Integrated Water Resource Plan

Water and Sewer Board Update

February 15, 2023

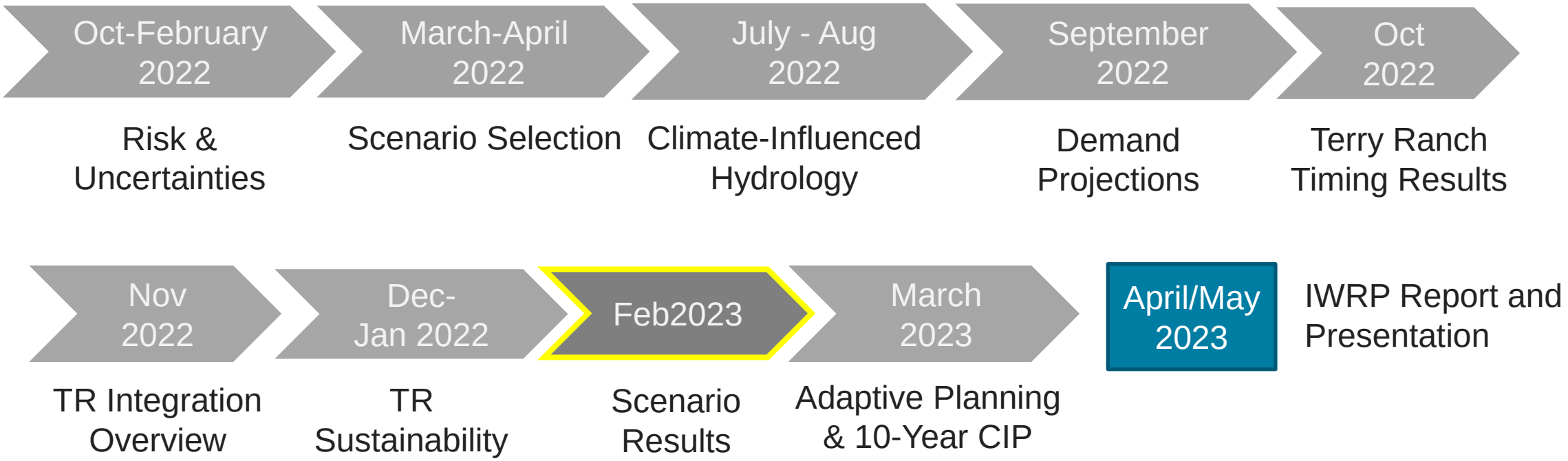
City of Greeley Colorado

Stantec

IWRP Vision Statement

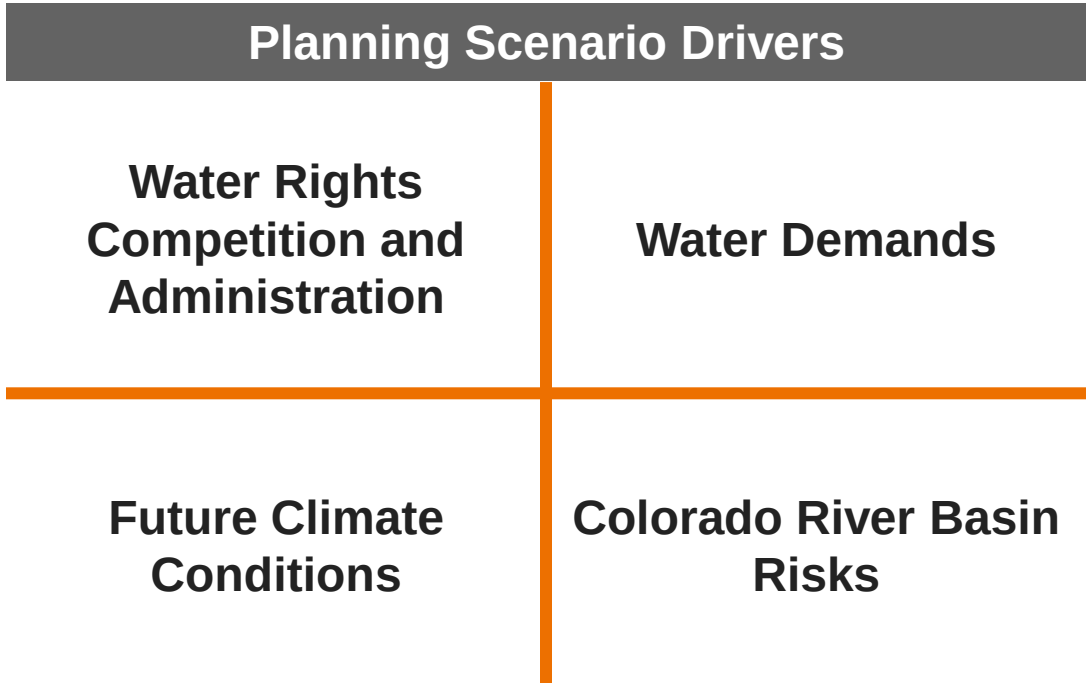
"An actionable and adaptive master plan for Greeley's water resources that uses modern, defensible methods to develop a roadmap ensuring a reliable water supply for our community through an uncertain future."

