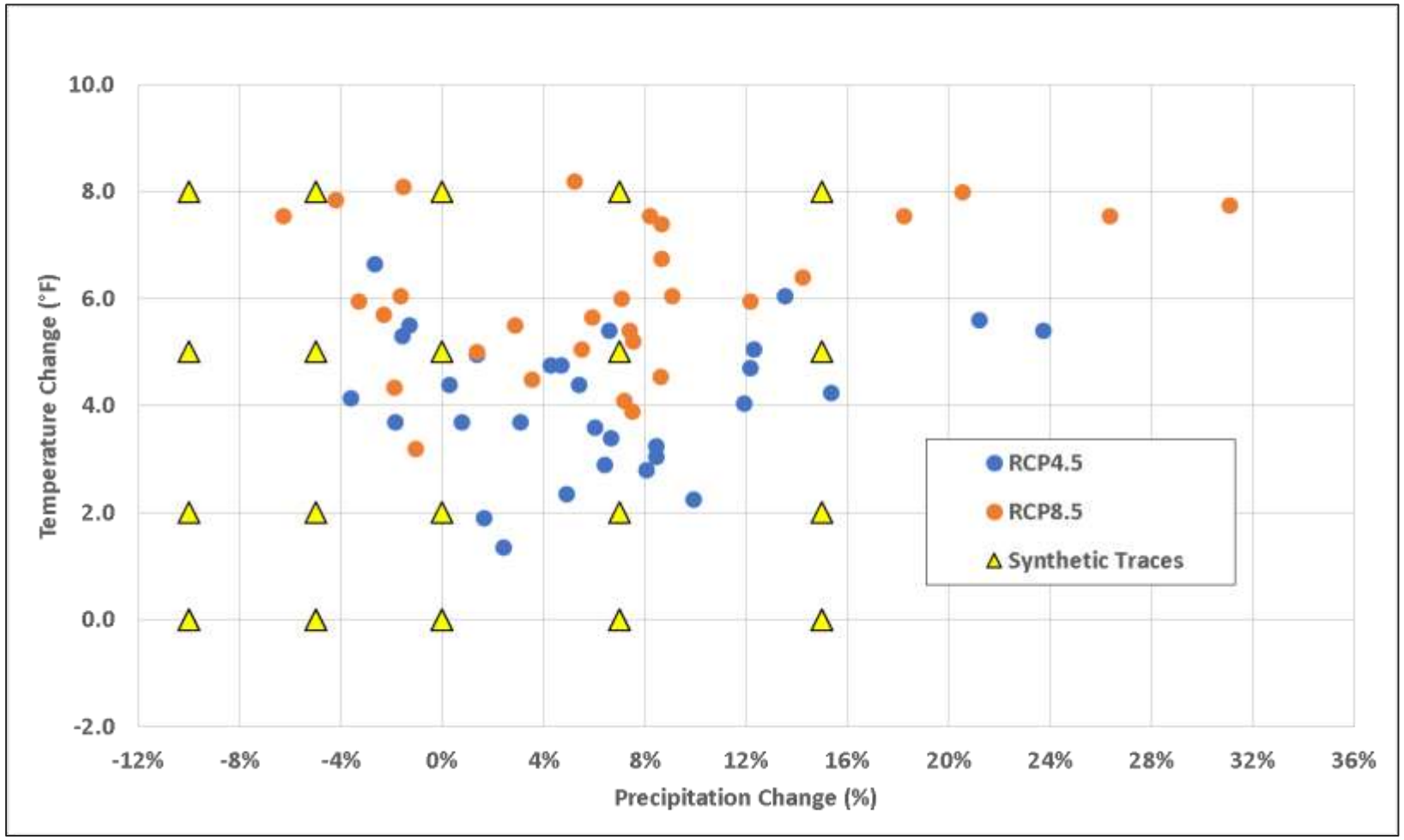
Timeseries of Greeley's annual entitlements under historical hydrology and a the new timeseries "D"

3 consecutive years worse than 2002

Current Climate Takeaways

- Resequencing using Tree Ring data shows droughts of greater intensity, duration, and frequency are possible regardless of long-term climate change
- Timeseries selected for the IWRP purposefully have more severe droughts than the historical record
- Different types of droughts will robustly stress Greeley's water supply system
- Builds on existing 1-in-50 Critical Drought approach which is a 6-year drought

