Update on

Fully Appropriated Evaluation Methodology

Water Stakeholder Meeting
Central Platte NRD – Grand Island, NE
January 7, 2013

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THE FLATWATER GROUP INC.

CPNRD

NEBRASKA Department of Natural Resources

Today's Discussion

- Review of Project Background, Goals, and Activities
- Platte River Basin Test Case
- Methodology Recommendations
- Next Steps

Project Background

- Project History
  - CPNRD working on IMP
  - Statutes link IMP to evaluation
    - Current evaluation methodology is not linked to IMP
  - Result: CPNRD and NDNR lead effort to look at methodology
  - **Goals:**
    - Best represent supplies and uses in basins
    - Link evaluation to the IMP process.

Scope of Project

- From minor tweaks to wholesale revisions were on the table
- Possible changes to rules and procedures
- Approach:
  - Research what's being done elsewhere – not necessarily looking to reinvent the wheel
  - Identify desired elements of methodology
  - Develop methodology for testing
  - Final recommendations

Literature Review

- Sources
  - State Statutes
  - Administrative Rules
  - Special Management Areas
  - Compacts and their accounting methods

Result = No "off-the-shelf" solution

Desirable Characteristics of Methodology

- Flexible time period – reflect cyclical nature of water budget
- Reflect seasonal variations
- Independently accounts for SW/GW use and supply
- Considers variation in water supply from year to year
- Consumptive/Non-consumptive use
- Utilize existing datasets when possible
- Consider impacts of conservation practices

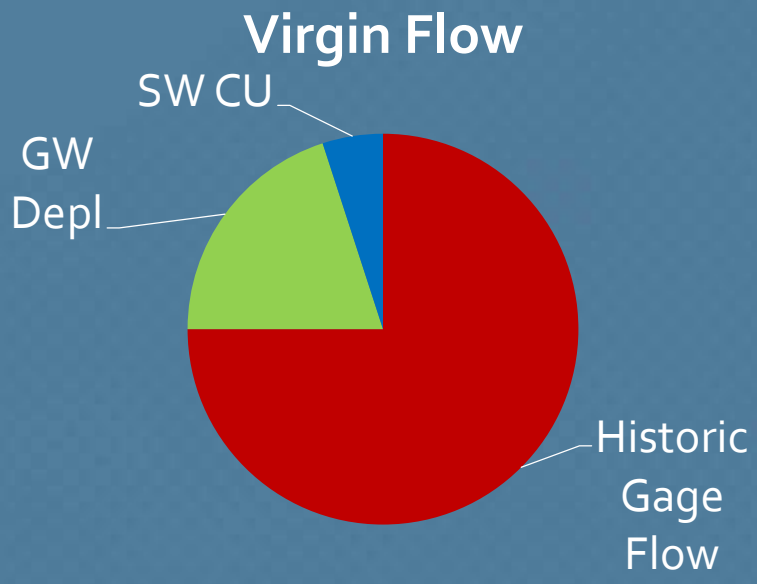
Methodology Development

- Methodology for Testing
  - **Supply** - Virgin Natural Flow Hydrograph for Supply
  - **Demand** - Identify SW and GW consumptive and non-consumptive uses
  - **SW/GW Integration** - Best available technology for SW-GW interaction (analytic, numerical modeling, etc.)
- Flexibility in tools for analysis
- Applications to Upper Niobrara and Lower Platte River

Methodology Development

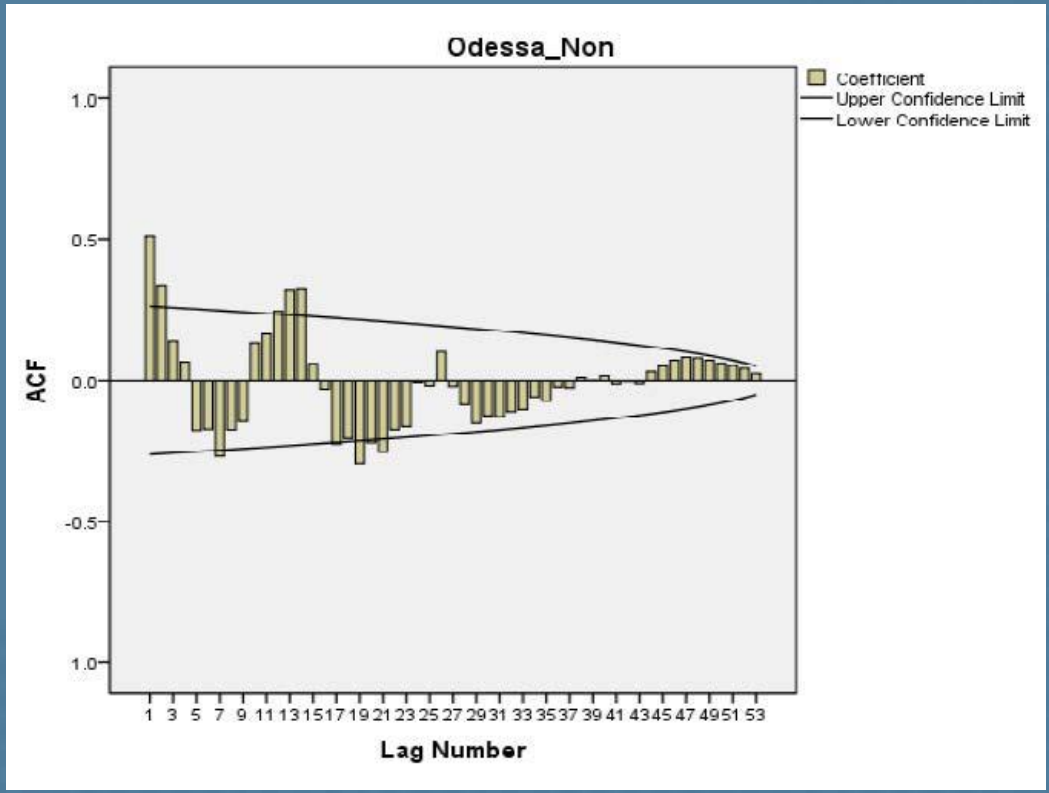
- Virgin Flow Hydrograph
  - Estimate of streamflow hydrograph "undepleted by activities of man"
  - Historic gaged flows + upstream consumptive uses:

Virgin Flow = Historic flow
+ historic SW CU
+ estimated GW depletions



Methodology Development

- Statistical Analysis to select time periods for analysis
  - Kendal Tau
    - Trends
  - Auto-Correlation
    - Cycles



Methodology Development

- Differentiate between SW and GW uses
- Represent discrete demands of each

GROUND WATER DEMANDS

Ground water irrigation (CU)
M & I wellfields (CU)

SURFACE WATER DEMANDS

Irrigation Canal Diversions (CU)
Individual irrigation appropriators (CU)
Hydropower (NonCU)
Instream flow appropriations (NonCU)
Reservoir evaporation (CU)

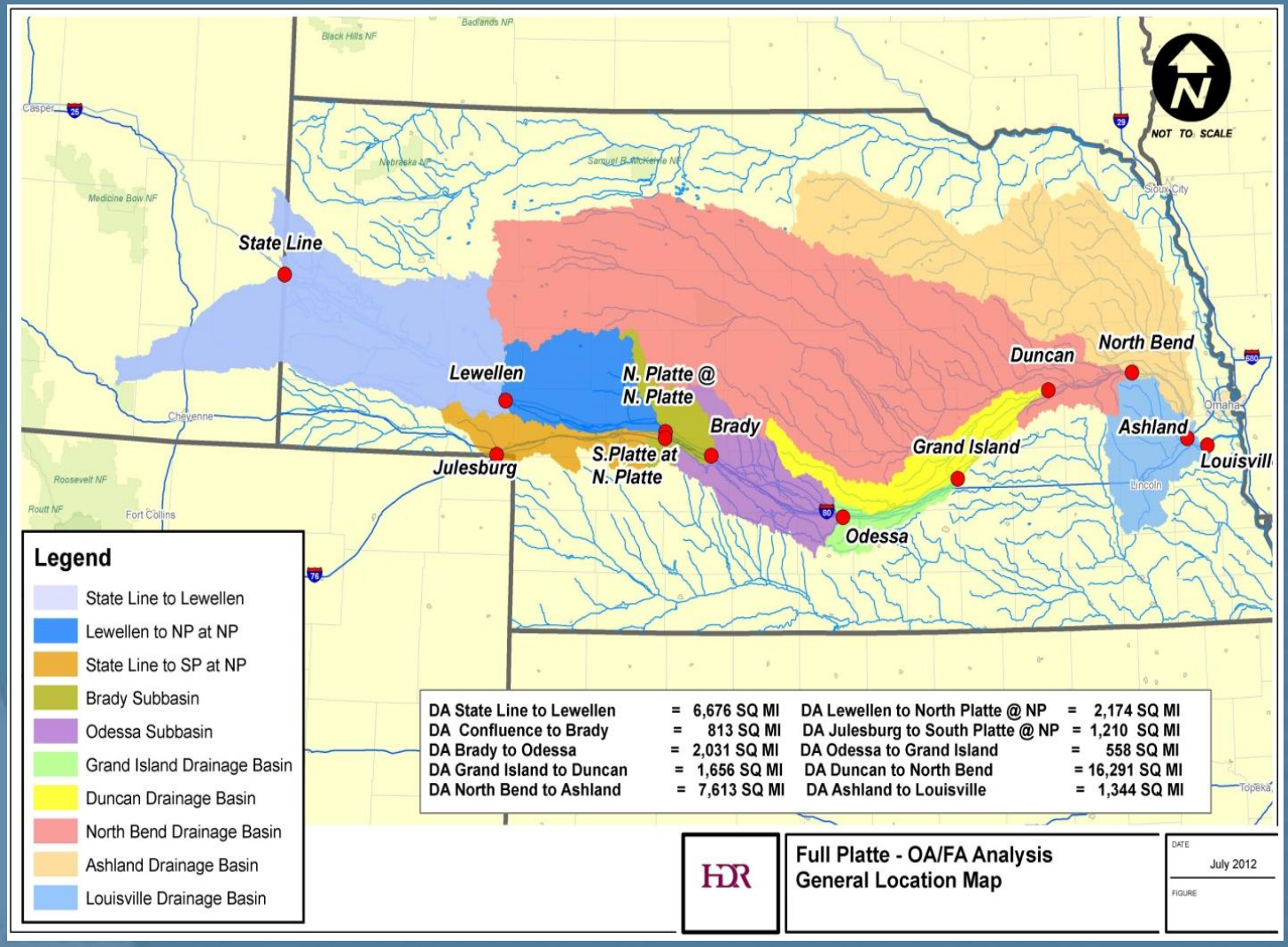
Methodology Development

- Representation of Downstream Demands
  - Use ratio of virgin natural flows to apportion downstream demands to upstream reach
- Precipitation – adjusted crop irrigation requirements
  - Variations in climatic conditions can be reflected in demands

Methodology Development

- Evaluation of GW demands using both depletions and consumptive use
  - Depletions illustrate historic usage impacts on current water supplies
  - Consumptive use illustrates current usage impacts (lag effect)

Methodology Development – Platte River Basin



Methodology Development – Platte River Basin

- Estimate Virgin Natural Flow at State Line
- Lake McConaughy and carryover storage
- Hydropower demands
- Additional Irrigation Canals
- Partitioning of supplies/demands to North and South Platte Rivers
- Municipal and Industrial demands

Methodology Development – Platte River Basin

- Virgin Natural Flow at State Line
  - South Platte River – Julesburg Gage Flows
  - North Platte River –
    - North Platte River at Wyoming/NE State Line
      + Horse Creek gage
      + 83% Interstate Canal *
      + Mitchell Gering Canal
      + Fr. Laramie Canal gaged flow at state line

*Interstate canal is gaged only at the point of diversion from North Platte River and water usage to serve Wyoming was estimated at 17%

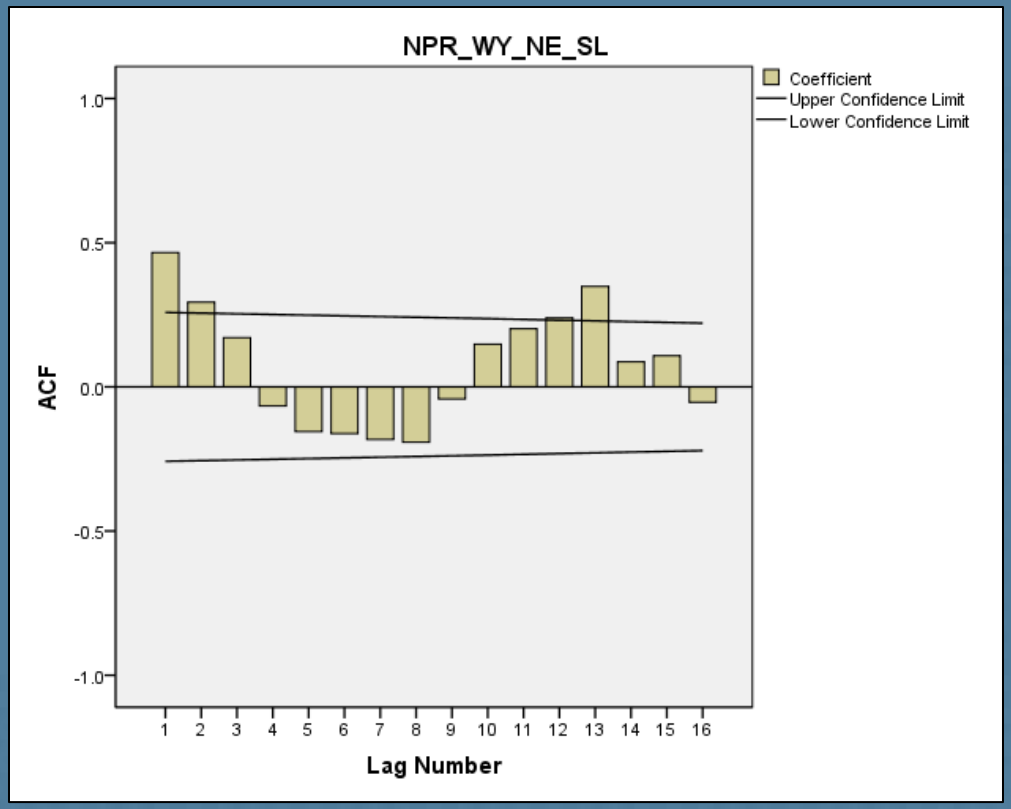
Methodology Development – Platte River Basin

- Statistical analysis of virgin natural flow to determine analysis period – Kendall Tau

		Statistically Significant Trend?					
Begin Year	End Year	Nebraska-Wyoming	Horse Creek	Ft. Laramie Canal	Mitchell Gering	Interstate Canal	Calculated State Line
1953	2009	NO	NO	NO	YES	NO	NO
1958	2009	NO	NO	NO	YES	YES	NO
1963	2009	YES	NO	NO	NO	YES	YES
1968	2009	YES	YES	NO	NO	YES	YES
1973	2009	YES	YES	NO	NO	YES	YES
1978	2009	YES	YES	NO	NO	YES	YES
1983	2009	YES	YES	NO	NO	YES	YES
1988	2009	NO	NO	NO	NO	NO	NO
1993	2009	NO	YES	NO	NO	YES	NO

Methodology Development – Platte River Basin

- Statistical analysis of virgin natural flow to determine analysis period - Autocorrelation