IWRP Timeline



IWRP Planning Scenario Review

- Incorporate uncertainty
- Define how key drivers of uncertainty may vary in the future
- Develop Planning Scenarios that narratively connect drivers of uncertainty



Initial Planning Scenarios

Planning Scenario Name	Water Supply System	Climate	Demands	Risks
High Bookend	Reduced Yields	Hot and Dry	High Bookend	CO Basin Reductions Increased Wildfires Increased Evaporation Regional water issues
Median	Reduced Yields	Warm	Median	CO Basin Reductions Increased Wildfires Increased Evaporation
Mix and Match	Reduced Yields	Hot and Wet	Median w/Decreased Per Capita Use	CO Basin Reductions Increased Wildfires Regional water issues
Low Bookend	Expected Yields	Warm and Wet	Low Bookend	CO Basin Reductions
No Climate Change	Expected Yields	No Change	Median w/Decreased Per Capita Use	CO Basin Reductions

Refined Planning Scenarios

Planning Scenario Name	Water Supply System	Climate	Demands	CO River Basin Risks
Unbearable	Reduced Yields	Hot	High Bookend	5-Year 25% Yield Reduction 1-year Outage Chronic 10% Yield Reduction
Stressed	Reduced Yields	Hot	Median	5-Year 25% Yield Reduction 1-year Outage
Continued Trends	Reduced Yields	Warm	Median w/Decreased Per Capita Use	5-Year 25% Yield Reduction 1-year Outage
Optimistic	Expected Yields	Warm	Low Bookend	2-year 25% Yield Reduction
No Climate Change	Expected Yields	No Change	Median w/Decreased Per Capita Use	2-year 25% Yield Reduction

Refined Planning Scenarios

Significant uncertainty in potential long-term precipitation changes and their impacts to hydrology and water rights.

Planning Scenario Name	Water Supply System	Climate	Demands	CO River Basin Risks
Unbearable	Reduced Yields	Hot	High Bookend	5-Year 25% Yield Reduction 1-year Outage Chronic 10% Yield Reduction
Stressed	Reduced Yields	Hot	Median	5-Year 25% Yield Reduction 1-year Outage
Continued Trends	Reduced Yields	Warm	Median w/Decreased Per Capita Use	5-Year 25% Yield Reduction 1-year Outage
Optimistic	Expected Yields	Warm	Low Bookend	2-year 25% Yield Reduction
No Climate Change	Expected Yields	No Change	Median w/Decreased Per Capita Use	2-year 25% Yield Reduction

Refined Planning Scenarios

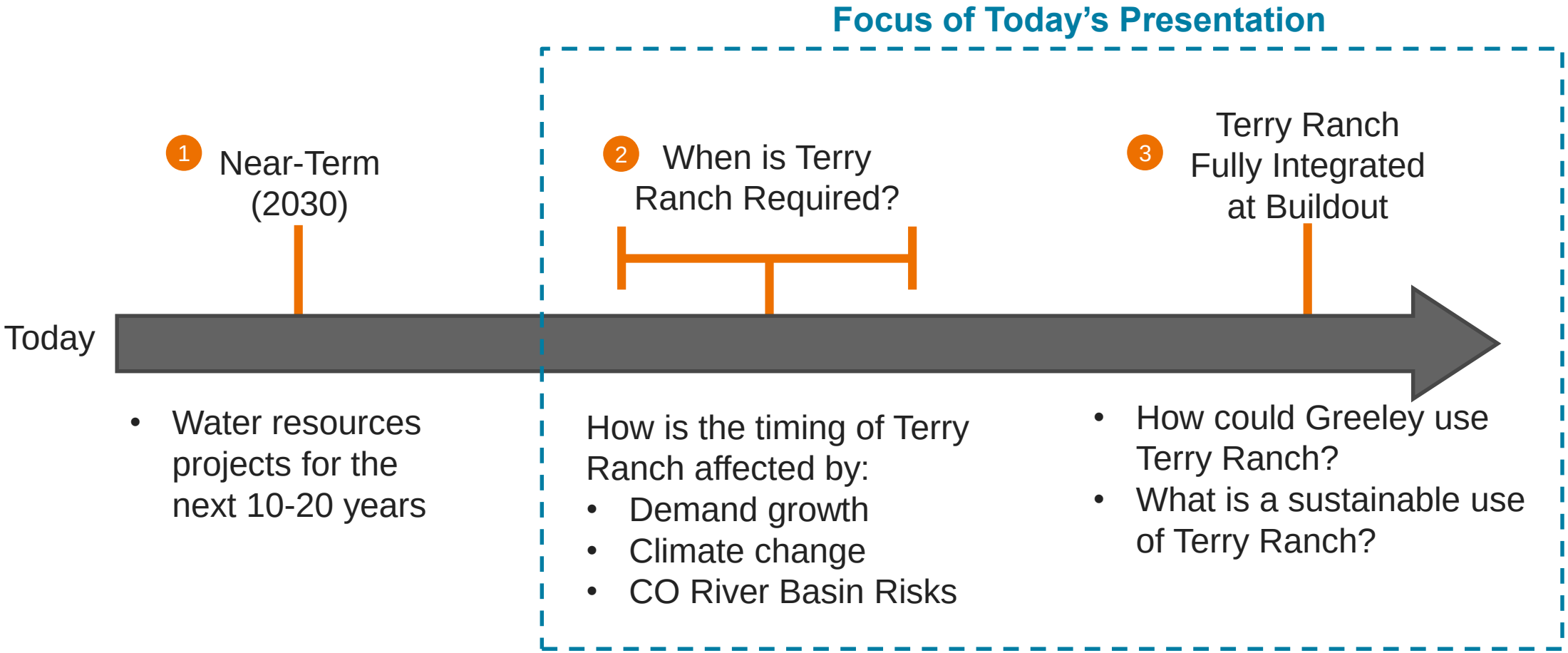
Focus on CO River Basin risks that have high potential for impacts to Greeley and that are not captured elsewhere in Scenario development.