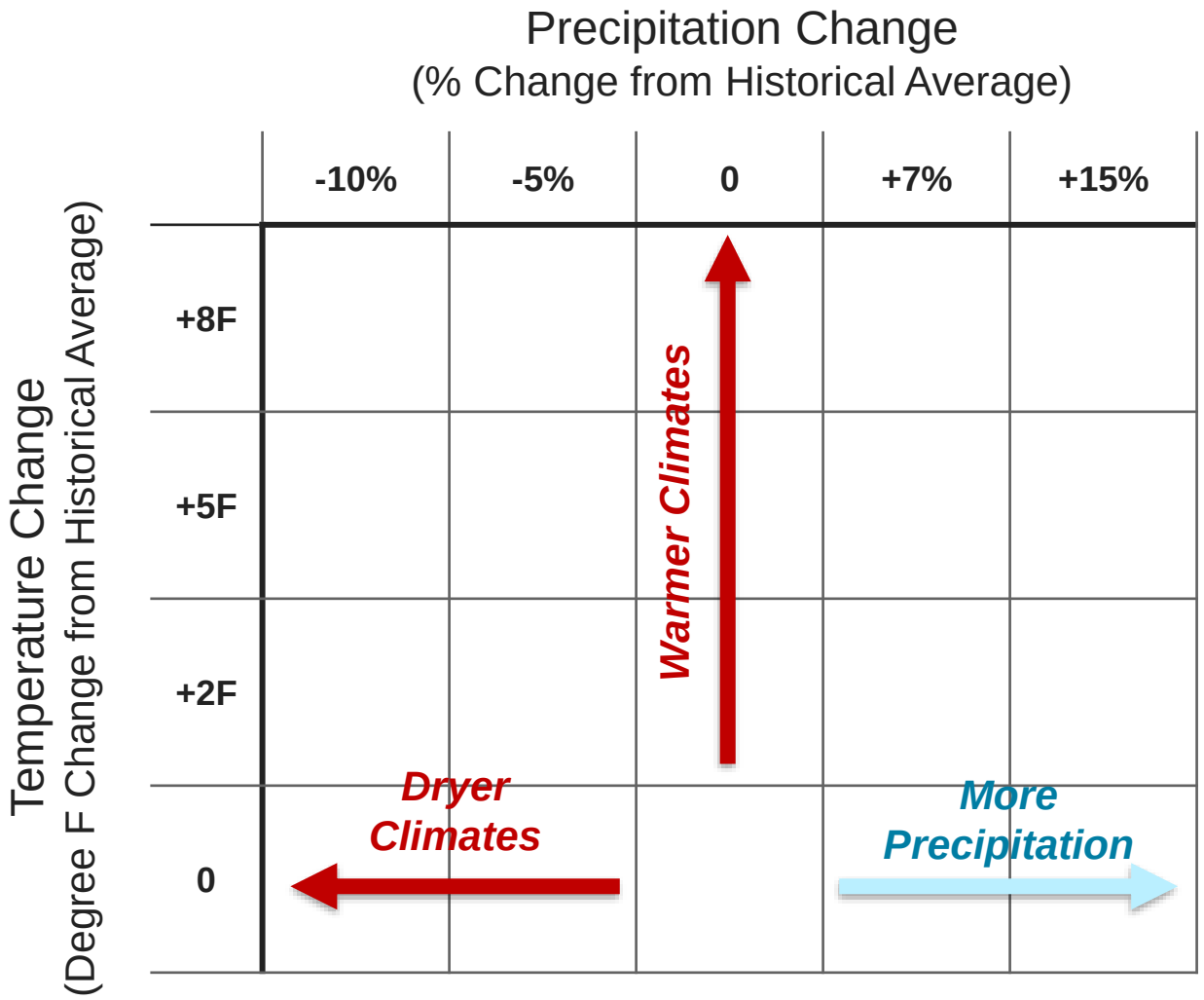
Potential Changes in Climate



- Orange and blue points are future T&P offsets as projected by various Global Climate Models for two emission scenarios
  - Poudre River Watershed
  - 2050 – 2074 climate
- Yellow triangles are selected T&P offsets

Precipitation Change
(% Change from Historical Average)

Temperature Change (Degree F Change from Historical Average)	-10%	-5%	0	+7%	+15%
+8F					
+5F					
+2F					
0					


Precipitation Change
(% Change from Historical Average)
-10%
-5%
0
+7%
+15%
Temperature Change
(Degree F Change from Historical Average)
+8F
+5F
+2F
0
Warmer Climates
Dryer Climates
More Precipitation

Average Annual Total Greeley Entitlements
(acre-feet per year)

	-10%	-5%	0	+7%	+15%
+8F					
+5F					
+2F					
0			75,400		

Average across 6 Timeseries + Historical

Key Takeaways

- Greeley's system has already been impacted by a warming climate and those will continue
- A dryer climate will reduce yields in all of Greeley's water supply systems
- Effects from a warmer climate with increased precipitation are difficult to quantify

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- How agricultural demands and water rights administration evolve as climate changes could be as impactful as the changing climate
- Greeley's system utilizes a diverse portfolio of water rights with a variety of priority dates – some more vulnerable than others. This diverse portfolio provides a robust and resilient water supply system for the Greeley residents.