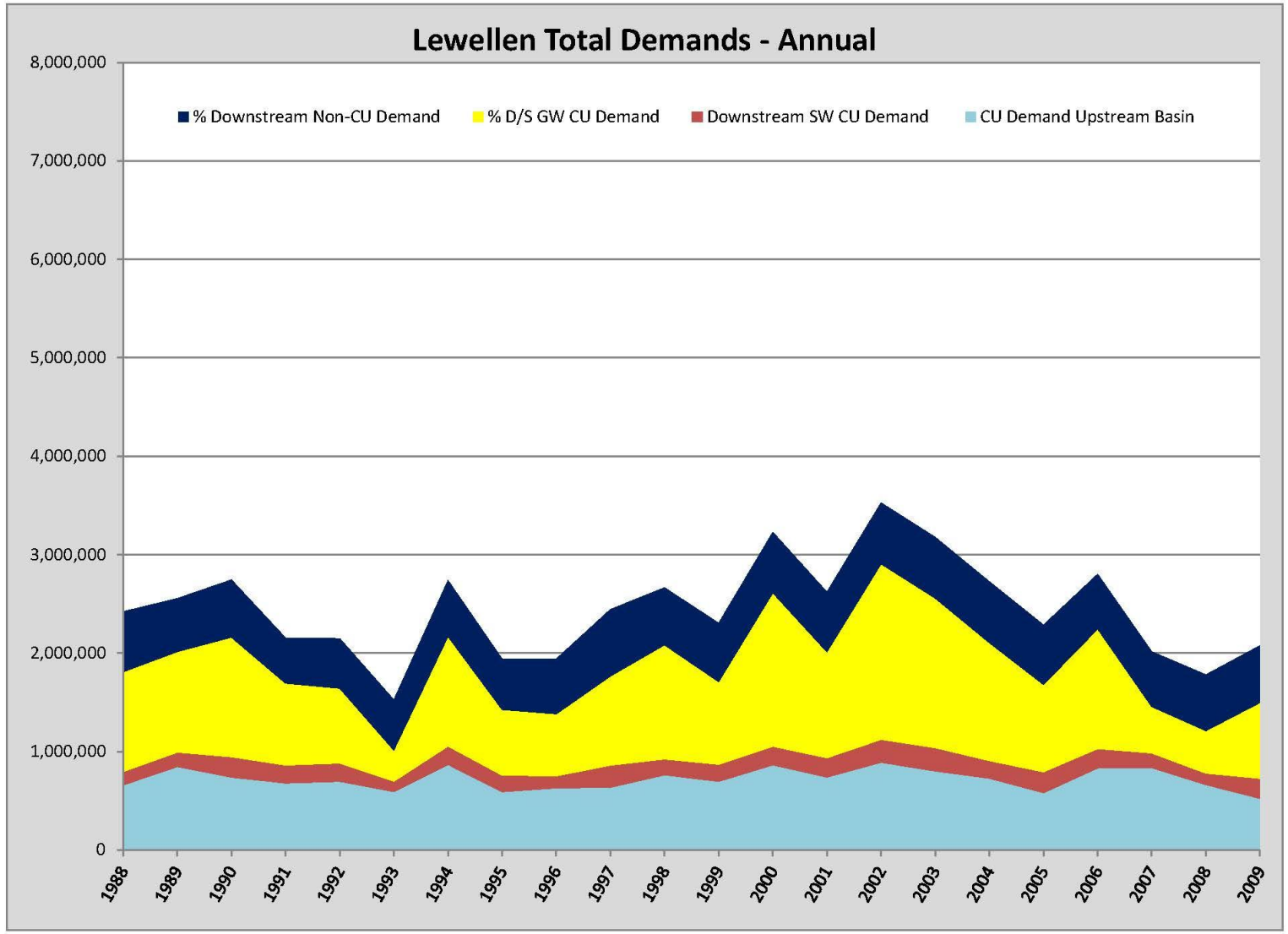
Methodology Development – Platte River Basin

- Lake McConaughy Storage
  - Inclusion of total storage in supply
    - Minimum dead storage of 80,000 AF used in this test case
  - Adjustment for change in storage

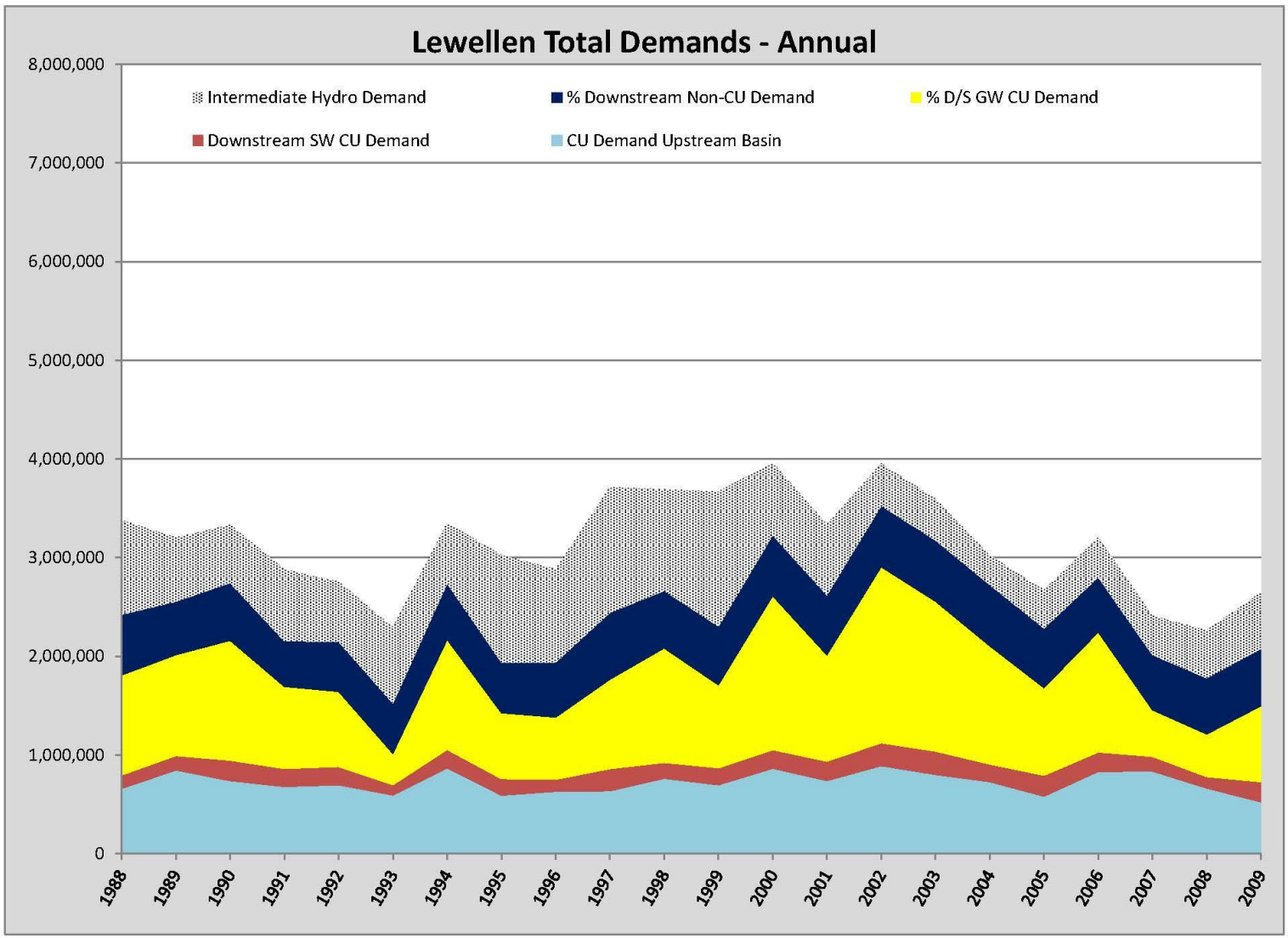
Methodology Development – Platte River Basin

- Hydropower Demand – 3 representations
  - No Hydropower demand
  - Full natural flow appropriation
  - Intermediate demand
    - Historic Lewellen Flow + 500,000 AF hydropower storage right

Lewellen Demand – Build Plot



Lewellen Demand – Build Plot



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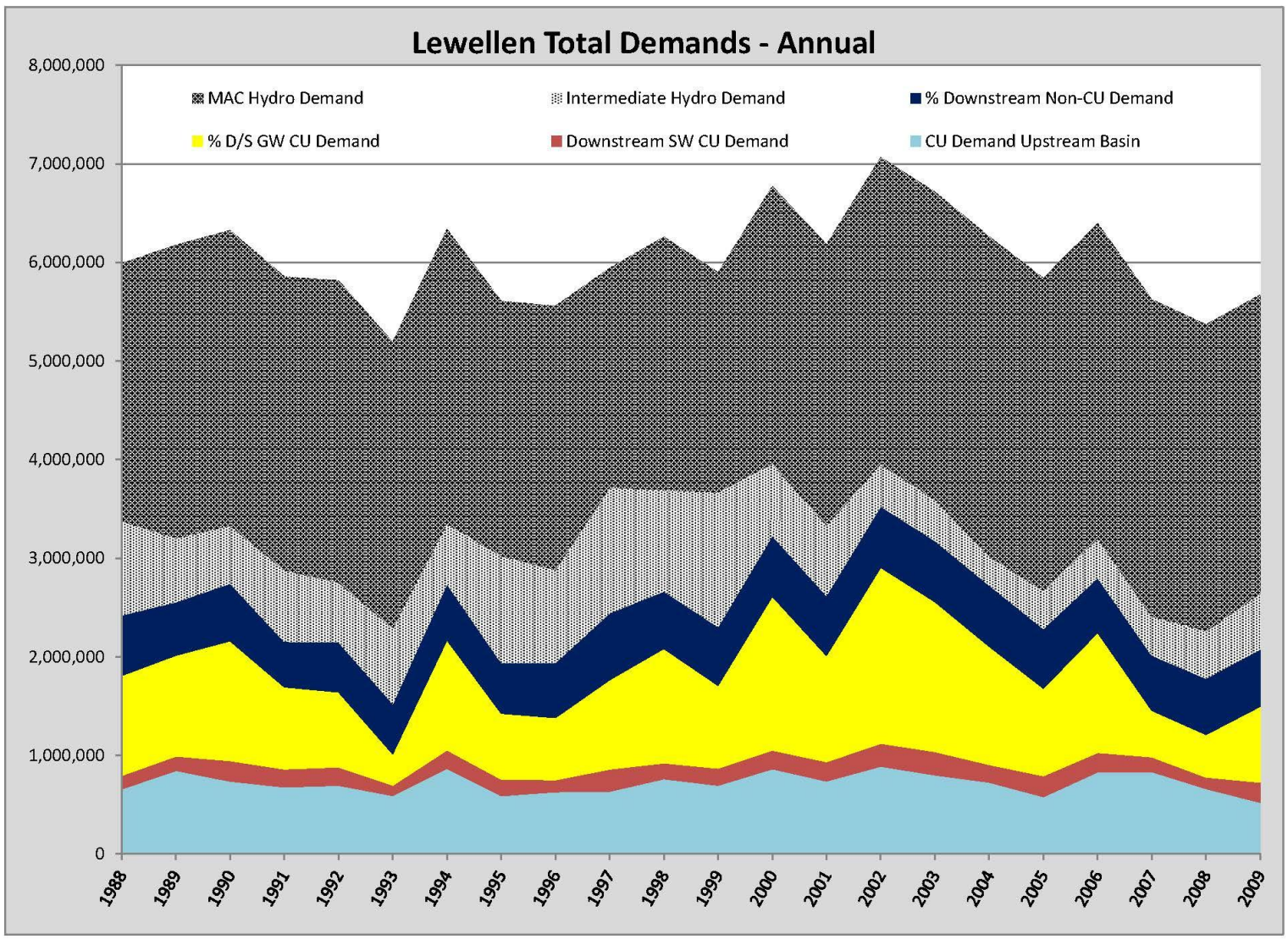


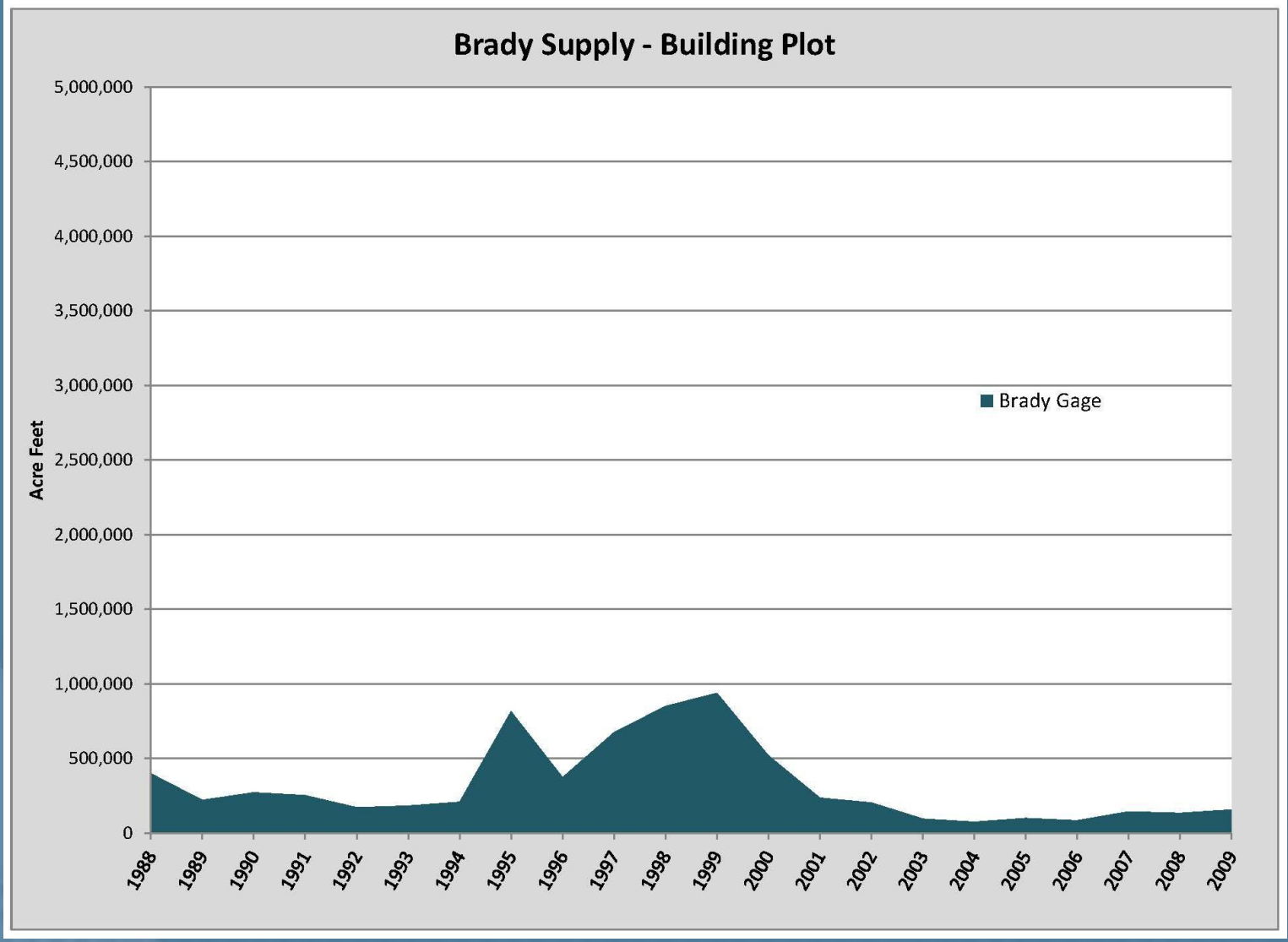
Methodology Development – Platte River Basin

- Additional Irrigation Canals
  - For developing supply - 50% of historic canal diversion assumed for CU with the exception of CNPPID irrigation usage (taken from CNPPID records)
  - For developing demand – precipitation adjusted NIR for appropriated acres used for CU demand.