Planning Scenario Name	Water Supply System	Climate	Demands	CO River Basin Risks
Unbearable	Reduced Yields	Hot	High Bookend	5-Year 25% Yield Reduction 1-year Outage Chronic 10% Yield Reduction
Stressed	Reduced Yields	Hot	Median	5-Year 25% Yield Reduction 1-year Outage
Continued Trends	Reduced Yields	Warm	Median w/Decreased Per Capita Use	5-Year 25% Yield Reduction 1-year Outage
Optimistic	Expected Yields	Warm	Low Bookend	2-year 25% Yield Reduction
No Climate Change	Expected Yields	No Change	Median w/Decreased Per Capita Use	2-year 25% Yield Reduction

Planning Scenarios

Planning Scenario	Description
Unbearable	Greeley's future demands have tracked with the most impactful future conditions: population has grown according to the highest forecast, climate has warmed rapidly, and impacts to Greeley's East Slope water rights and Colorado River supplies are the most severe.
Stressed	A rapidly warming climate and faster-than-expected population growth within established water providers such as Greeley exacerbates water availability issues. Greeley's water supply system must meet this increased demand amongst significant yield impacts.
Continued Trends	Recent trends in per capita water use, climate change, Colorado River basin issues, and competition for water rights continue.
Optimistic	Greeley's water supply system is less stressed than anticipated due to a combination of improved water conservation savings, diminished climate change impacts, and advantageous water rights yields.
No Climate Change	Without climate change, Greeley's water supply system would be less stressed and require less additional water resources.

Planning Horizons



The IWRP Adaptive Plan

- Defines actions for Greeley after completion of the IWRP to continue prudent planning
  - Extends benefit of IWRP beyond completion

- Consists of indicators to monitor, trigger points and corresponding actions (e.g. Terry Ranch implementation), and schedule of activities
  - Per capita demands, water right change case outcomes, annual demands
  - Annual report, quarterly updates, etc.

- Adaptive Plan is developed using outcomes and conclusions from the IWRP

Planning Scenario Results:
Terry Ranch Integration and Timing

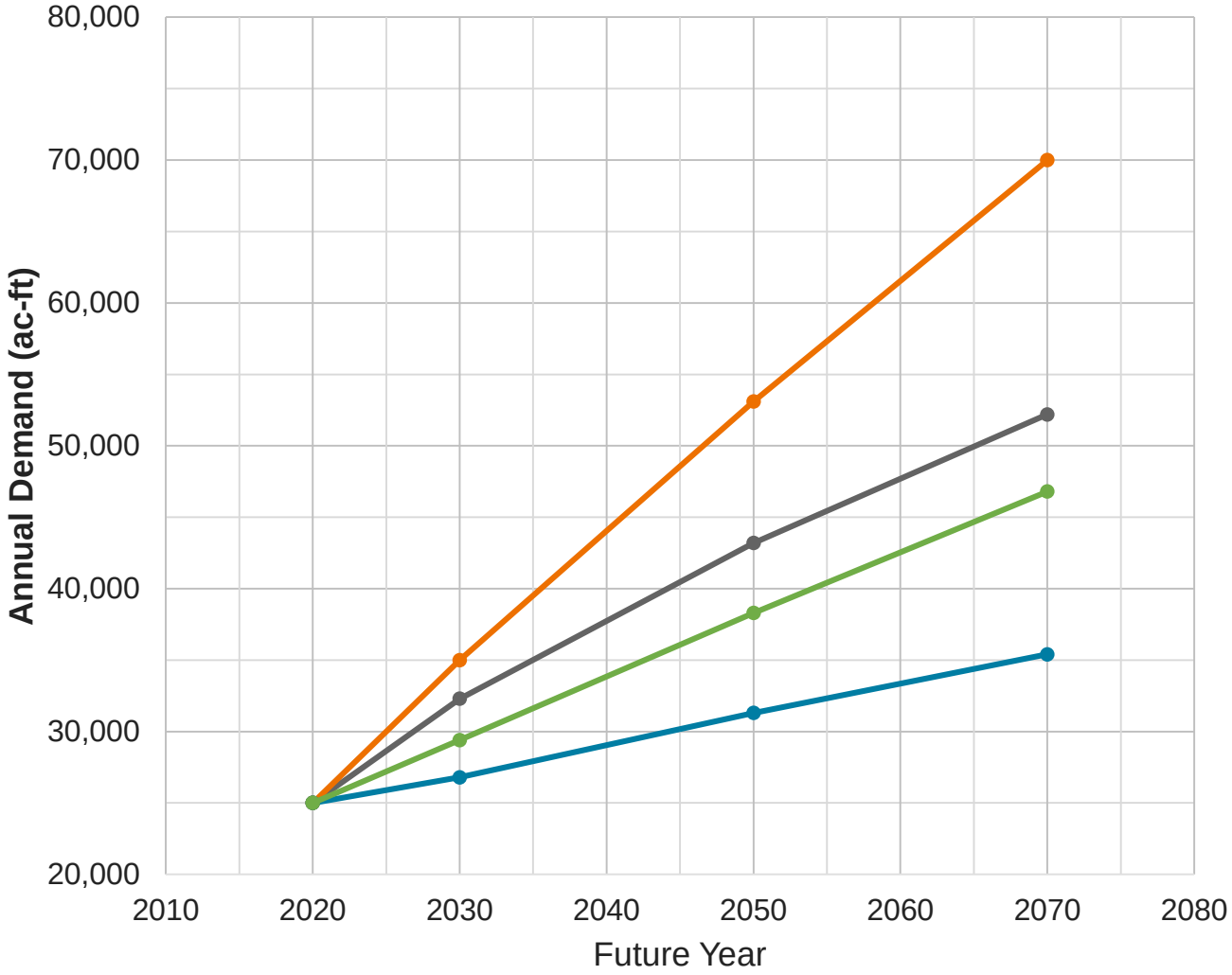
Planning Scenarios

Planning Scenario	Description
Unbearable	Greeley's future demands have tracked with the most impactful future conditions: population has grown according to the highest forecast, climate has warmed rapidly, and impacts to Greeley's East Slope water rights and Colorado River supplies are the most severe.
Stressed	A rapidly warming climate and faster-than-expected population growth within established water providers such as Greeley exacerbates water availability issues. Greeley's water supply system must meet this increased demand amongst significant yield impacts.
Continued Trends	Recent trends in per capita water use, climate change, Colorado River basin issues, and competition for water rights continue.
Optimistic	Greeley's water supply system is less stressed than anticipated due to a combination of improved water conservation savings, diminished climate change impacts, and advantageous water rights yields.
No Climate Change	Without climate change, Greeley's water supply system would be less stressed and require less additional water resources.