Unknown Effects of Hydrograph Shift

- Agricultural Demands
  - Timing and volume of agricultural demands may change how water rights yield
- Water Rights Administration
  - Yields from changed water rights may decrease as hydrograph departs further away from historical pattern

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The IWRP accounts for these by:

1. Conservative modeling assumptions
2. Risk that decreases Greeley's simulated entitlement
3. Adaptive planning

Effects of Hydrograph Shift

Agricultural water demands

Historic **Hydrology** and
Ag. Demand Timing

Effects of Hydrograph Shift

Agricultural water demands

Historic **Hydrology** and **Ag. Demand** Timing

Shifted **Hydrology** and Historic **Ag. Demand** Timing showing “excess” water available

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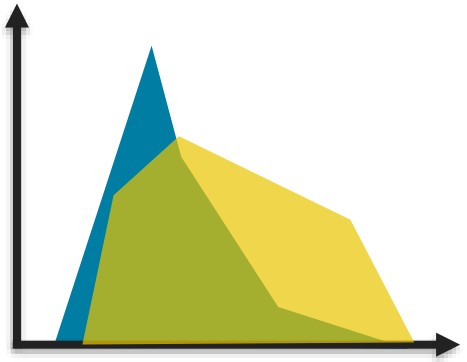
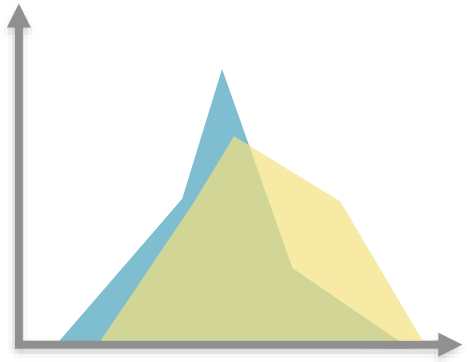


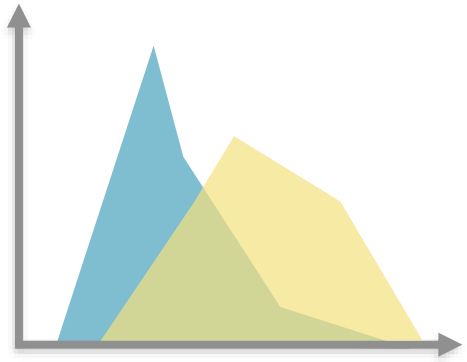
How **Ag. Demand** changes to align with **Hydrology** and Climate will impact Greeley

Effects of Hydrograph Shift

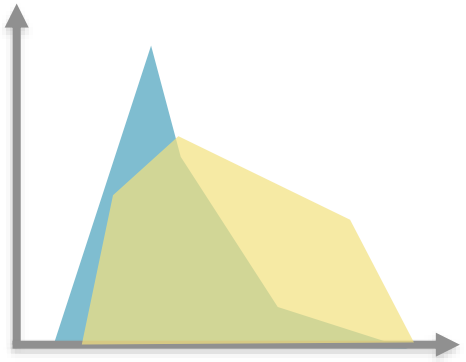
Water Rights Administration



Historic **Hydrology** and **Ag. Demand** Timing



Shifted **Hydrology** and Historic **Ag. Demand** Timing showing "excess" water available



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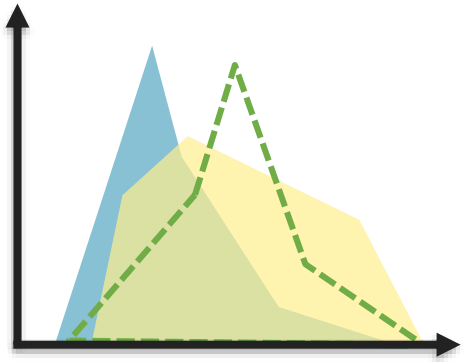

Historical Use will impact yields from changed water rights.

Total System

Total Water Supply System
Average Annual Entitlements (acre-feet per year)

	-10%	-5%	0	+7%	+15%
+8F	50,800	59,200	67,500	76,600	83,500
+5F	51,000	59,000	67,100	75,700	82,200
+2F	58,800	68,100	75,400	83,600	88,300
0	59,300	68,300	75,400	82,600	87,200

Change in Total Water Supply System from 0/0 Climate
Average Annual Entitlements (acre-feet per year) & Percent

	-10%	-5%	0	+7%	+15%
+8F	-24,600 -33%	-16,200 -21%	-7,800 -10%	1,200 2%	8,100 11%
+5F	-24,300 -32%	-16,300 -22%	-8,300 -11%	400 0%	6,800 9%
+2F	-16,600 -22%	-7,300 -10%	0 0%	8,200 11%	13,000 17%
0	-16,100 -21%	-7,100 -9%	0 0%	7,200 10%	11,800 16%

Conclusion Statement	Confidence
Droughts of greater duration, frequency, and severity than observed are possible under current climate.	
Greeley's system has already been impacted by a warming climate and those climate will continue.	
A dryer climate will reduce yields in all of Greeley's water supply systems.	
Senior systems are less vulnerable to climate change.	
High Mountain Reservoirs are vulnerable to climate change.	
The Colorado system is vulnerable to climate change.	
Changes in agricultural demands and water rights administration will impact Greeley.	
How changes in agricultural demands and water rights administration impact Greeley are quantifiable.	
Reductions in precipitation could decrease Greeley's entitlements between 20% and 30%.	
Climates with increased precipitation will mitigate impacts of a warming climate.	

Next Steps and Questions