Methodology Development – Platte River Basin

- Partitioning of supplies/demands to North and South Platte Rivers
  - Ratio of computed virgin natural flow used similar to previous analysis
- Municipal and Industrial demands
  - For supply – historic consumptive used
  - For demand – current and future consumptive use estimates used

Brady Analysis – Supply build



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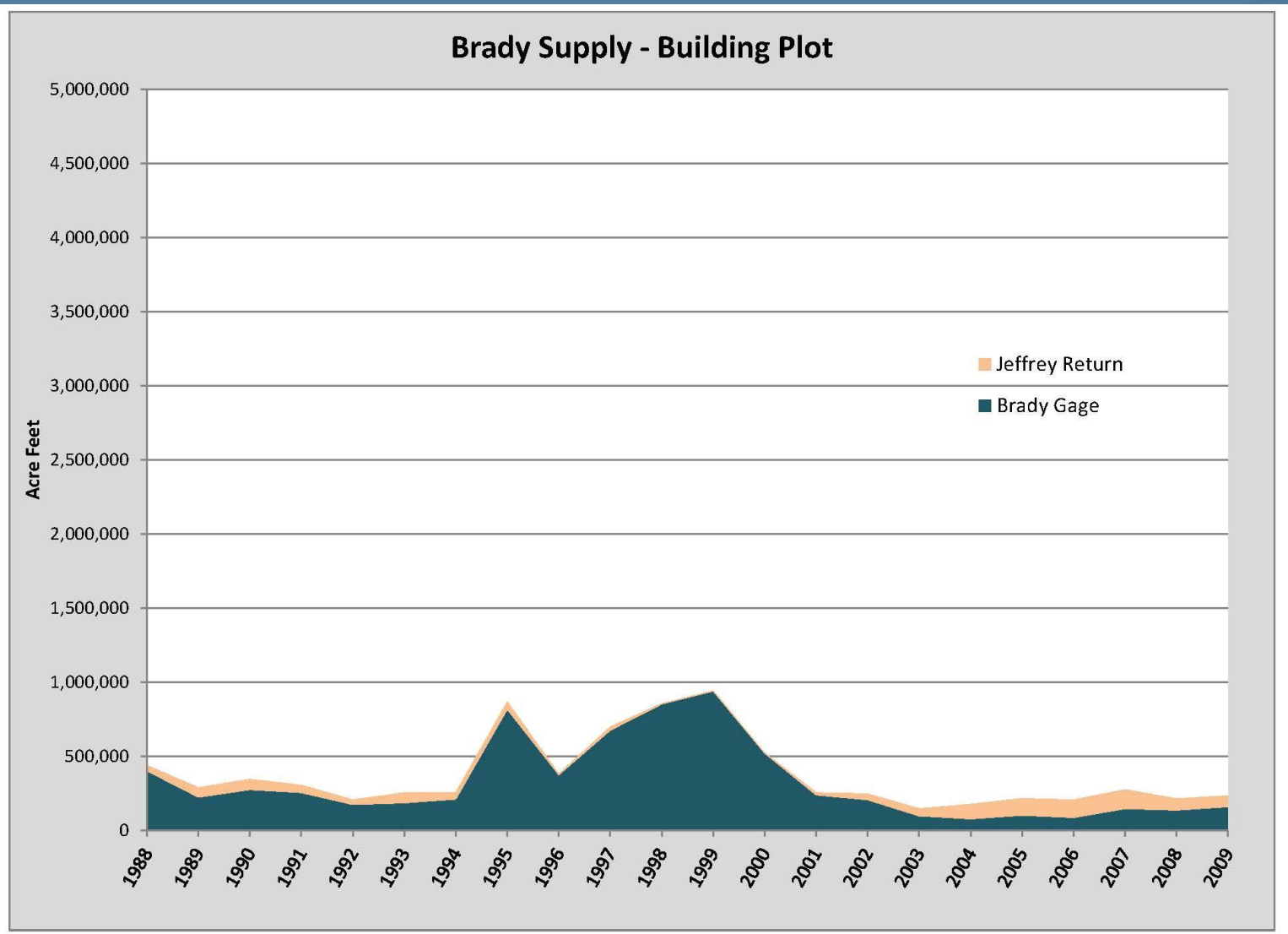

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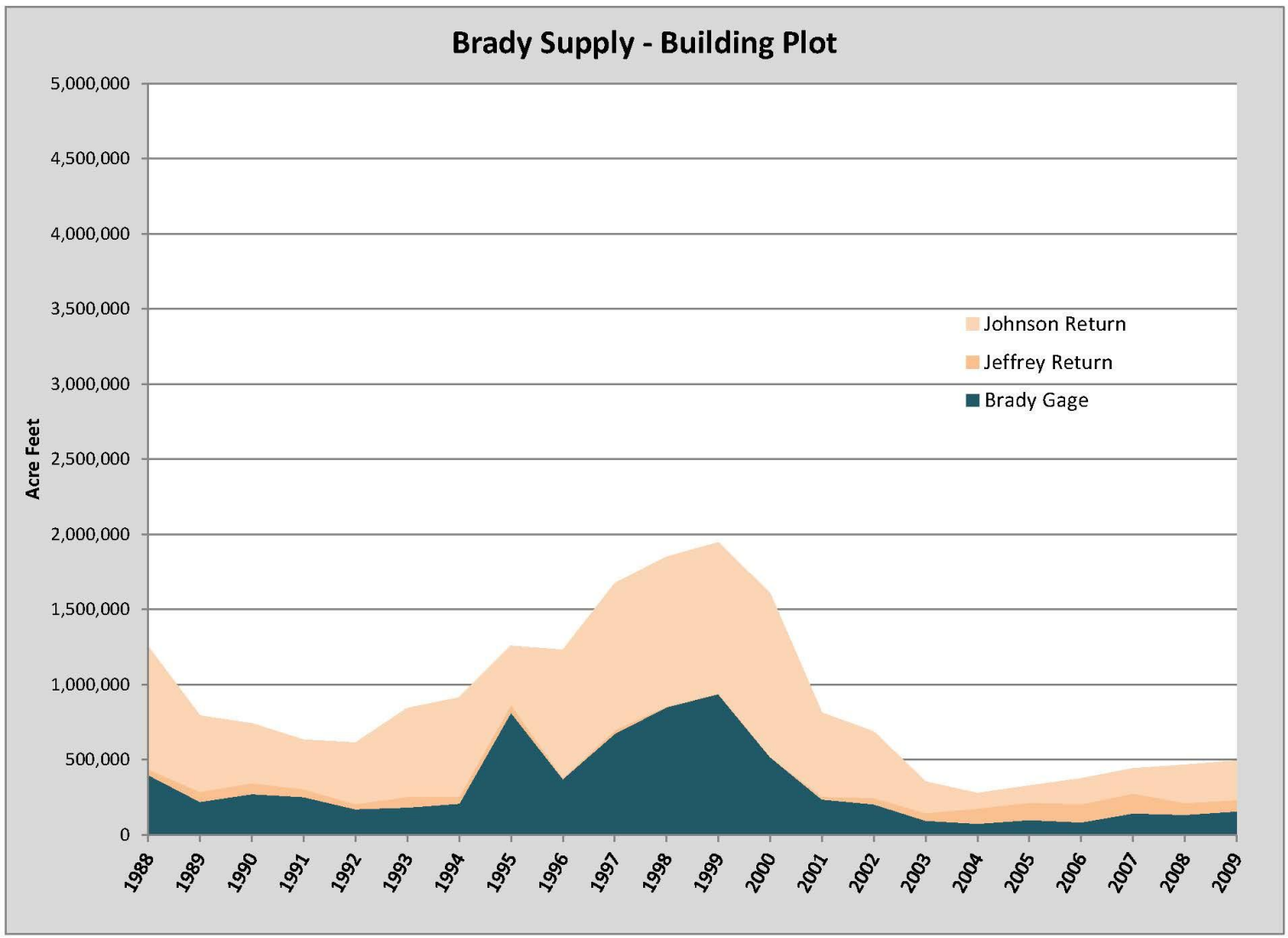

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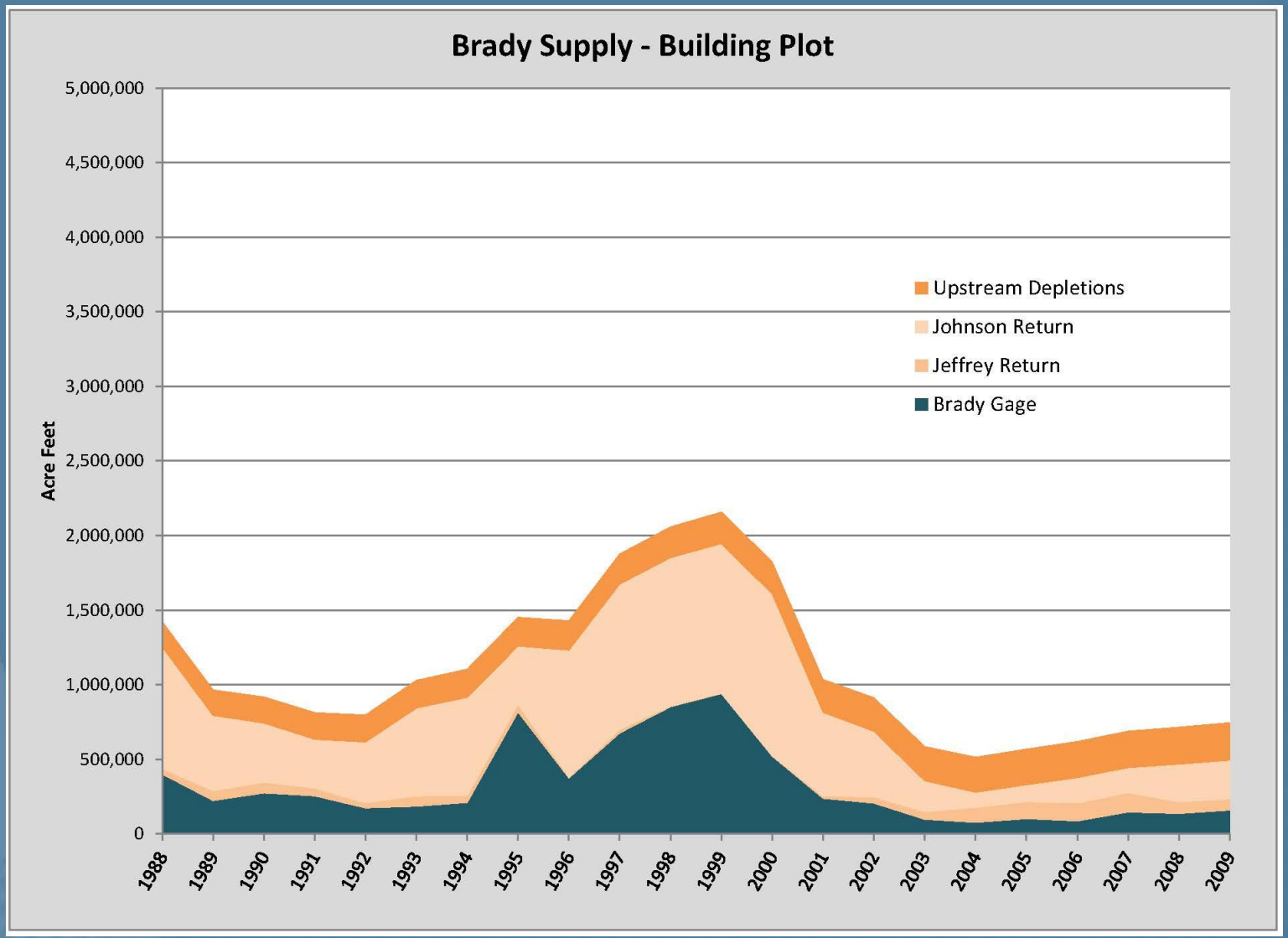

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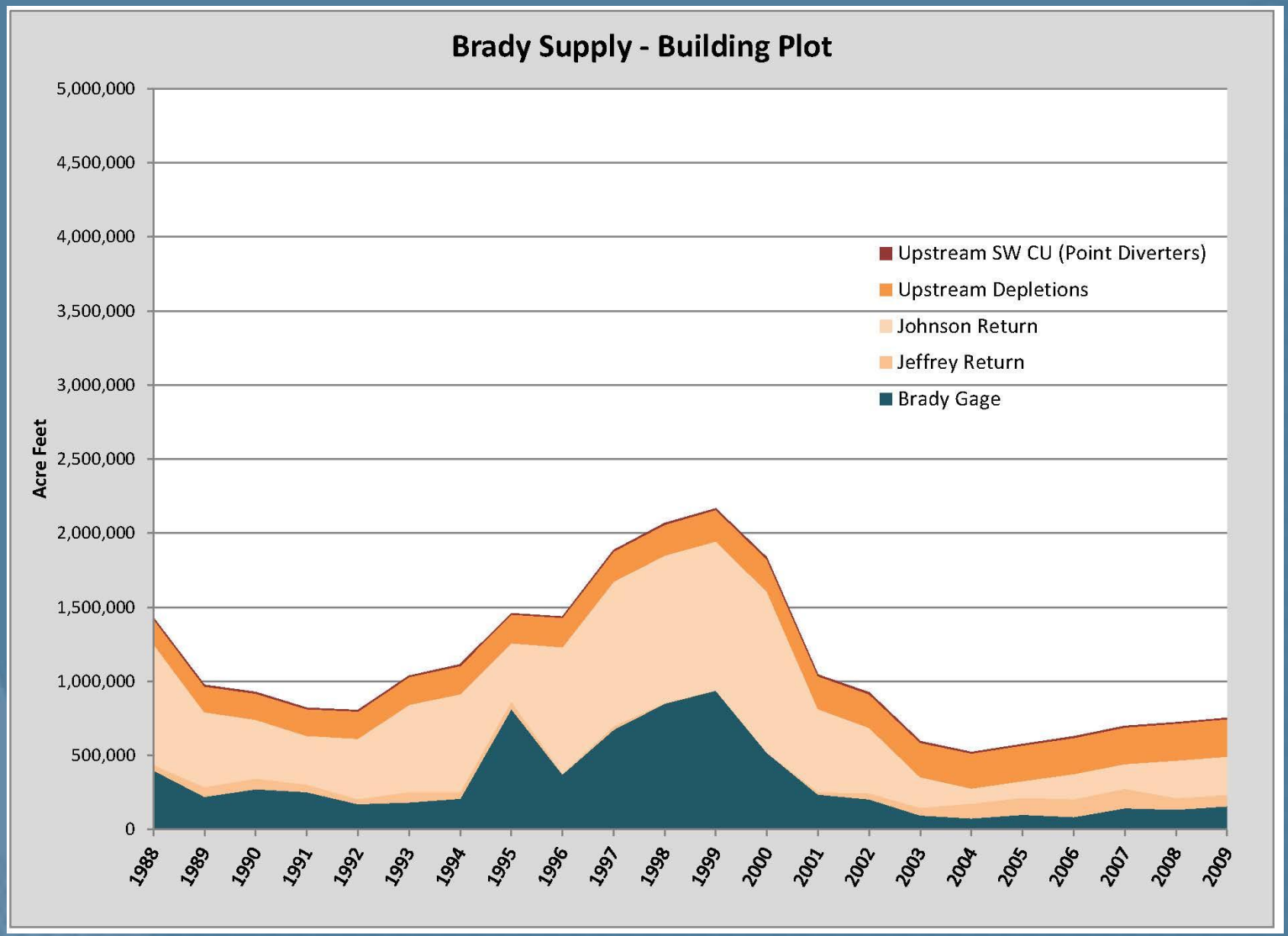

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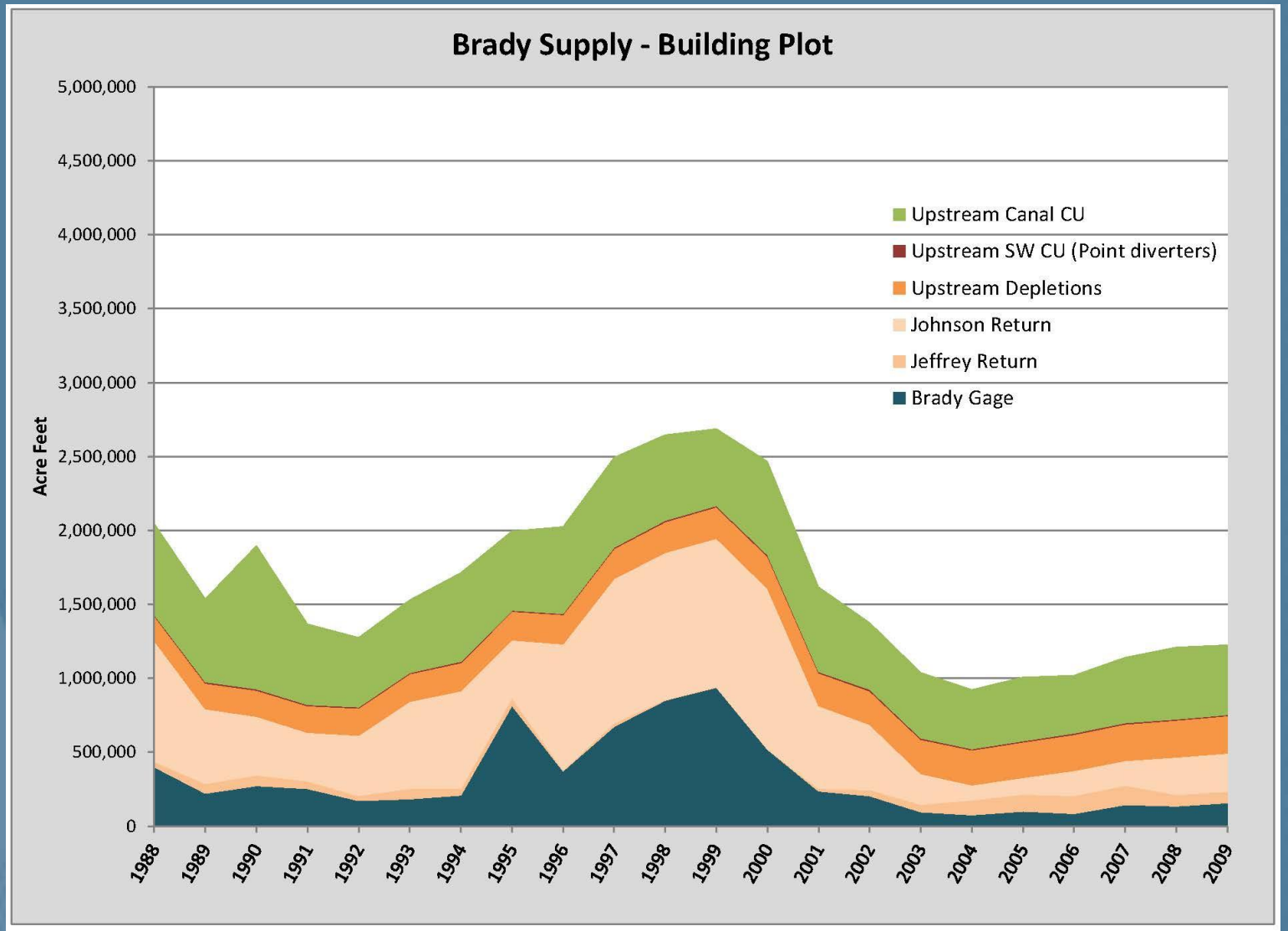