TR Integration Planning Horizon

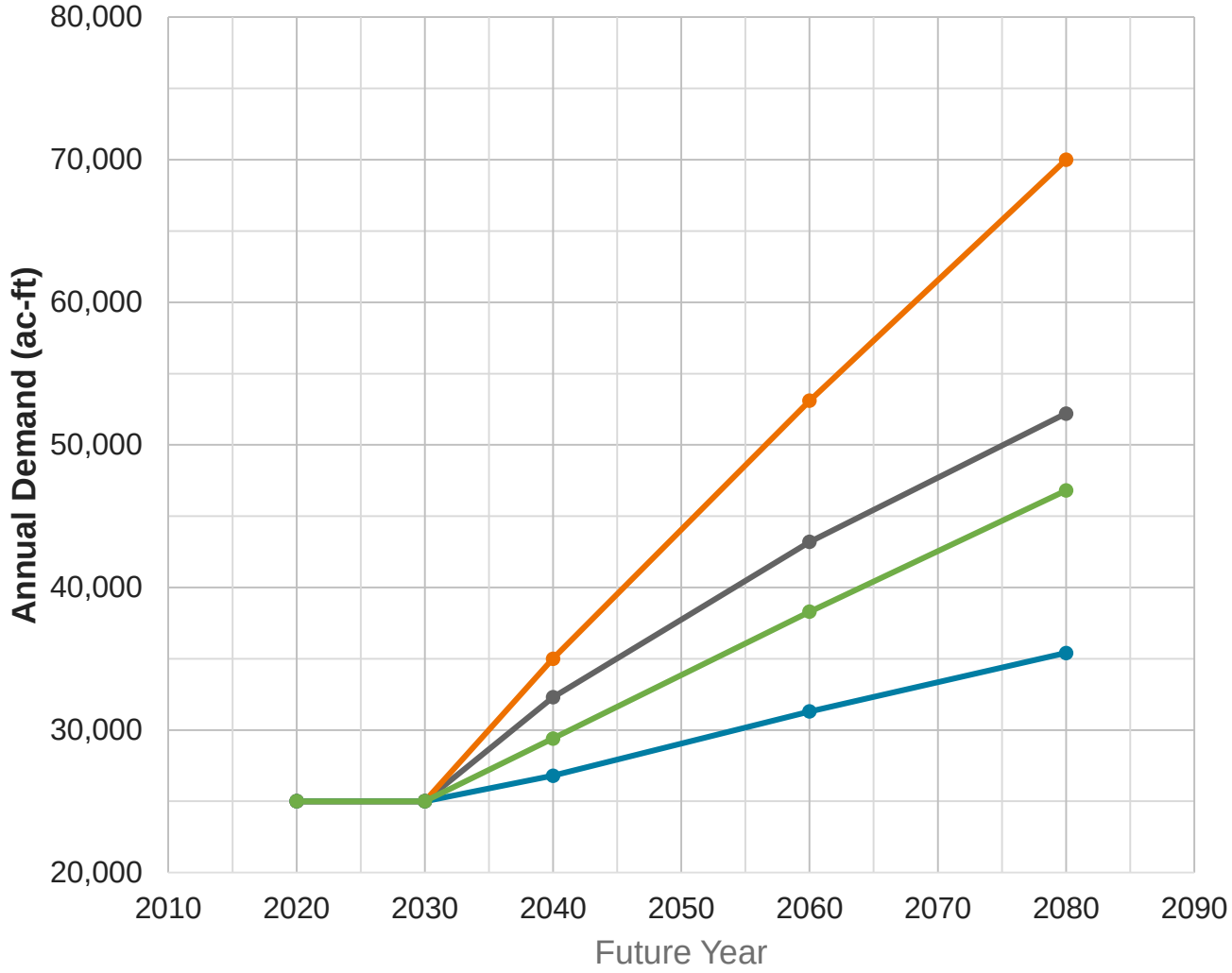
Planning Scenario Name	Water Supply System	Climate	Demands (Potable and Non-Potable)	Risks
Unbearable	10% Reduced Yields	+8F Warmer	70,000 af (2070 High Bookend)	High CO Basin Impacts
Stressed	10% Reduced Yields	+8F Warmer	57,100 af	Med. CO Basin Impacts
Continued Trends	10% Reduced Yields	+5F Warmer	46,800 af (2070 Median w/Decreased Per Capita Use)	Med. CO Basin Impacts
Optimistic	No Yield Change	+2F Warmer	46,800 af (2070 Median w/Decreased Per Capita Use)	Low CO Basin Impacts
No Climate Change	No Yield Change	No Change	57,100 af	Low CO Basin Impacts

Future Demand Uncertainty



- Current 2070 projects have a range of 35,000 af. That's 10,000 af more than Greeley's current demands!
- A demand of 45,000 af could be realized between 2040 (20 years) to 2120 (100 years!)

Future Demand Uncertainty



- If demand growth does not occur as assumed, projected demands may not be realized until even later

Terry Ranch Integration Results

Preliminary Model Results Subject to Change

Planning Scenario	Additional Water Resources	% of Years with Drought Response	Average Annual Terry Ranch Extraction	Average Annual Terry Ranch Injection	Terry Ranch Long-Term Delta	Remaining Legal Aquifer Percent
Unbearable	Retiming Storage + High Water Acquisitions	100%	10,800 af	100 af	-925,000 af	23%
Stressed	Retiming Storage + High Water Acquisitions	64%	8,100 af	1,600 af	-563,000 af	53%

Adaptive Planning Consideration:

- Greeley's water supply system is vulnerable to significantly warmer climates. If climate warming is tracking with a possible 8°F future, Greeley may need to consider additional long-term solutions.

Terry Ranch Integration Results

Preliminary Model Results Subject to Change

Planning Scenario	Additional Water Resources	% of Years with Drought Response	Average Annual Terry Ranch Extraction	Average Annual Terry Ranch Injection	Terry Ranch Long-Term Delta	Remaining Legal Aquifer Percent
Adaptive Planning Consideration: • Additional water rights and Terry Ranch retiming storage could help mitigate uncertain demand growth and impacts to yield from climate change.						
Continued Trends	Retiming Storage + High Water Rights	35%	4,800 af	3,600 af	-107,000 af	91%
Optimistic	None	12%	2,500 af	4,400 af	156,000 af	113%
No Climate Change	Retiming Storage + Some Water Rights	36%	4,000 af	2,100 af	-162,000 af	86%

Terry Ranch Integration Results

Preliminary Model Results Subject to Change

Planning Scenario	Additional Water Resources	% of Years with Drought Response	Average Annual Terry Ranch Extraction	Average Annual Terry Ranch Injection	Terry Ranch Long-Term Delta	Remaining Legal Aquifer Percent
Unbearable	Retiming Storage + High Water Acquisitions	100%	10,800 af	100 af	-925,000 af	23%
Stressed	Retiming Storage + High Water Acquisitions	64%	8,100 af	1,600 af	-563,000 af	53%
Continued Trends	Retiming Storage + High Water Rights	35%	4,800 af	3,600 af	-107,000 af	91%
Optimistic	None	12%	2,500 af	4,400 af	156,000 af	113%
No Climate Change	Retiming Storage + Some Water Rights	36%	4,000 af	2,100 af	-162,000 af	86%

Terry Ranch Integration Conclusions

- Terry Ranch is a sustainable water supply source for Greeley under most Planning Scenarios with some additional water resources.
  - Include further evaluation of retiming storage and water rights in CIP
- If the climate warms rapidly (8°F by 2070), impacts to yield may require Greeley to consider additional long-term solutions.
  - Monitor yield impact trends as part of Adaptive Plan
- Demand growth and impacts to yields from climate change will drive what additional water resources Greeley needs.
  - Incorporate these indicators into Adaptive Plan

Terry Ranch Timing Analysis

- Simulate Planning Scenarios under range of Greeley demands
- Determine maximum demand that can be met while meeting planning performance criteria:
  - Meet 100% of Indoor Demands
  - Drought Restrictions No More than 20% of Years
  - Stage 3 Drought Restrictions No More than 10% of Years
- Use Adaptive Plan to identify triggers for Terry Ranch implementation

TR Timing Planning Horizon

Planning Scenario Name	Water Supply System	Climate	Risks
Unbearable	10% Reduced Yields	+5F Warmer	High CO Basin Impacts
Stressed	10% Reduced Yields	+5F Warmer	Med. CO Basin Impacts
Continued Trends	10% Reduced Yields	+2F Warmer	Med. CO Basin Impacts
Optimistic	No Yield Change	+2F Warmer	Low CO Basin Impacts
No Climate Change	No Yield Change	No Change	Low CO Basin Impacts

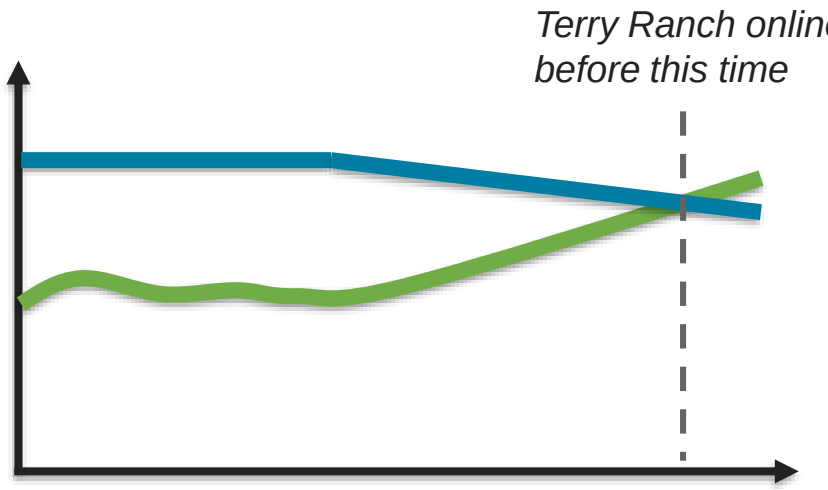
Terry Ranch Timing Results

Preliminary Model Results Subject to Change

Planning Scenario	Max. Annual Demand (Potable + Non-Potable) that Meets Planning Performance
Unbearable	32,600 af
Stressed	34,600 af
Continued Trends	37,800 af
Optimistic	41,800 af
No Climate Change	43,800 af

Triggering Terry Ranch with an Adaptive Plan

- Cannot confidently predict when Terry Ranch will be required due to uncertain demand growth
- As time progresses, surface water supply yields could be reduced by:
  - Effects of climate change
  - Colorado River Basin issues
  - Uncertain water rights change case outcomes
- Identify indicators to monitor in Adaptive Plan, and corresponding trigger actions