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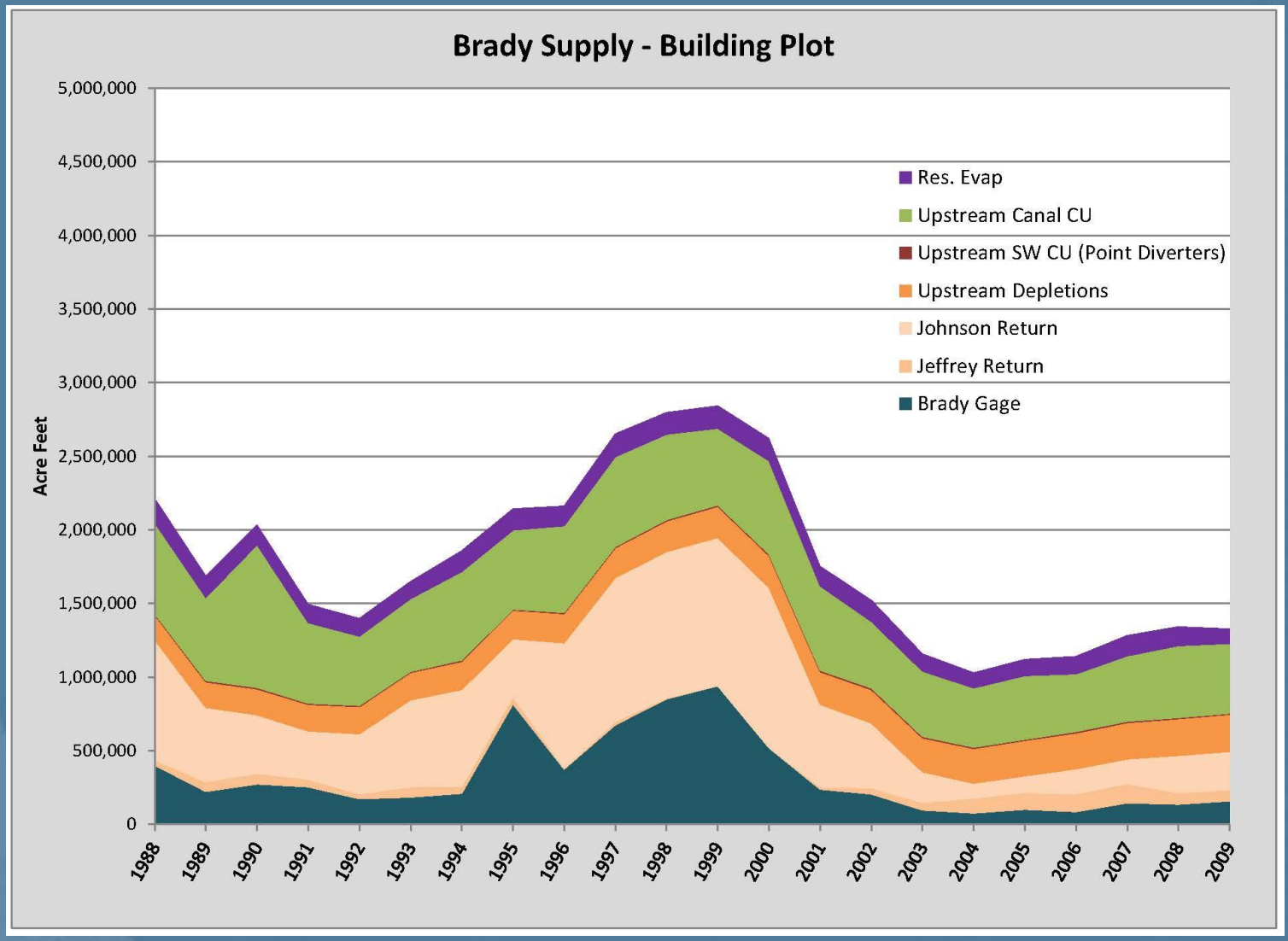

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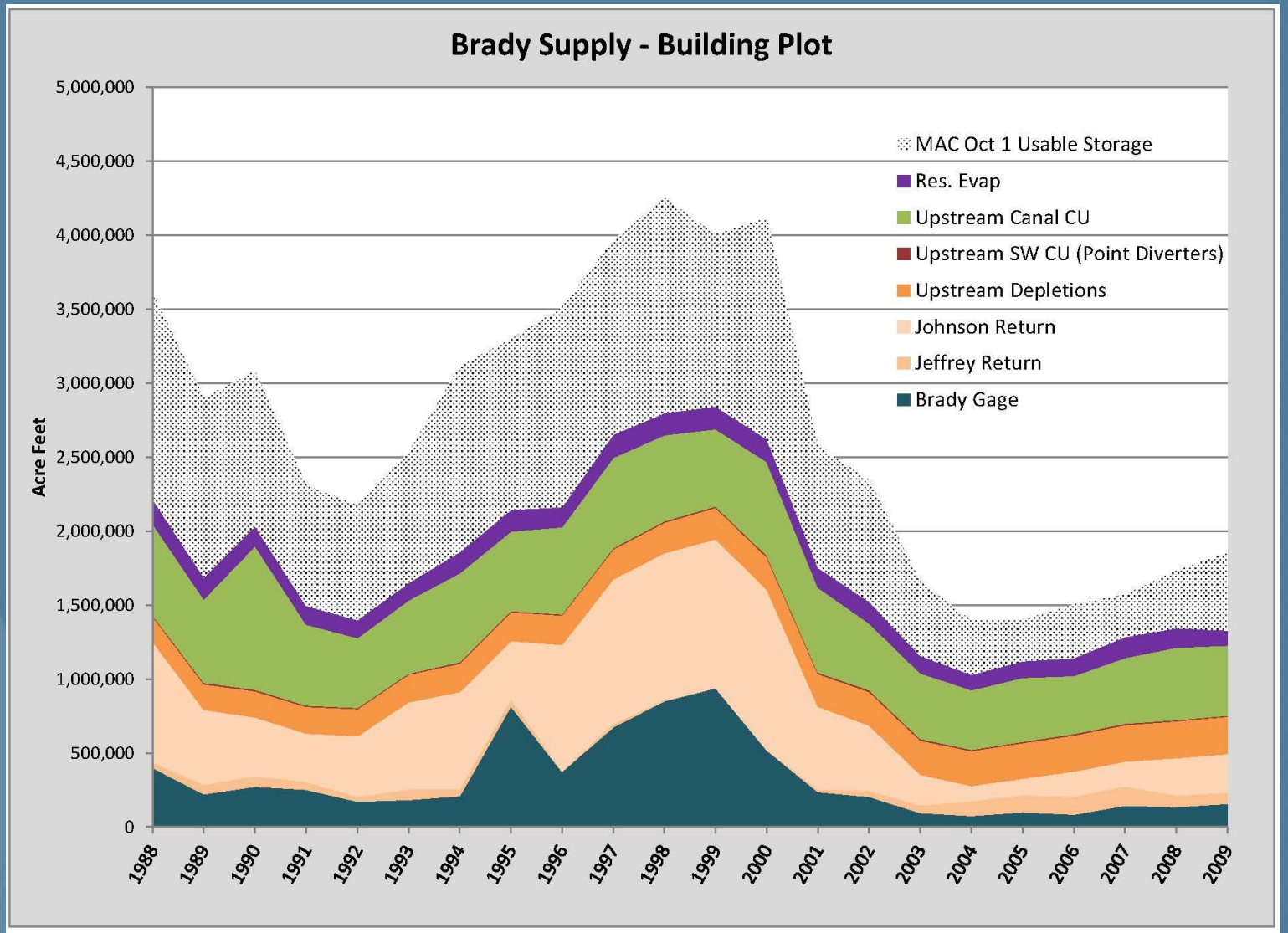

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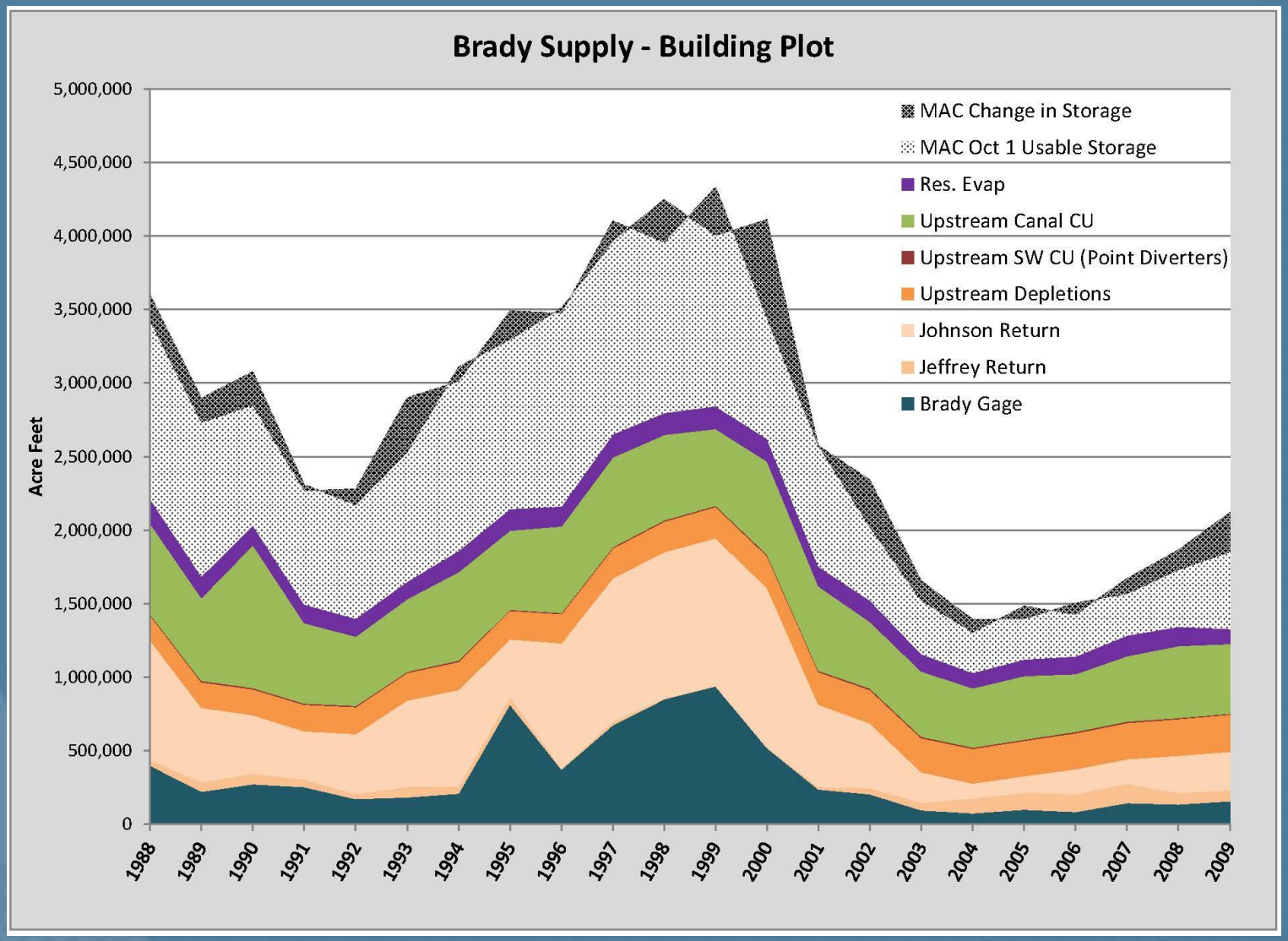
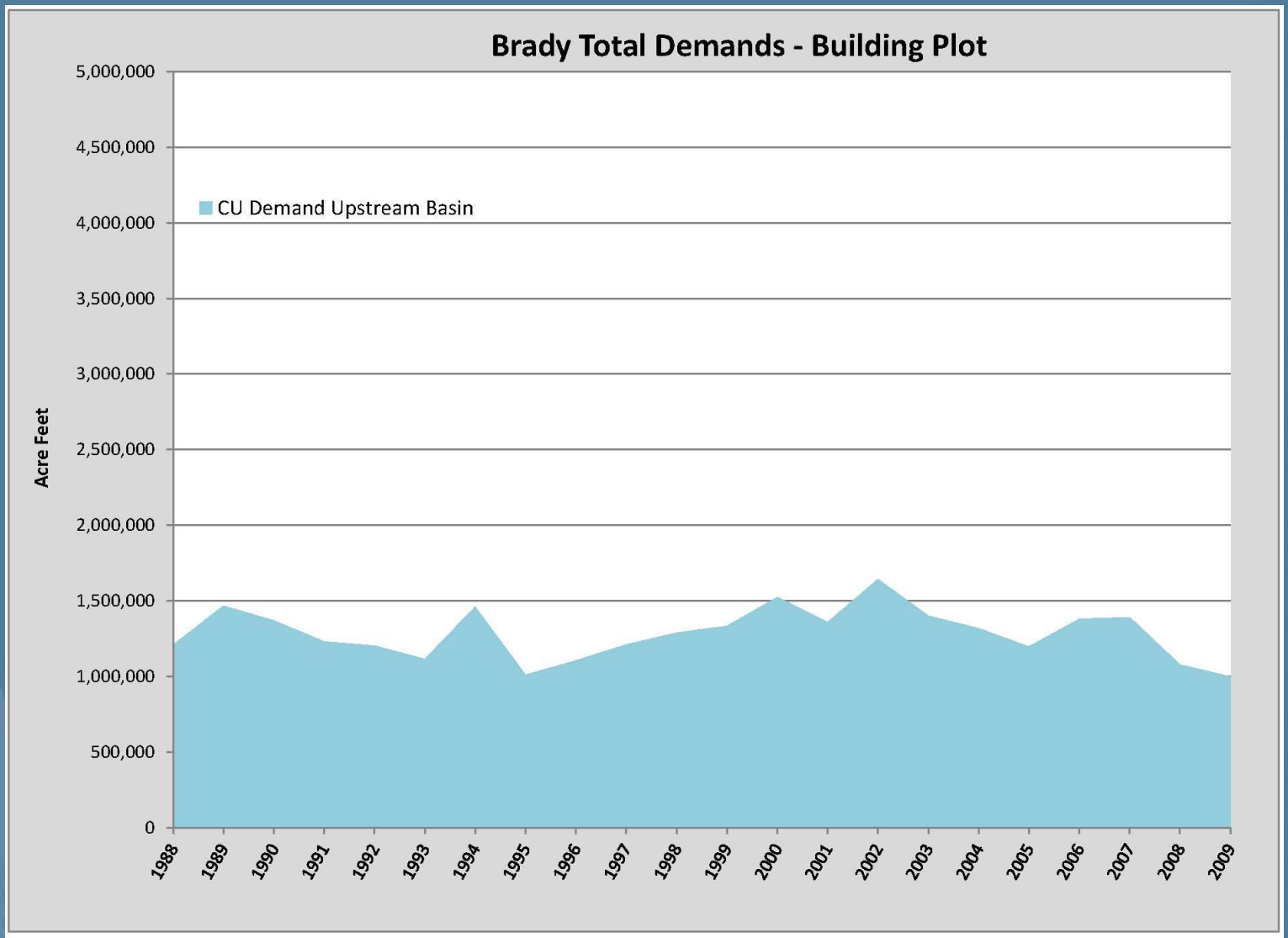


Brady Analysis – Demand build



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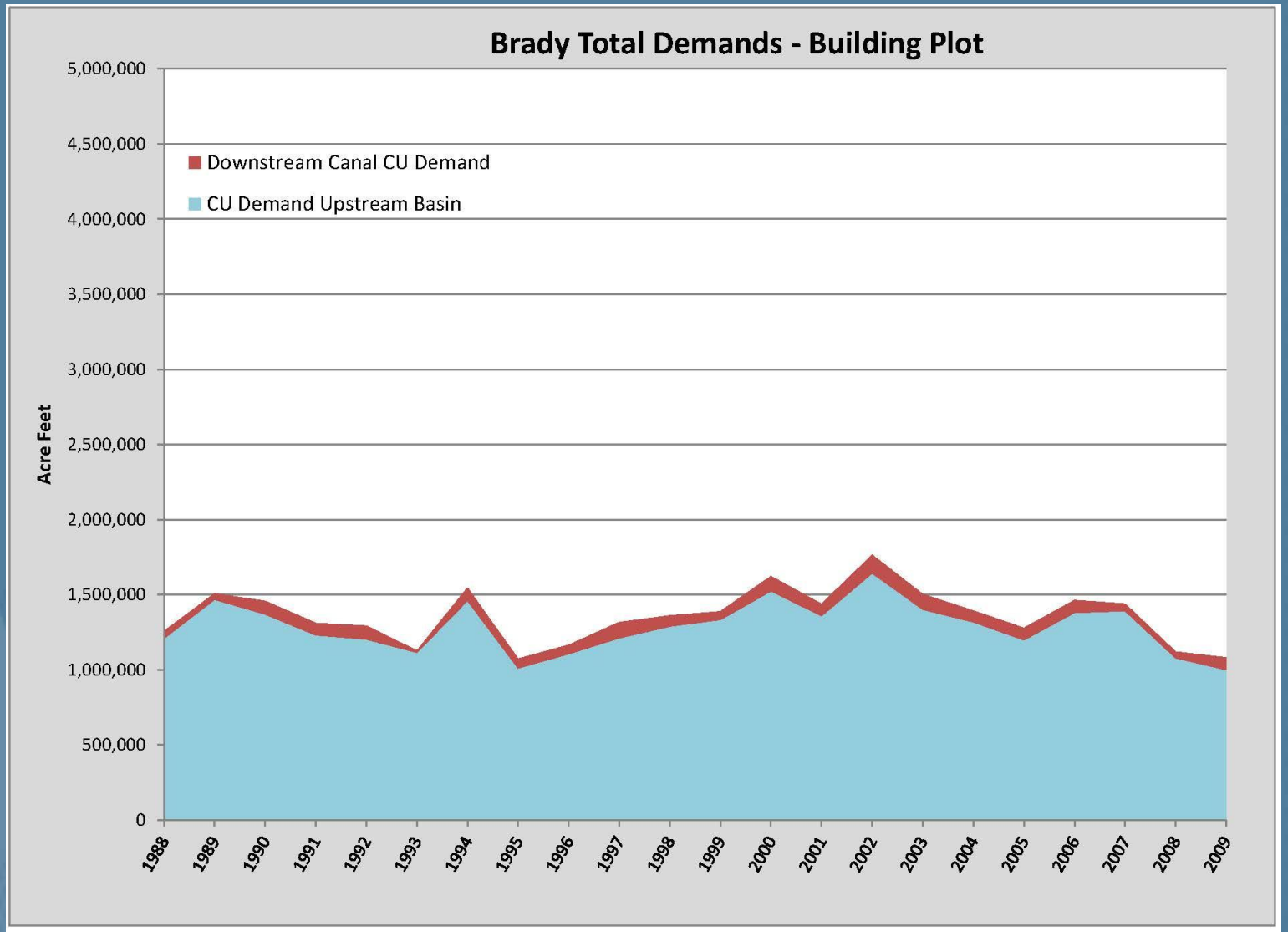

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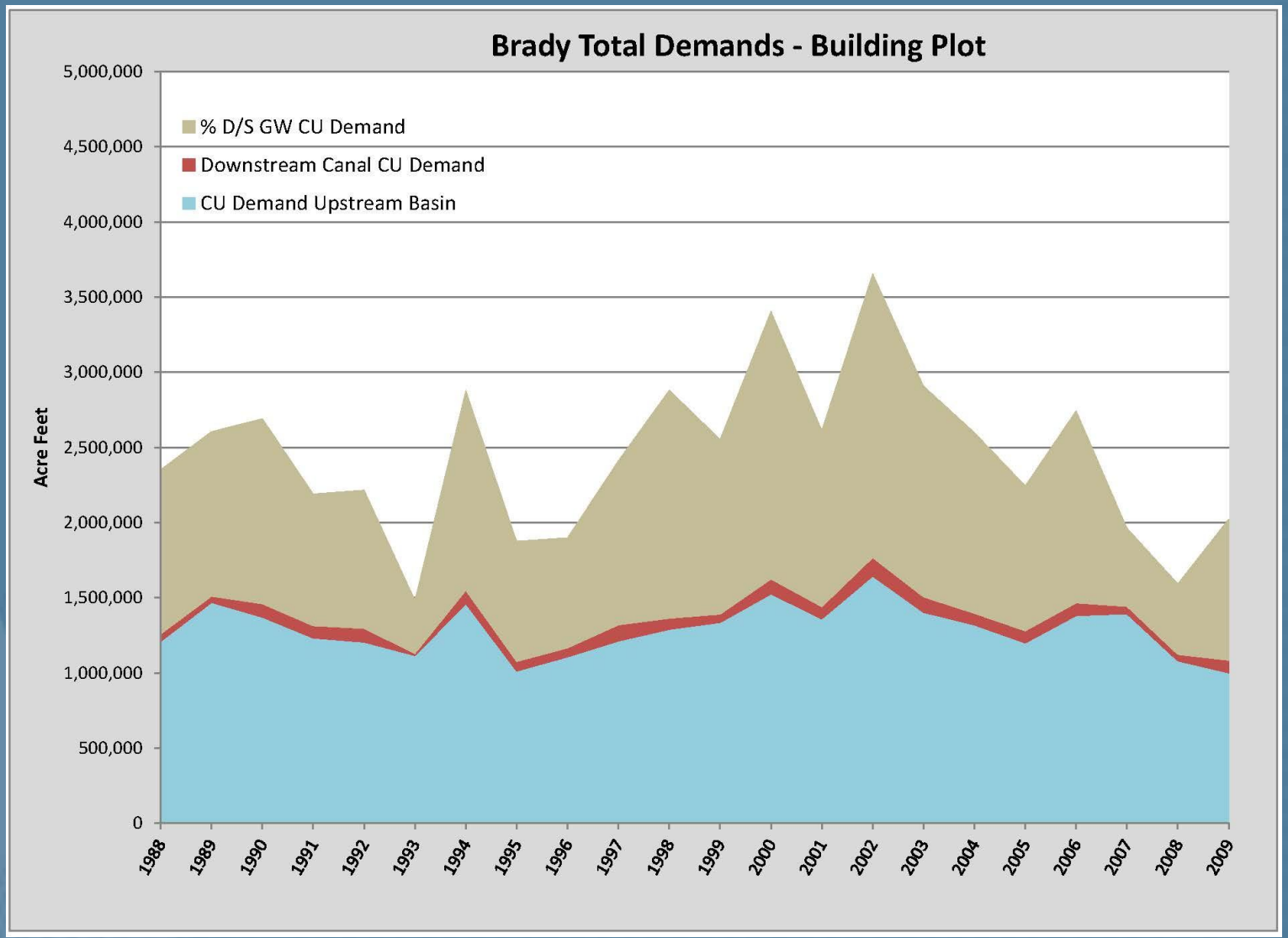

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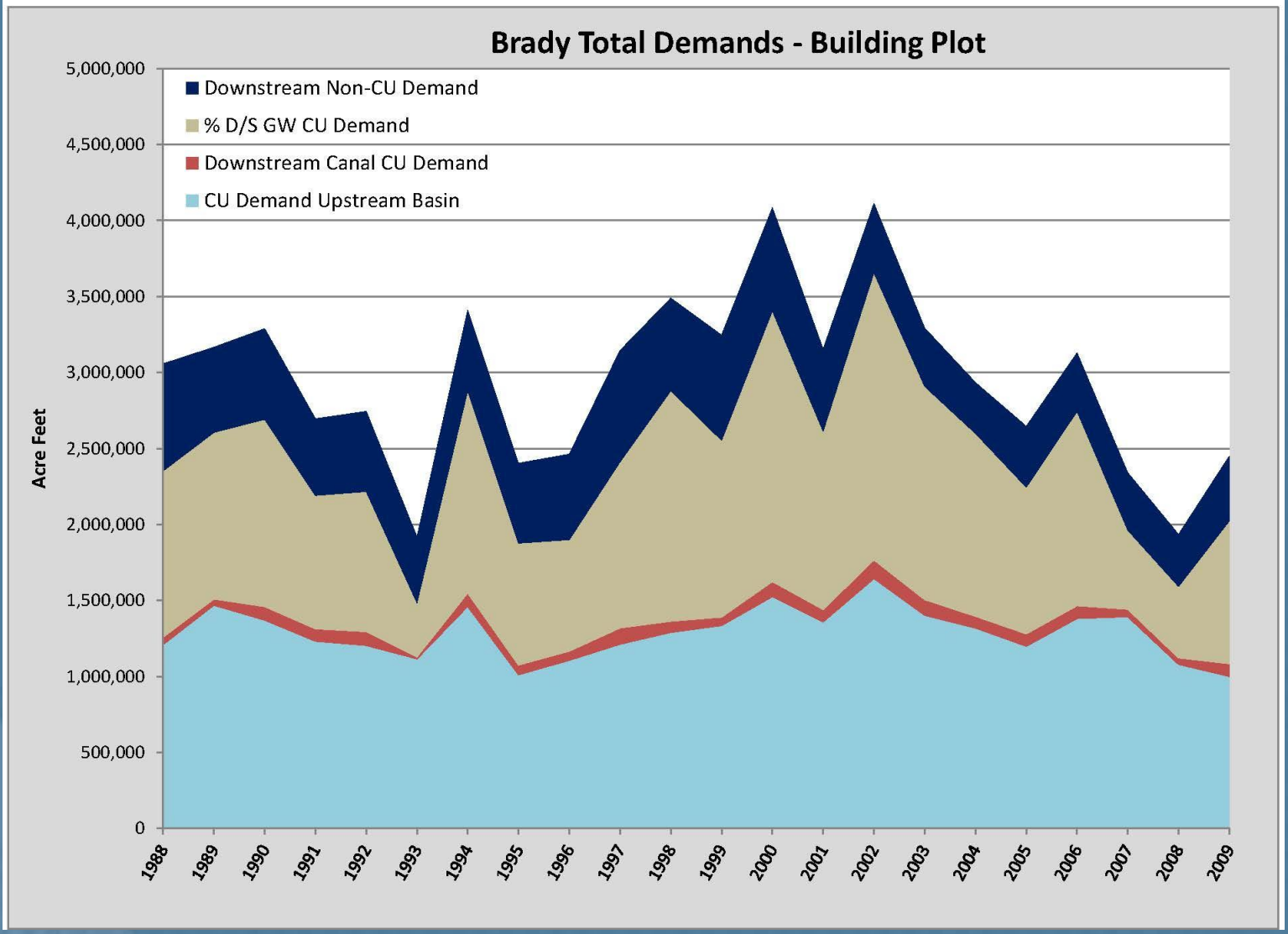
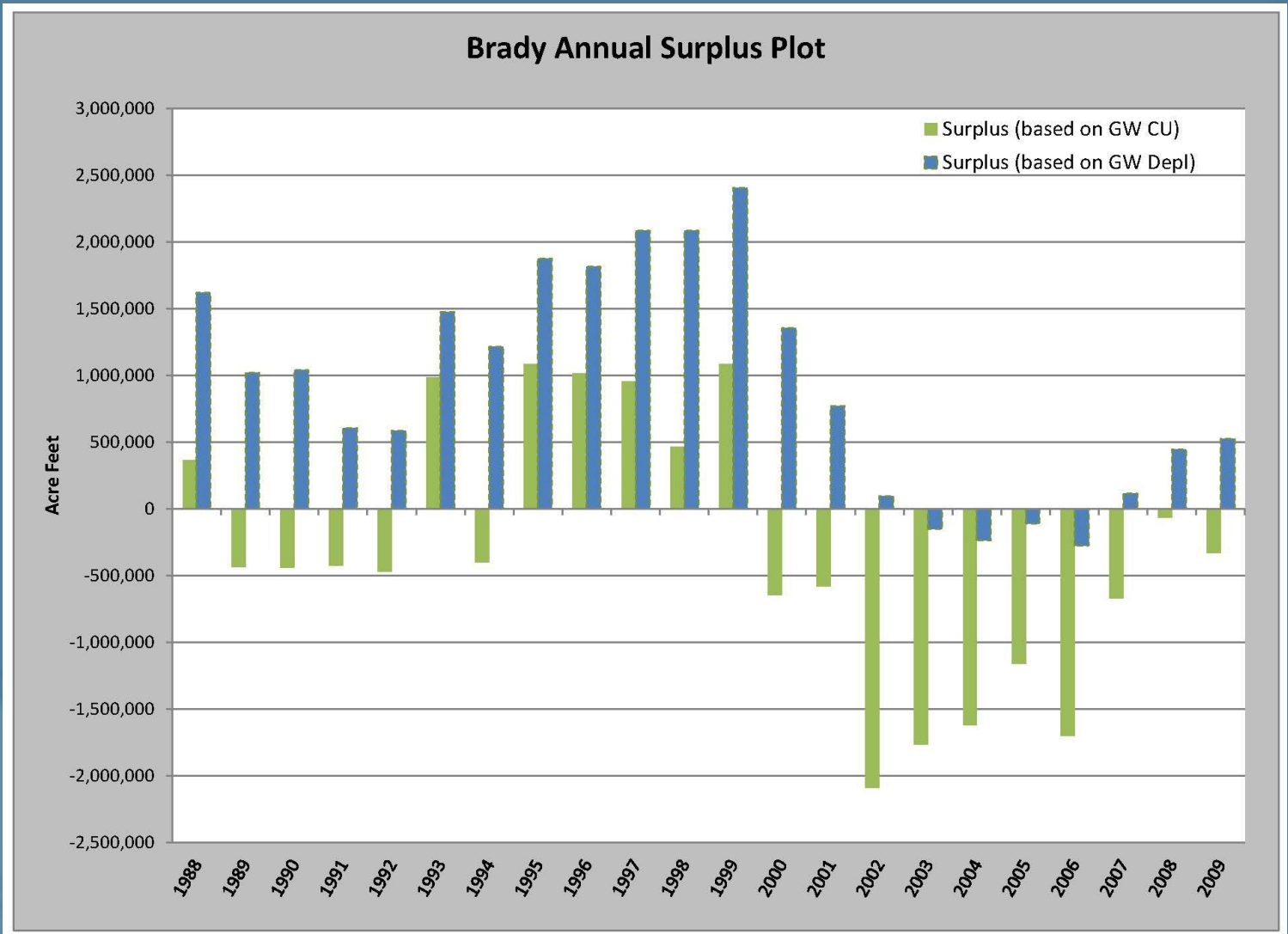
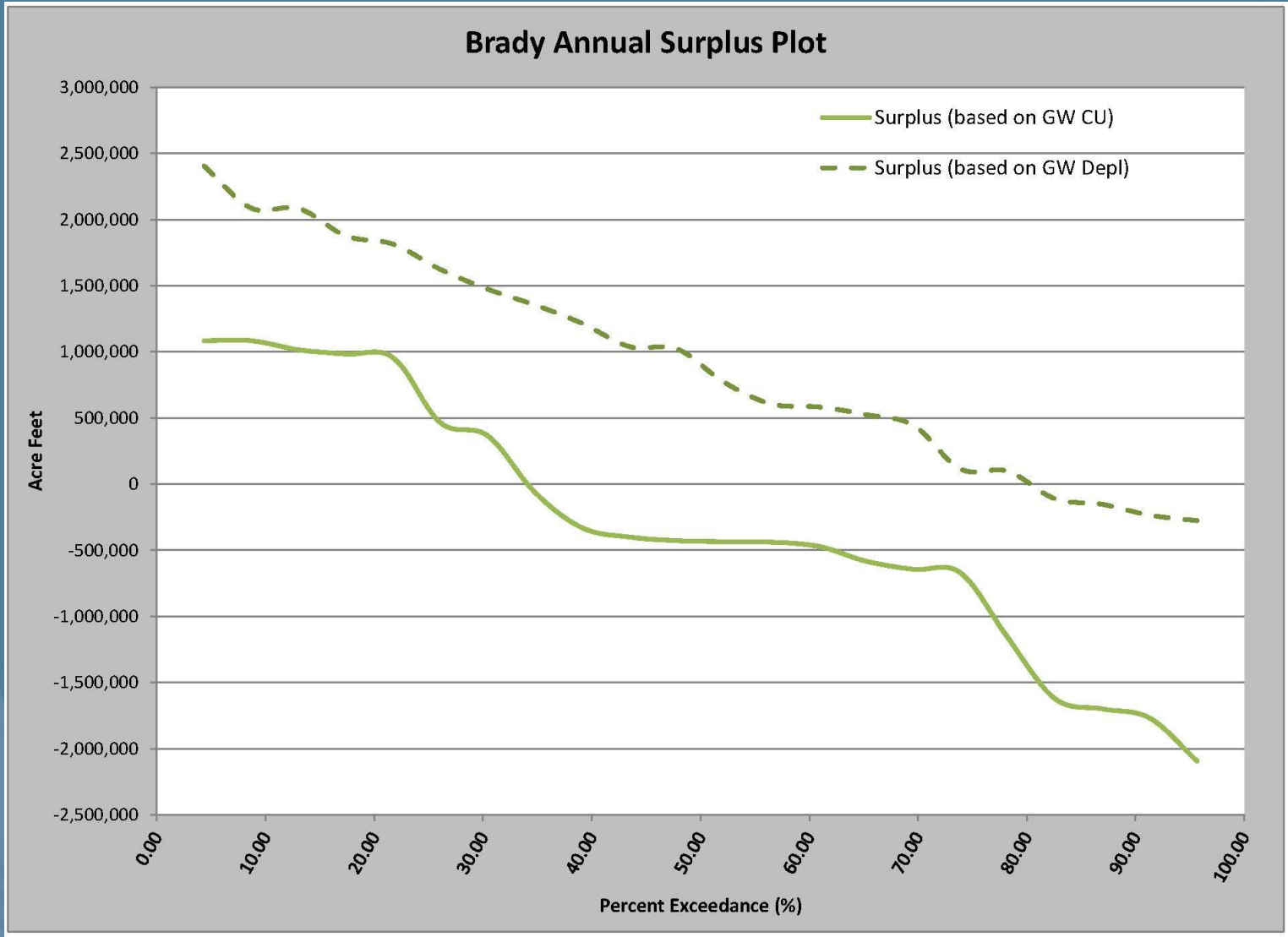