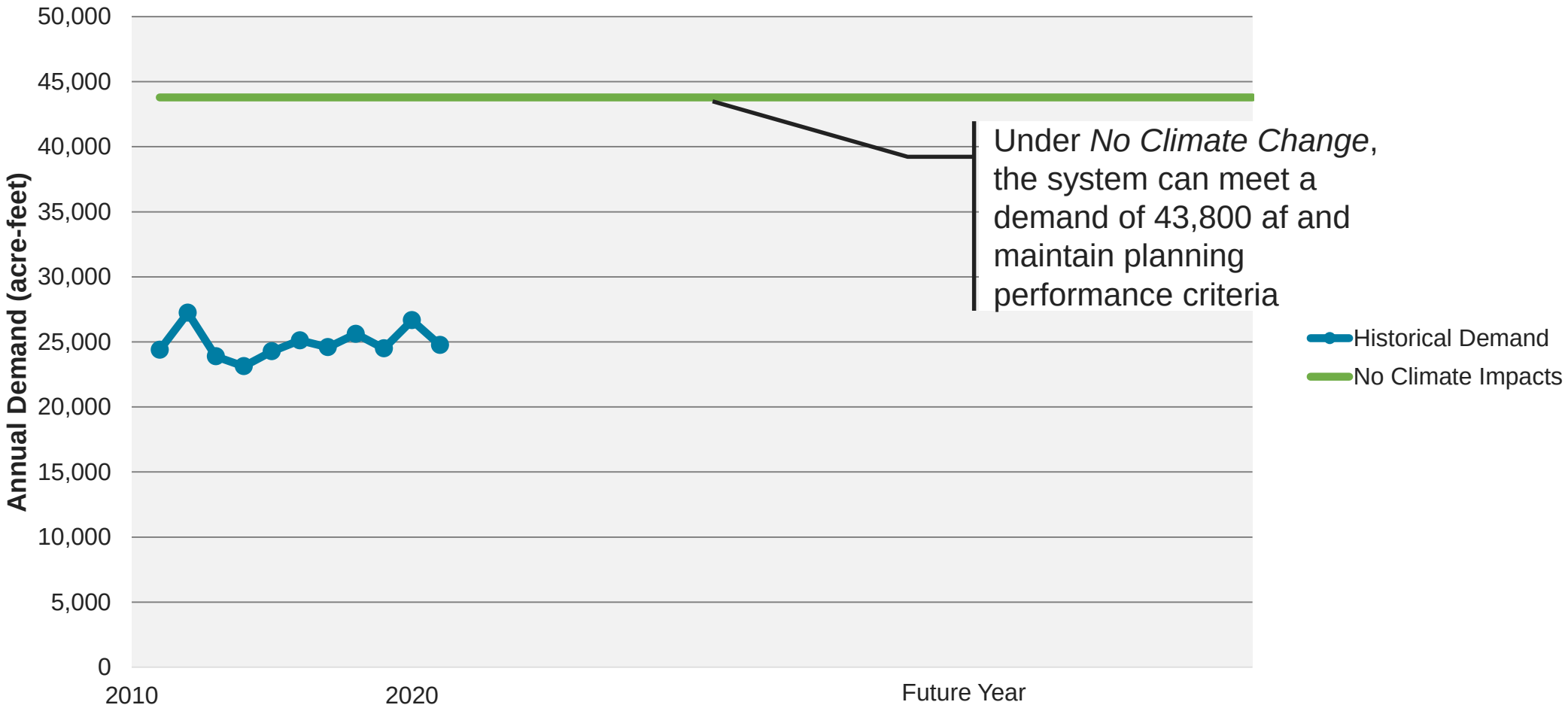


As **Greeley's Demands** resume growing, **Water Supply Yields** could gradually degrade. Terry Ranch will be required prior to when demands exceed supplies.

Providing sufficient time to complete Terry Ranch will be critical to the Adaptive Plan.