Brady Analysis – Arithmetic Plot



Brady Analysis – Surplus Plot



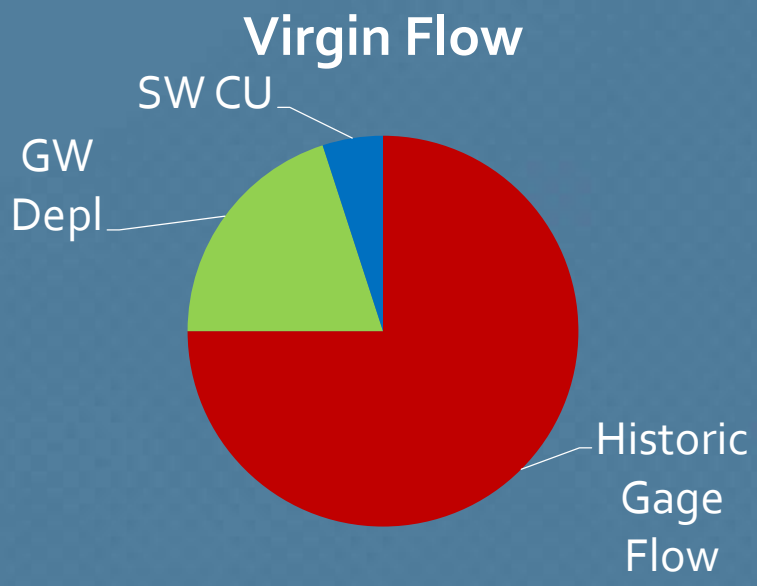
Methodology Recommendations

- Supply
- Demand
- Evaluation

Methodology - Supply

- Virgin Flow Hydrograph
  - Estimate of streamflow hydrograph "undepleted by activities of man"
  - Historic gaged flows + upstream consumptive uses:

Virgin Flow = Historic flow
+ historic SW CU
+ estimated GW depletions



Methodology - Supply

- Statistical Analysis to select time periods for analysis
  - Kendal Tau
    - Trends
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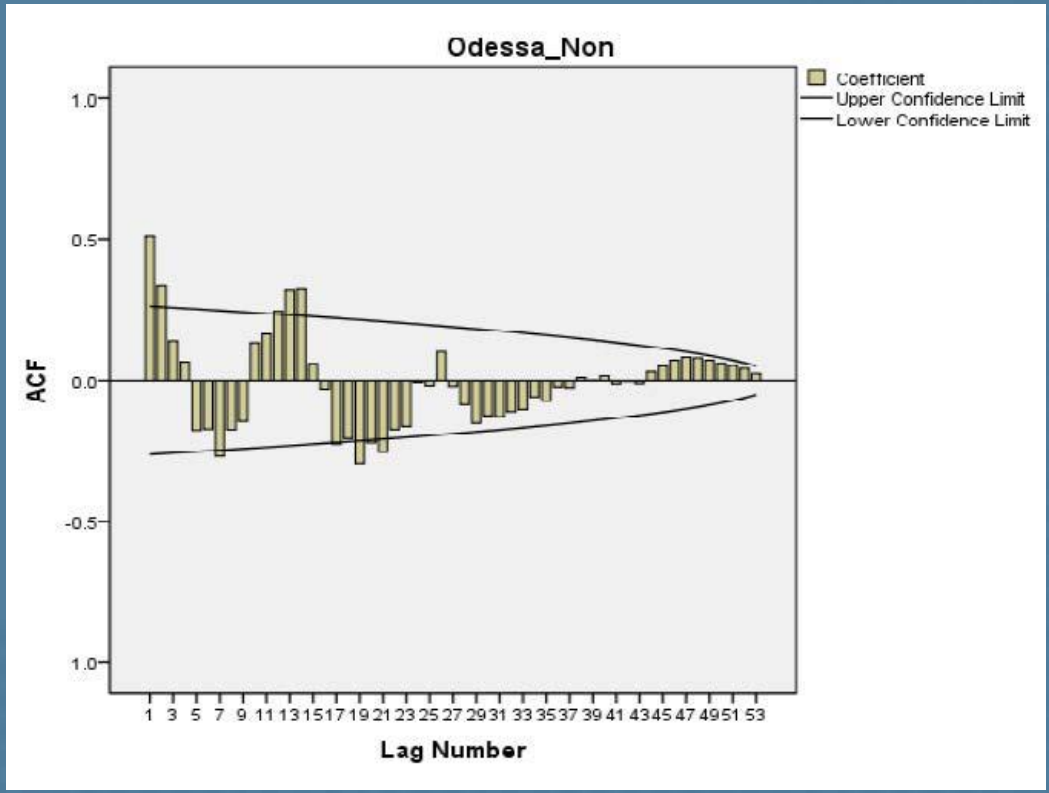


Methodology - Supply

- Discrete components of computed virgin natural flow insight into:
  - Relative magnitudes
  - Trends
  - Illustrates importance of key assumptions and areas of future refinements

Methodology – Supply

- Reservoir Storage
  - Account for change in storage in supply
  - For Lake McConaughy – account for change in storage *AND* total available storage in supply

    => accounts for carryover storage

Methodology - Demands

- Differentiate between SW and GW uses
- Represent discrete demands of each

GROUND WATER DEMANDS

Ground water irrigation (CU)
M & I wellfields (CU)

SURFACE WATER DEMANDS

Irrigation Canal Diversions (CU)
Individual irrigation appropriators (CU)
Hydropower (NonCU)
Instream flow appropriations (NonCU)
Reservoir evaporation (CU)

Methodology - Demands

- Consumptive Use
  - Ground Water Irrigation
  - Surface Water Irrigation
  - Municipal and Industrial
  - Reservoir Evaporation

Methodology - Demands

- Non-Consumptive Use
  - Hydro-Power – 3 scenarios
    - No hydropower demand
    - Full appropriation for hydropower
    - Intermediate demand (historic flows, physical capacity, etc.) – case specific
  - Instream Flow Appropriations
    - Appropriated right, capped to the flow available at the time of granting

Methodology - Demands

- Representation of Downstream Demands
  - Use ratio of virgin natural flows to allocate downstream demands to upstream reach
- Precipitation – adjusted crop irrigation requirements
  - Variations in climatic conditions can be reflected in demands

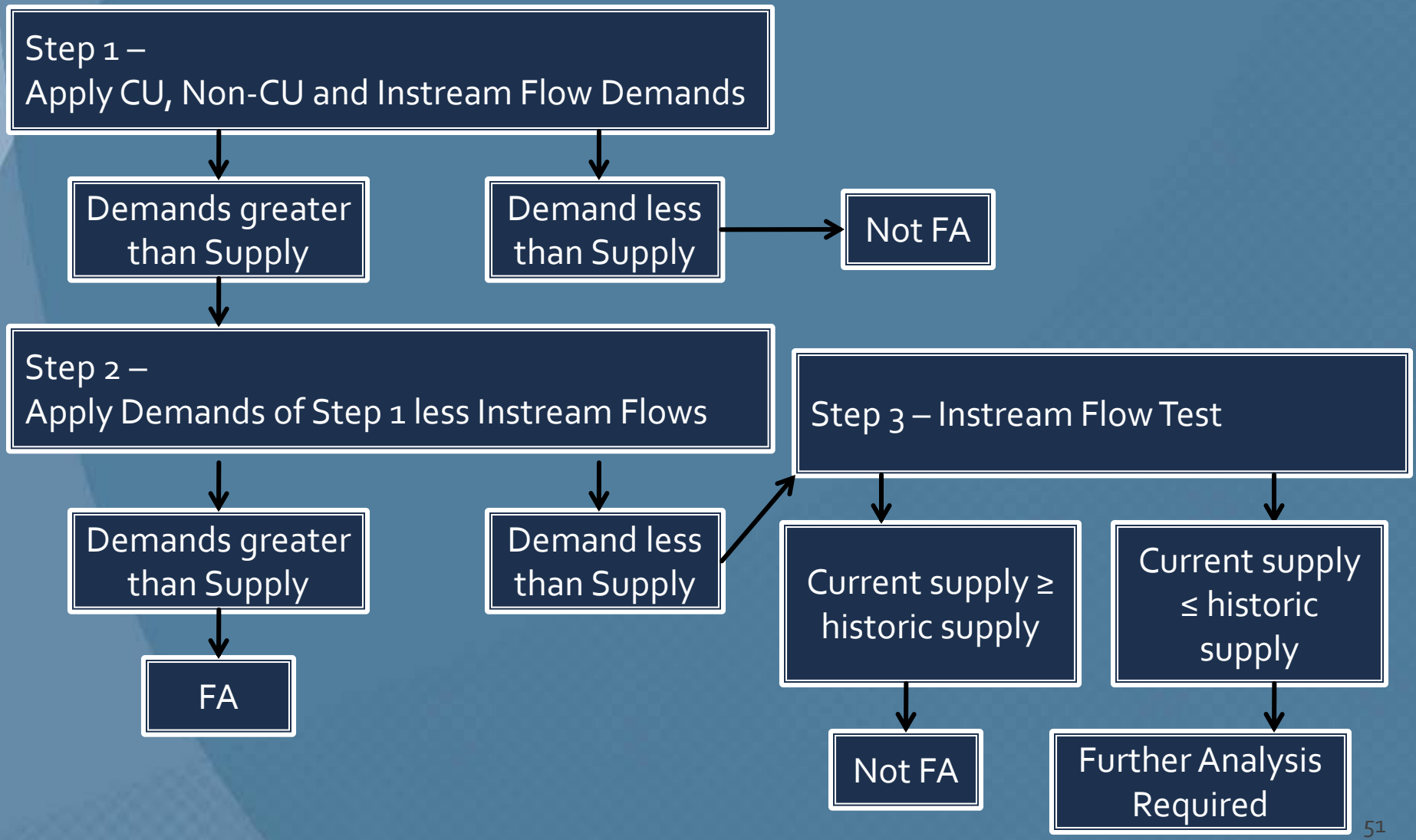
Methodology - Demands

- Evaluation of GW demands using both depletions and consumptive use
  - Depletions illustrate historic usage impacts on current water supplies
  - Consumptive use illustrates current usage impacts (lag effect)

Methodology - Evaluation

- Use of Surplus (Supply – Demand) as a metric
  - To retain the paired supply/demand for each year the surplus or deficit each year is calculated.
  - This surplus is then plotted for each year (arithmetic curve) in addition to being ranked and plotted using a frequency curve.

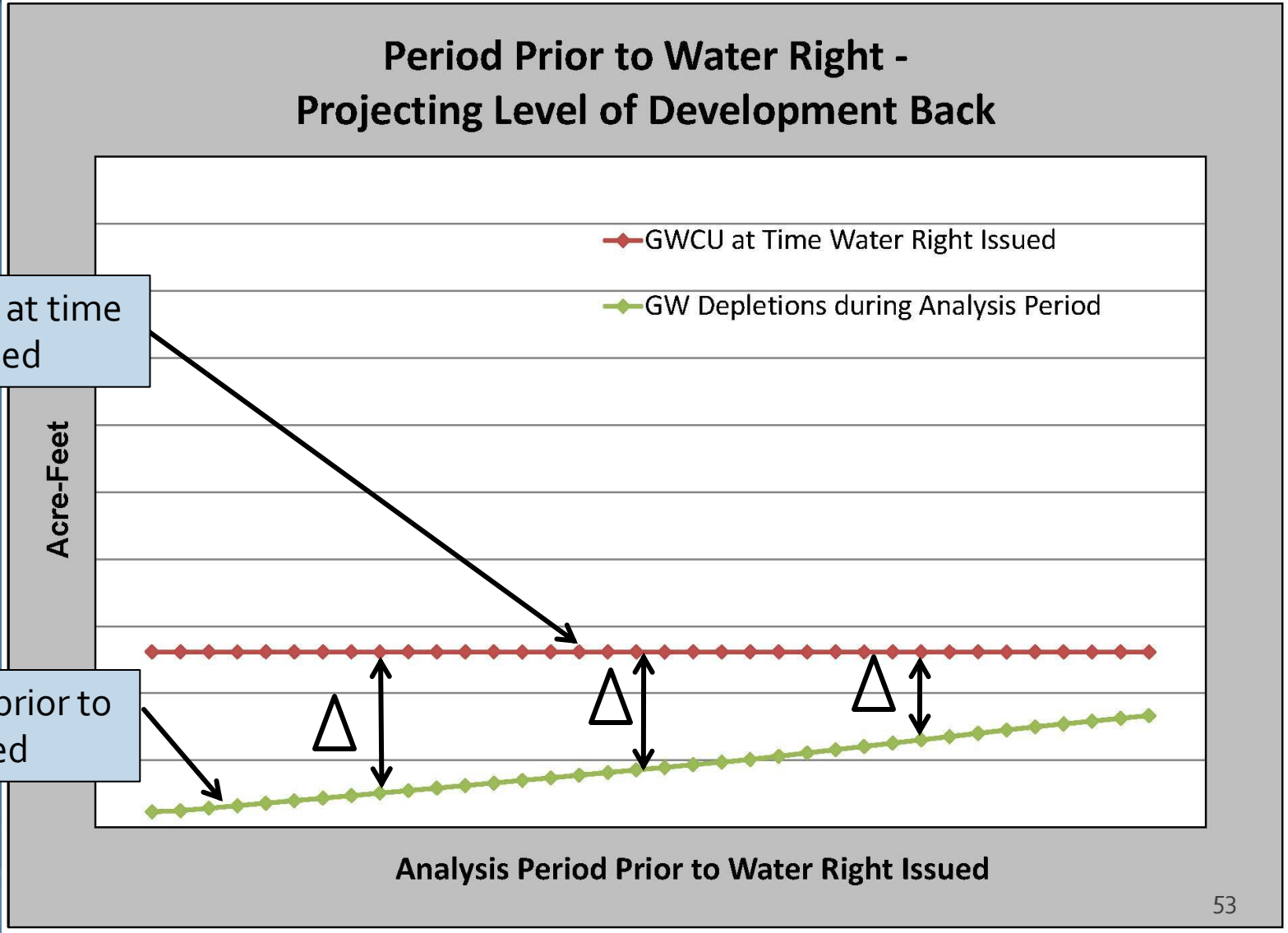
Methodology – Evaluation



Methodology- Evaluation

- Instream Flow Test
  - Statute ties appropriation to that available at time of granting.
  - Two time periods (chosen by statistical analysis)
    - 1) Analysis Period Prior to Water Right Issued
      - Corrections made to account for level of development at time water right issued.
    - 2) Current Analysis Period
      - Correction made to account for current level of depletions.
  - Lesser of adjusted flows ("reasonably expected") or instream flow appropriation.

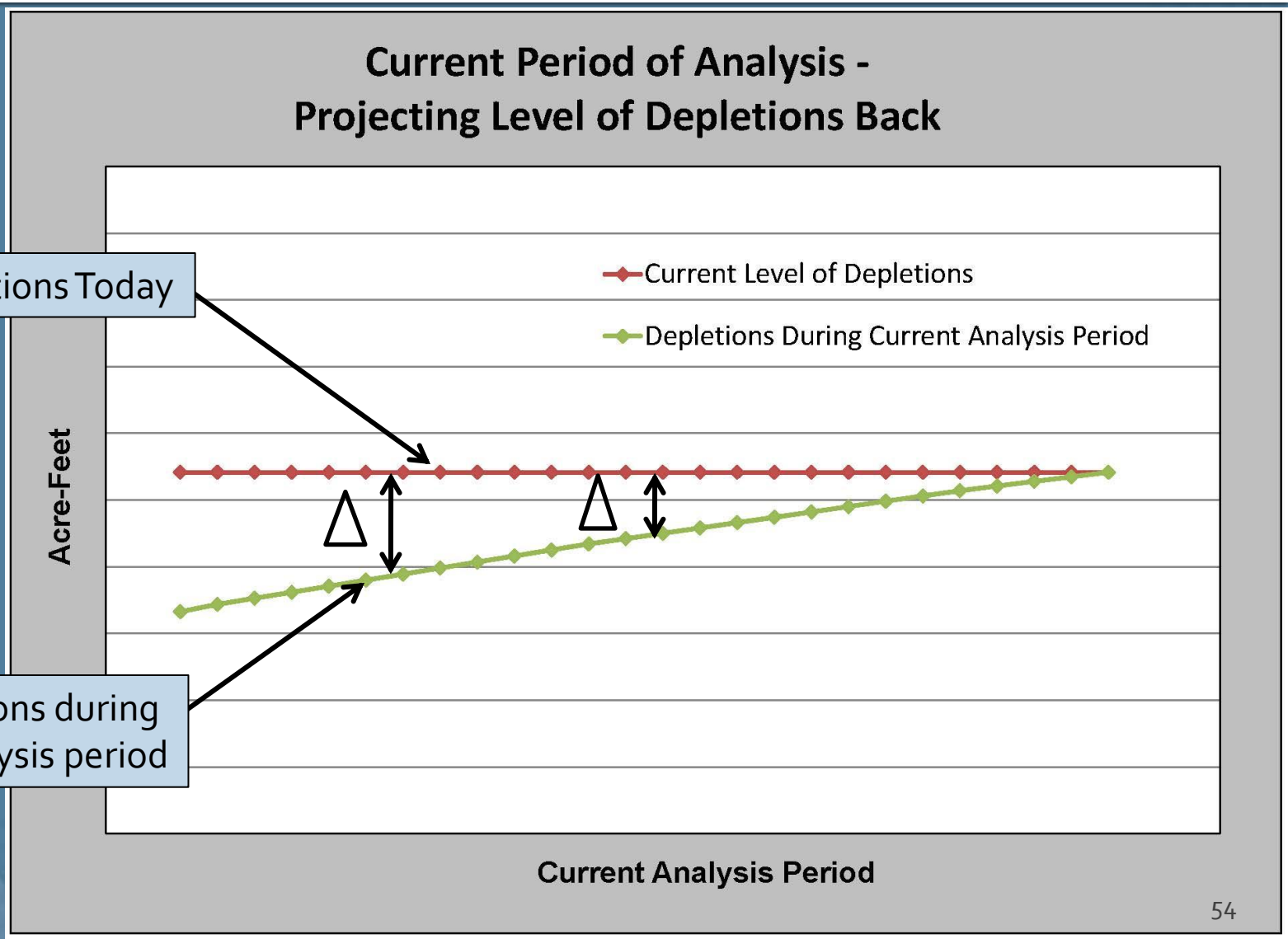
Methodology- Instream Flow Test



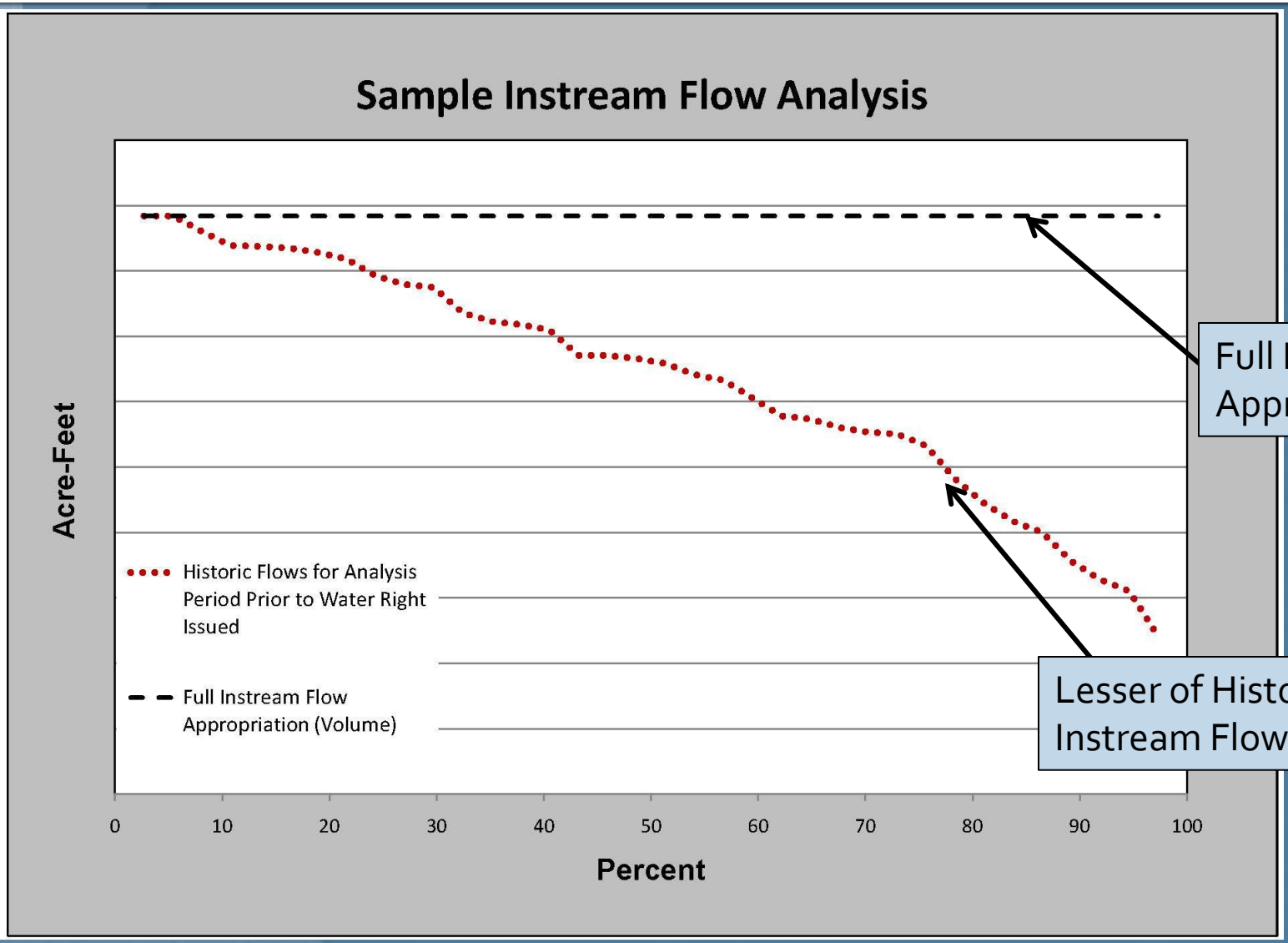
Level of GWCU at time water right issued

GW Depletions prior to water right issued

Methodology- Instream Flow Test



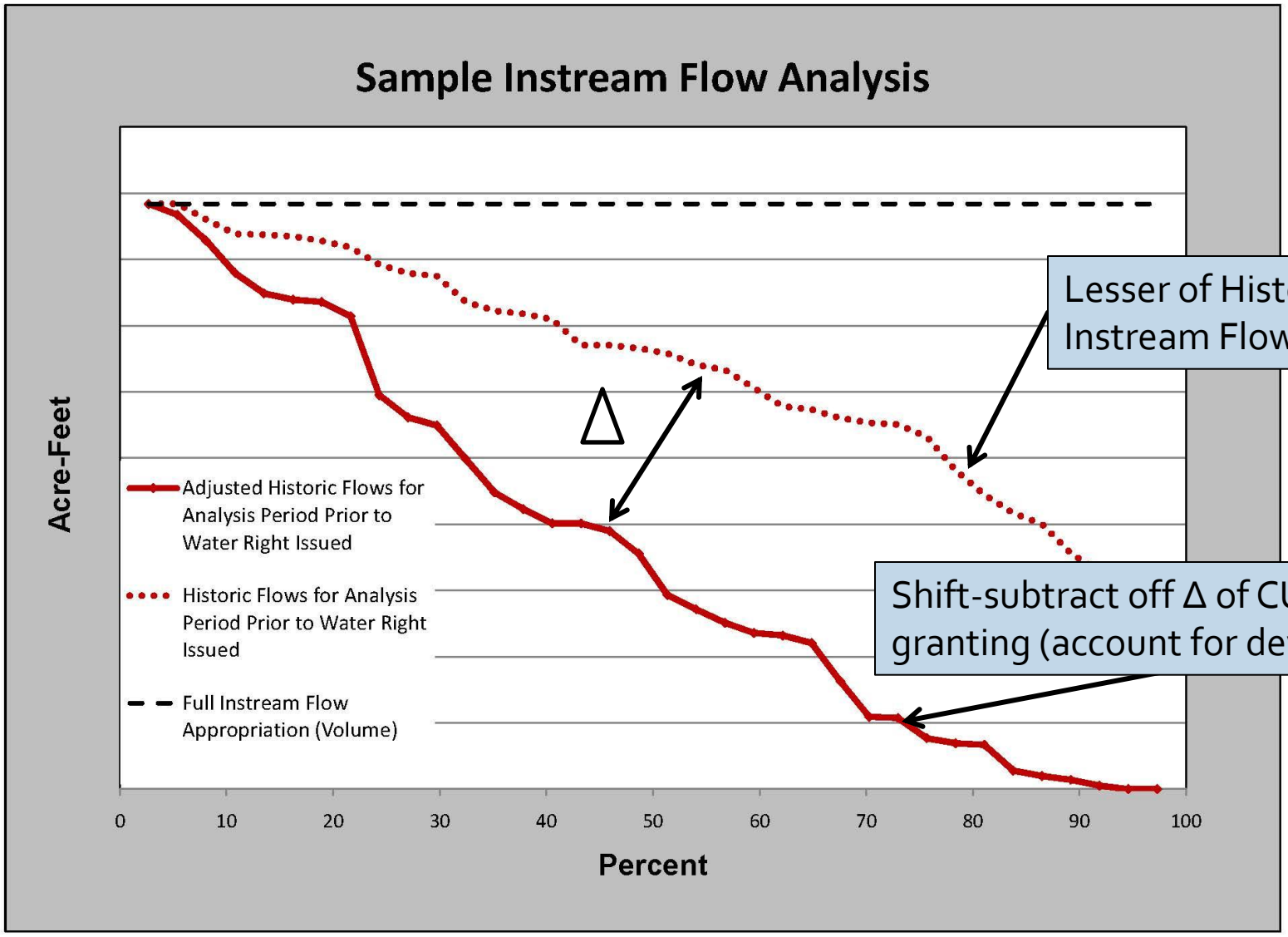
Instream Flow Test Comparison Plot



Full Instream Flow Appropriation

Lesser of Historic Flow and Instream Flow Appropriation

Instream Flow Test Comparison Plot



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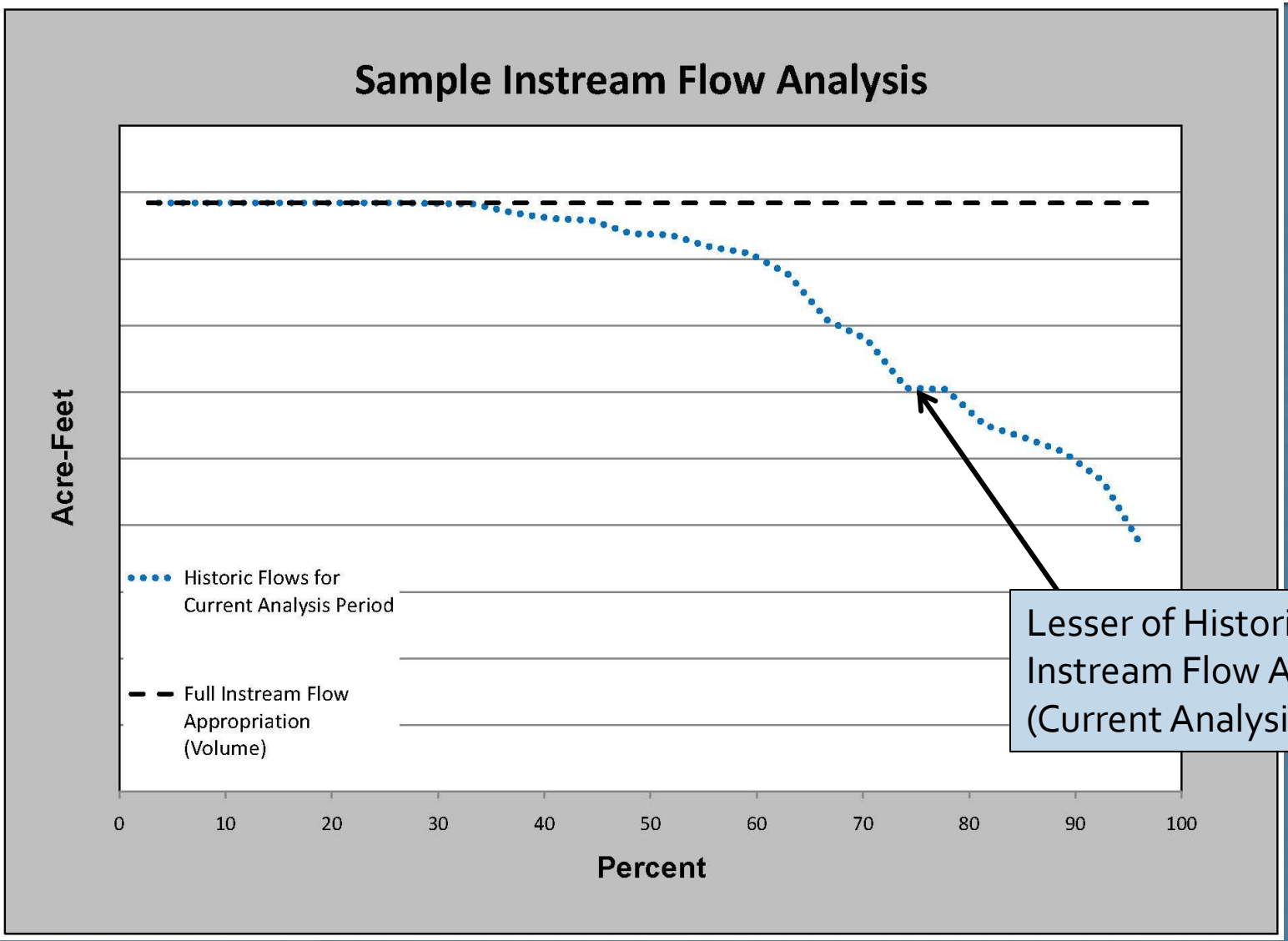