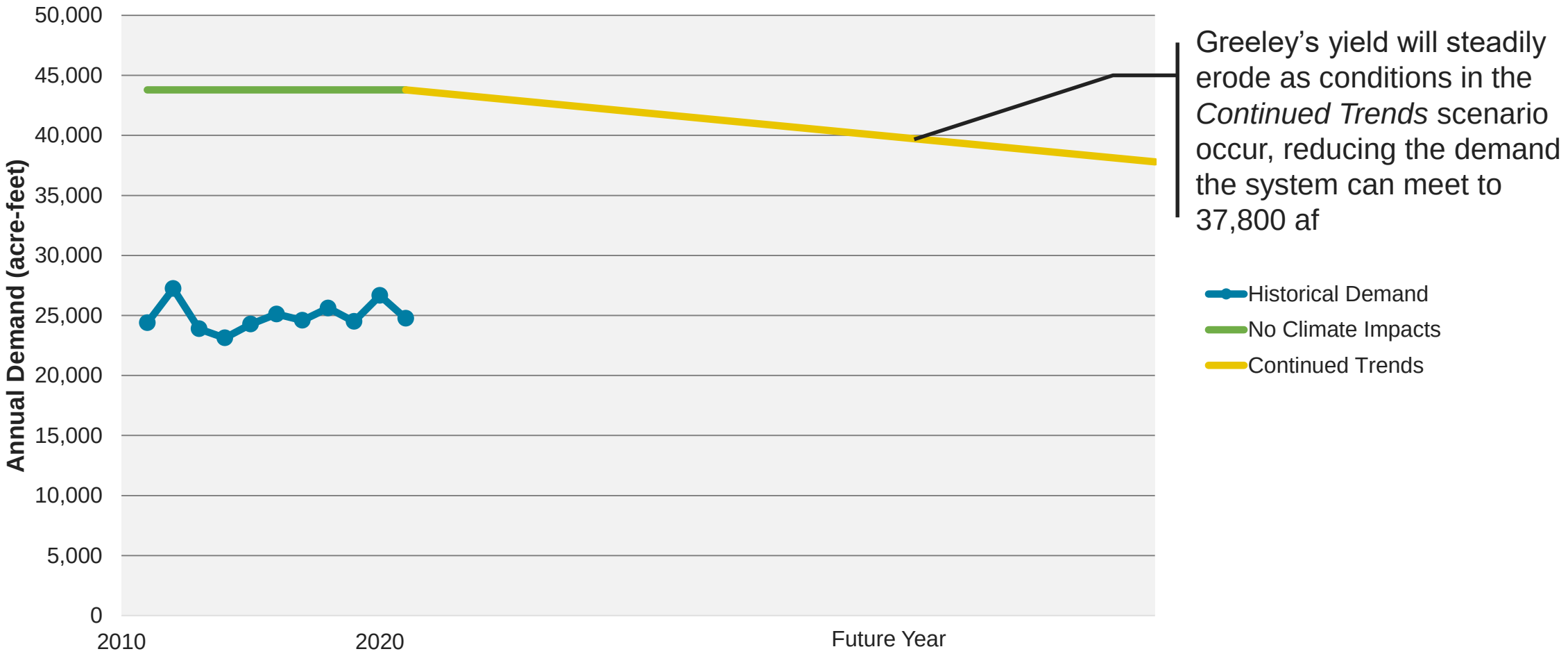
Triggering Terry Ranch Approach

Preliminary Model Results Subject to Change



Triggering Terry Ranch Approach

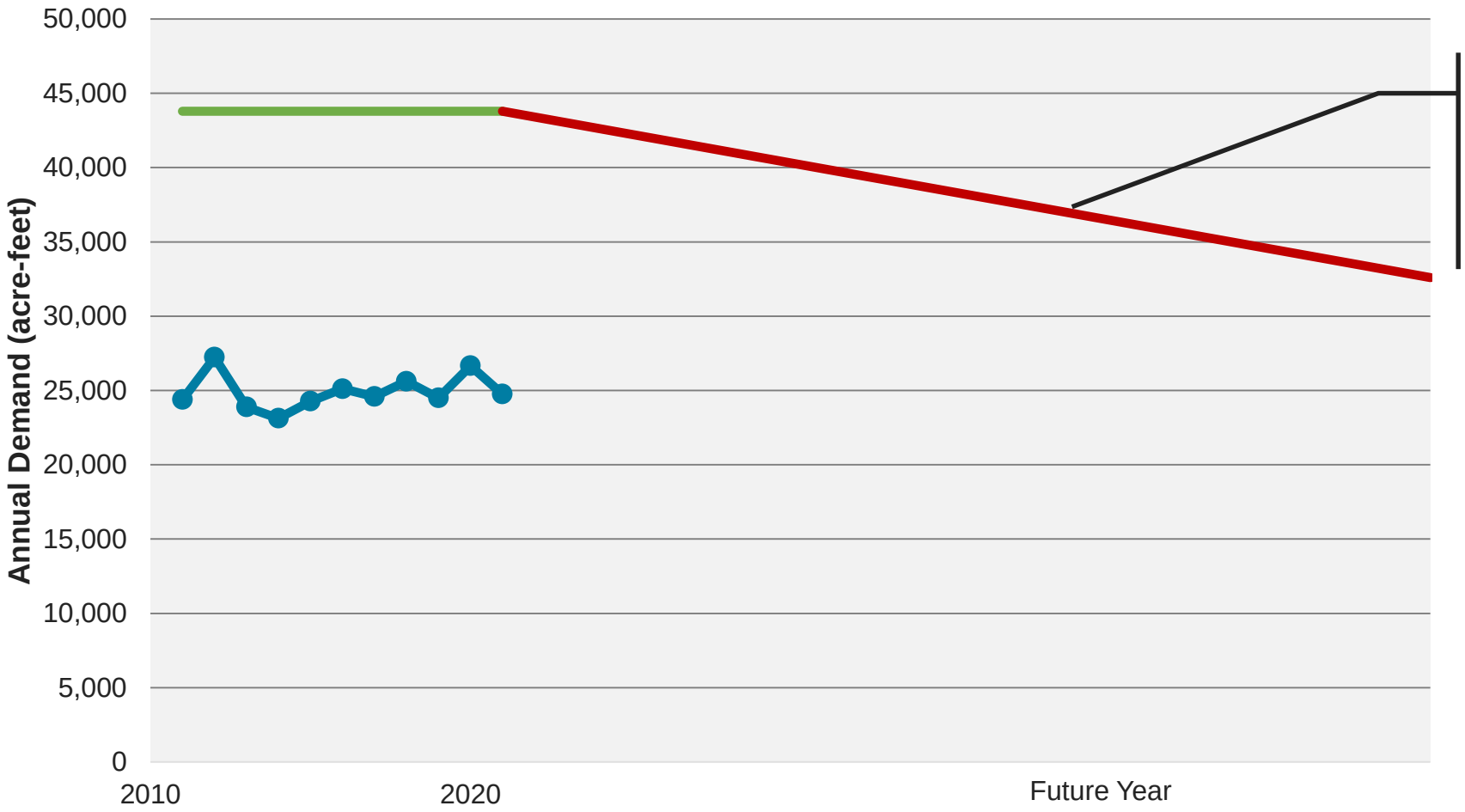
Preliminary Model Results Subject to Change



Greeley's yield will steadily erode as conditions in the *Continued Trends* scenario occur, reducing the demand the system can meet to 37,800 af

Triggering Terry Ranch Approach

Preliminary Model Results Subject to Change

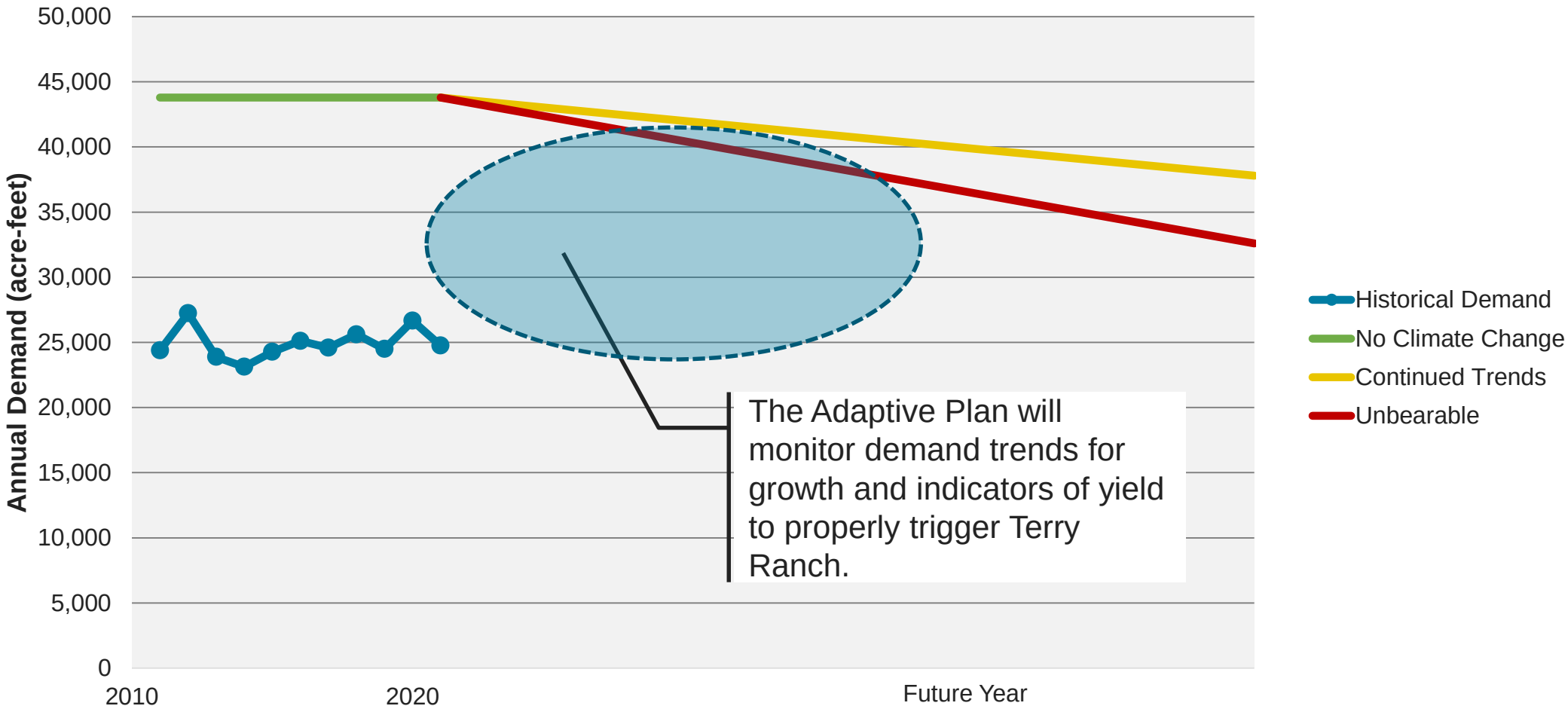


Greeley's yield could erode more under the *Unbearable scenario*, reducing the demand the system can meet to 32,600 af

Historical Demand
No Climate Change
Unbearable

Triggering Terry Ranch Approach

Preliminary Model Results Subject to Change



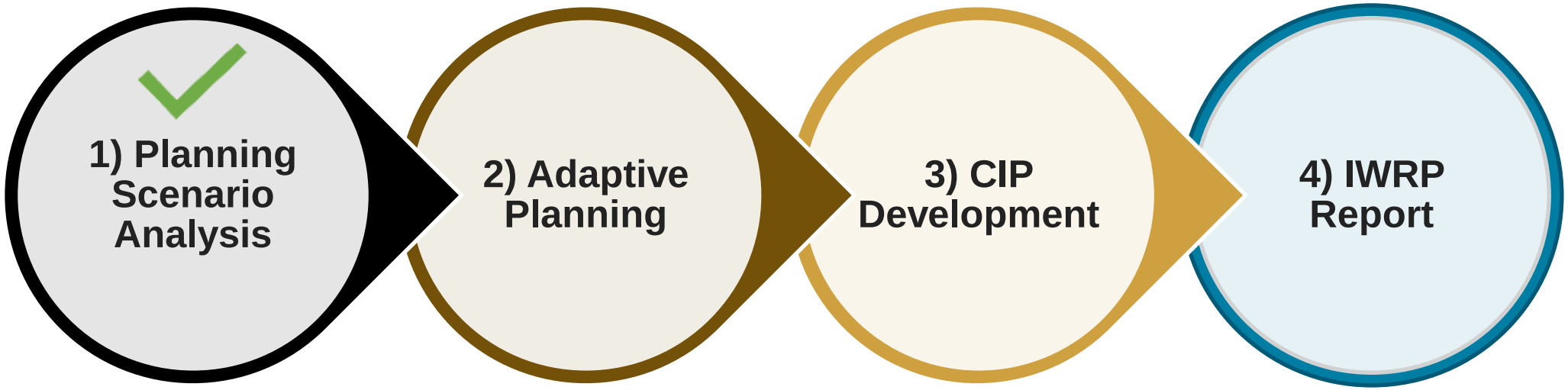
Greeley's Long-Term Big Picture

- **Greeley's water supply system is robust and adaptable:**
  - Greeley's water supply system is robust against reasonably stressful future conditions. The most impactful stressors (demand and climate) will likely have long lead times that can be effectively monitored using the Adaptive Plan to trigger Terry Ranch implementation.

- **Demand growth is highly uncertain**:
  - Demand growth will have the greatest influence over Greeley's water resources actions. At this point there is significant uncertainty of what that growth will look like. Monitoring demands will be the most important aspect of the Adaptive Plan.

- **Greeley should monitor climate change impacts**:
  - Greeley's system is vulnerable to yield impacts from a changing climate. The Adaptive Plan will identify how to monitor yield trends (change case outcomes, hydrograph shifts) to better understand impacts from climate change.

Next Steps



- How is Terry Ranch used in the Planning Scenarios?
- What conditions does Greeley need to monitor and what is the plan to do so?
- What are the costs and timing for water resource projects for the next 10 years?
- Present IWRP outcomes to Board and City Council in April

Questions?