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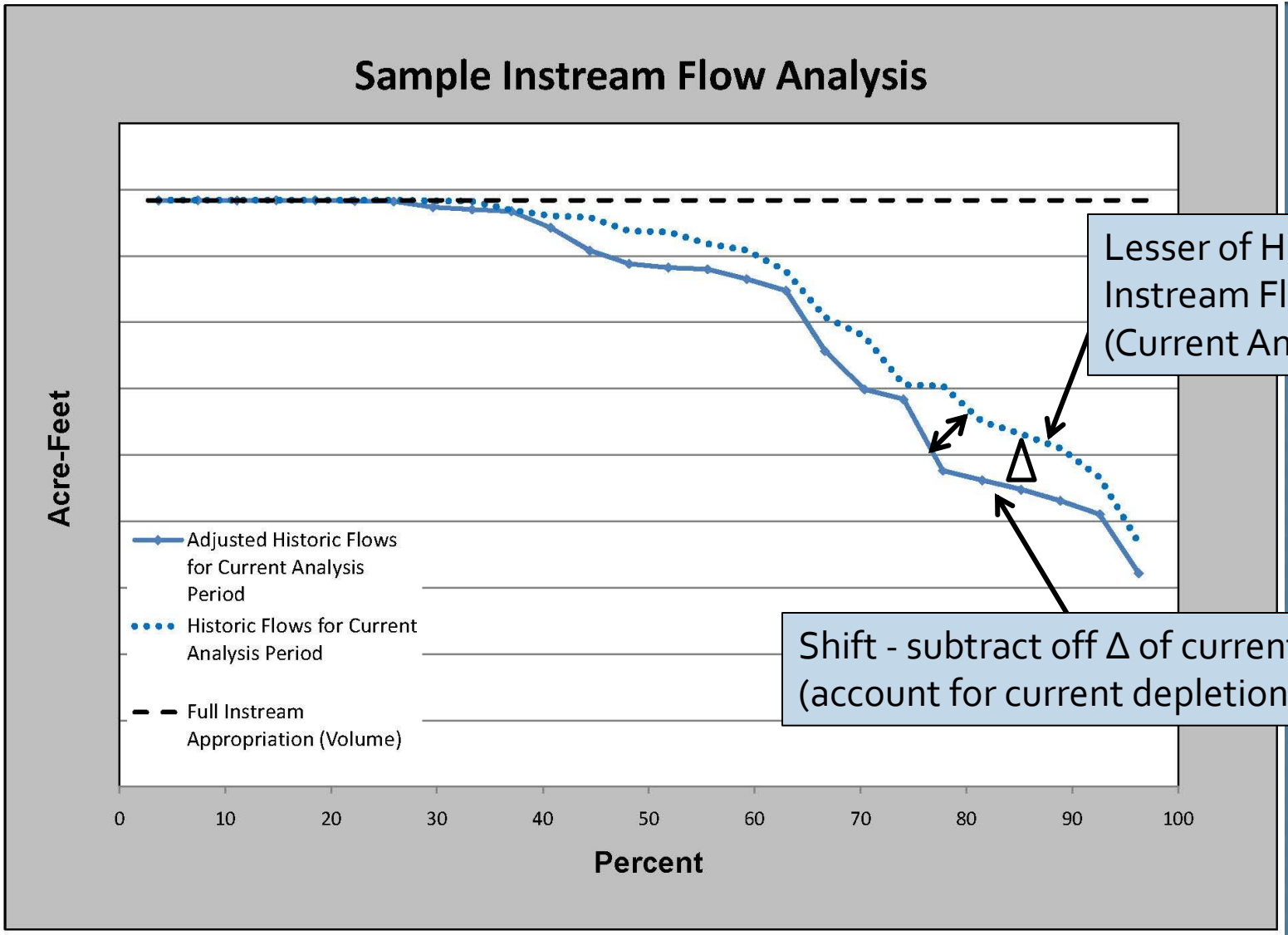

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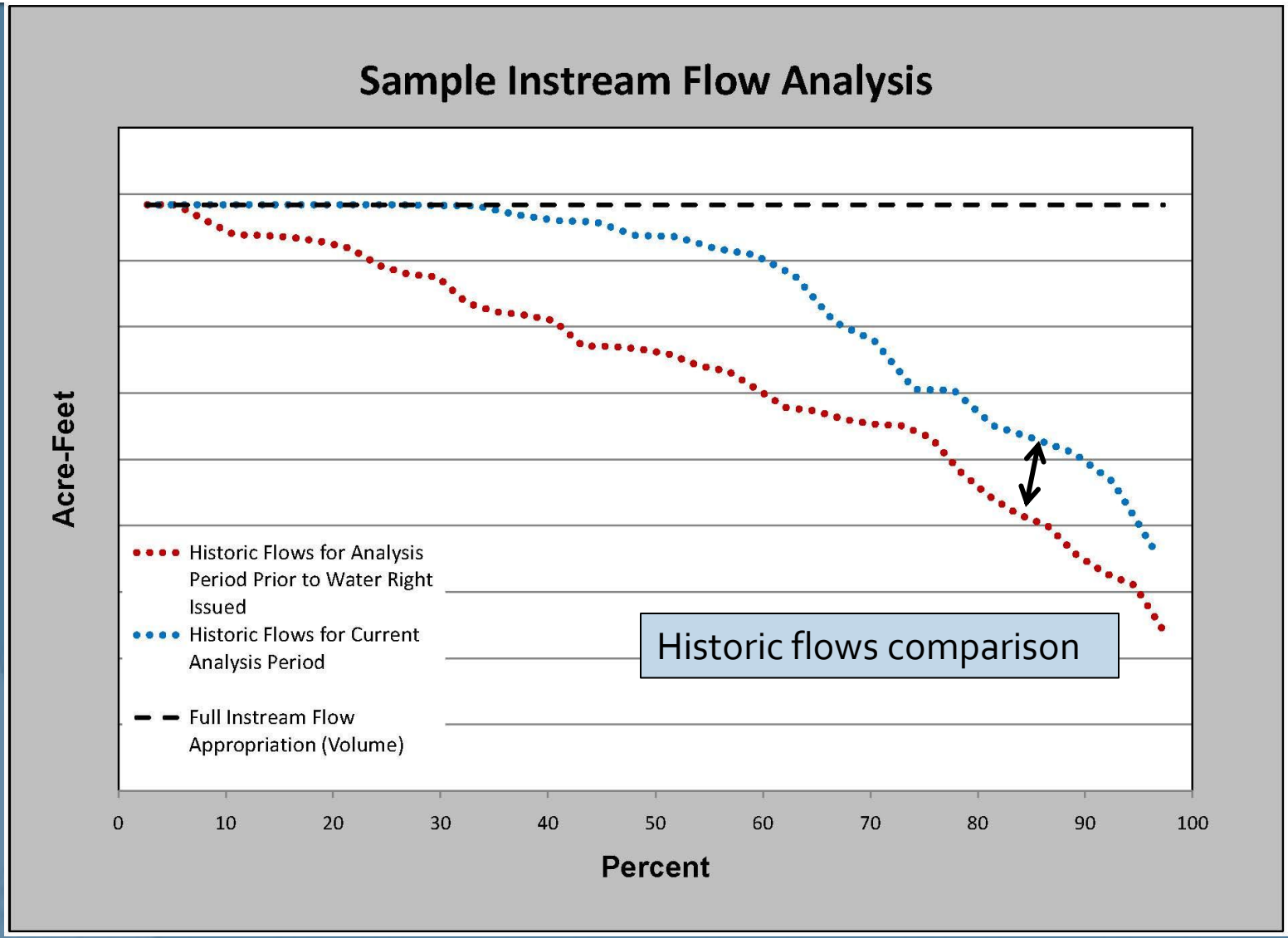

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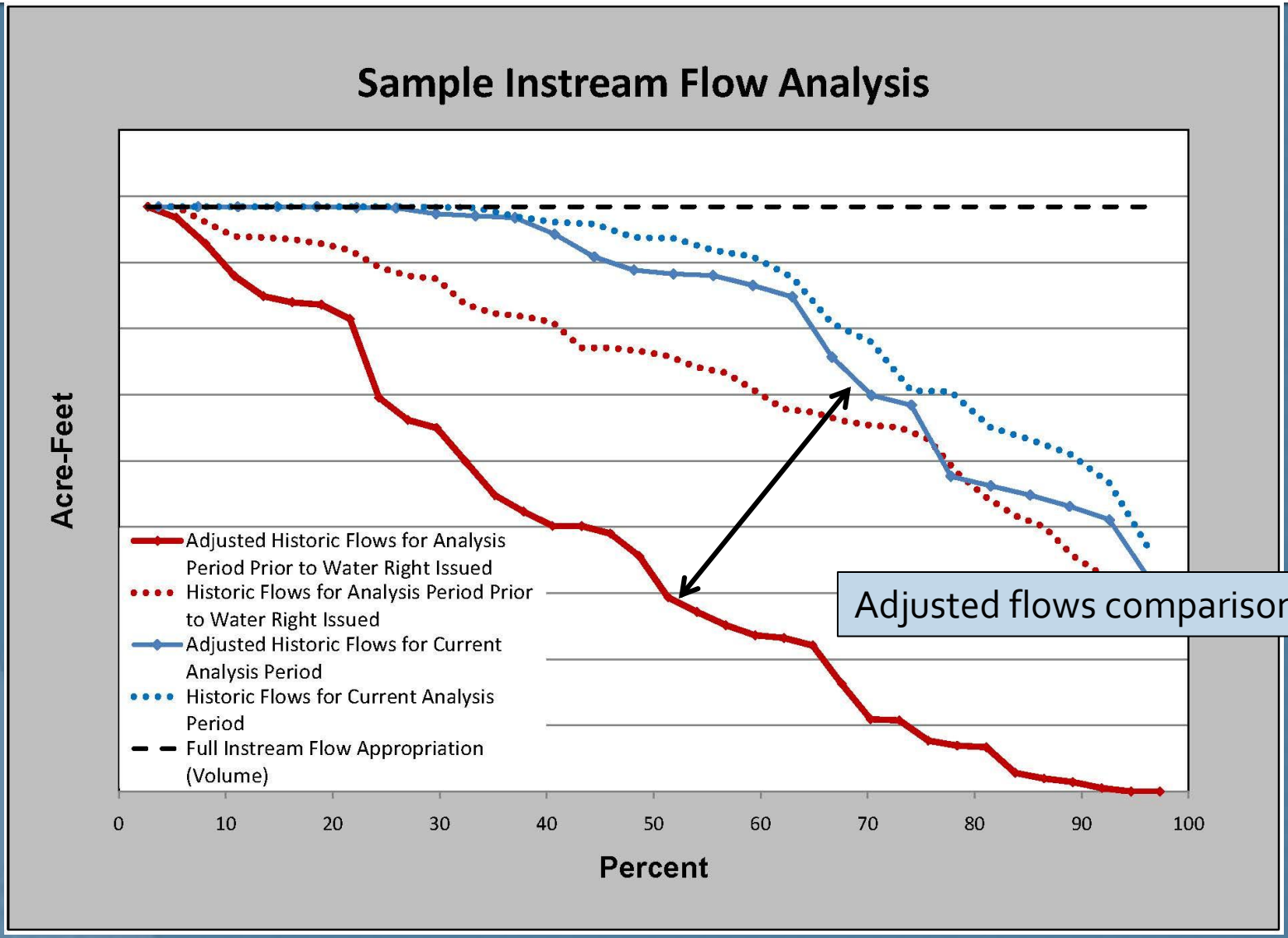
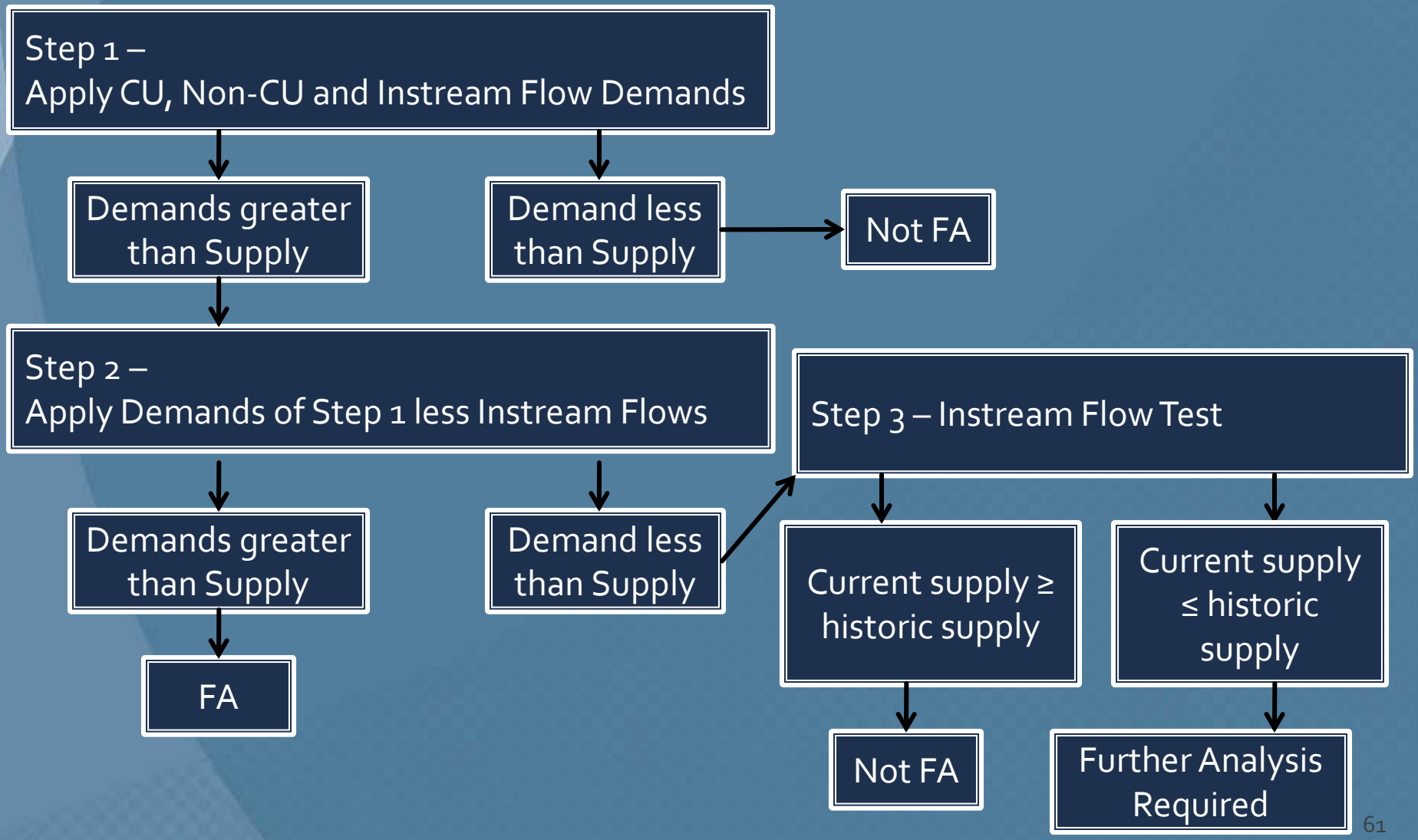


Methodology – Evaluation



Recommendations Summary

- Virgin natural flow hydrograph
- Statistical testing of virgin natural flow
- Discrete components of supply and demand
- Use of reservoir total and change in storage
- Consumptive use demands
- Non-consumptive uses (hydropower and instream flows)
- Consider GW depletion and full consumptive use
- Consideration of downstream demands
- Use of surplus (supply-demand) as a metric
- Three-step analysis in determining basin status
- Instream flow erosion test

Next Steps

- Incorporation of Platte River Basin analysis and Final Recommendations into Final Technical Memorandum
- DNR begin the rulemaking process

Questions?