Update on

Fully Appropriated Evaluation Methodology

Central Platte NRD – Grand Island, NE

May 20, 2011

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THE FLATWATER GROUP INC.

NRD

NEBRASKA Department of Natural Resources

Today's Discussion

- Project History and Background Information
- Update on Project Activities
  - Literature Review
  - Development of Potential Refinements
- Next Steps
- Q/A Session

History and Background

- LB 962 passed in 2004
  - DNR fully appropriated evaluation by Jan 1 each year
  - If fully appropriated – IMP developed (within 3-5 yrs)
  - IMPs
    - Manage GW and SW to sustain subbasin/reach
    - Identify difference between over appropriated (OA) and fully appropriated (FA)

History and Background

- Project History
  - 2009 - CPNRD working on IMP - need OA-FA difference
  - CPNRD approached NDNR about proposed methodology
  - NDNR: Statutes link OA-FA difference to evaluation
    - Current methodology does not provide OA-FA difference
  - 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

Literature Review

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

Literature Review

- Focus
  - Primarily on Western states
  - Rules related to basin closures
  - Criteria or thresholds for basin closure
  - Computational procedures employed

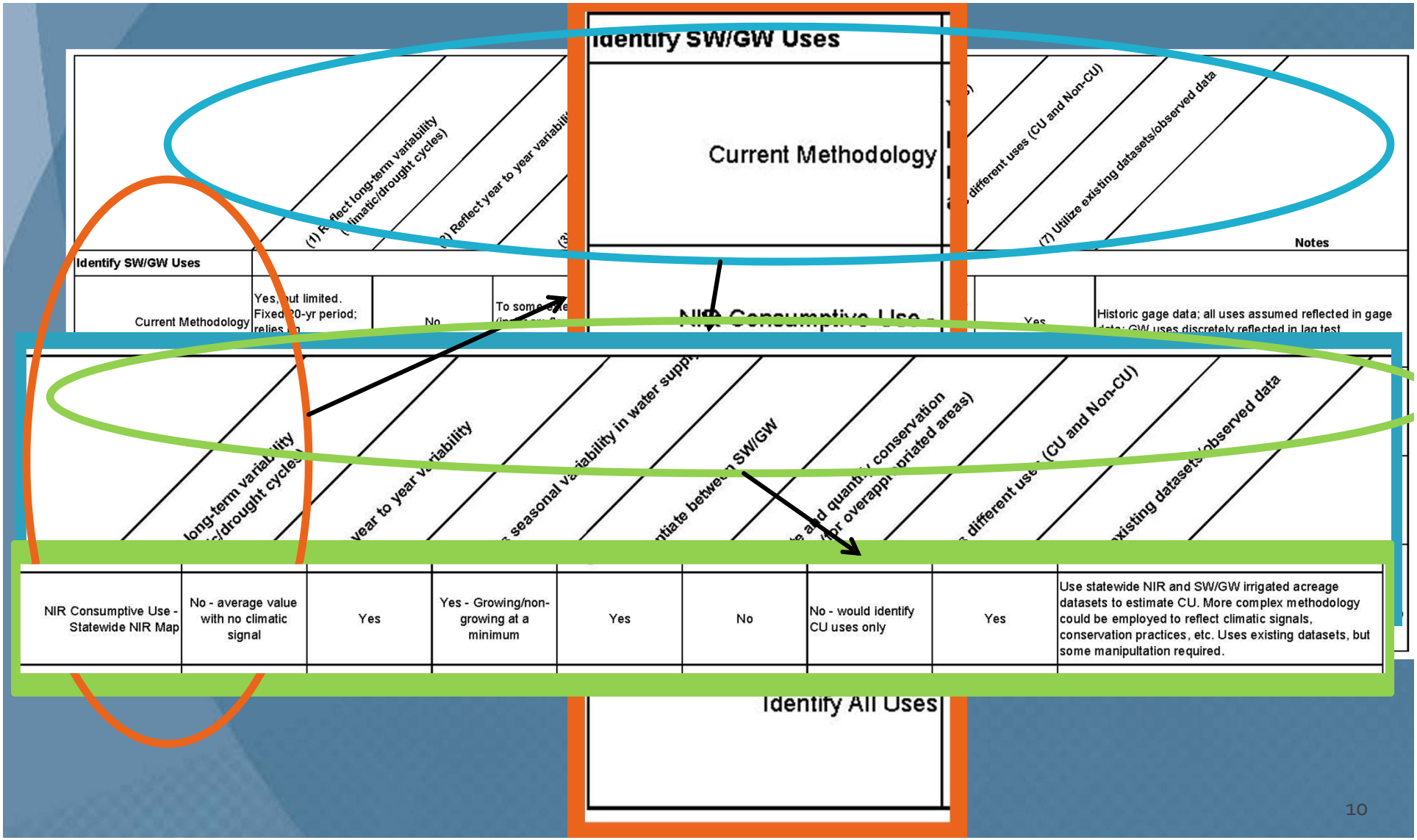
Literature Review

- Findings:
  - Most basin closures by decree
  - Most have SW and GW under common authority – administer both under priority system
  - Lack of integrated SW/GW approach
  - Some elements may be applicable to Nebraska
    - Oregon Frequency Curve
    - Texas' 75/75 rule
    - Accounting Methods of Republican River and Pecos River compacts
- No off-the-shelf solution

Methodology

- Key Desirable Characteristics of Method
  - 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
  - Evaluate/consider conservation measures
  - Consumptive/Non-consumptive use
  - Utilize existing datasets when possible

Methodology



Identify SW/GW Uses	(1) Reflect long-term variability (climatic/drought cycles)	(2) Reflect year to year variability	(3) Reflect seasonal variability in water supply	(4) Differentiate between SW/GW	(5) Address conservation (for overappropriated areas)	(6) Identify different uses (CU and Non-CU)	(7) Utilize existing datasets/observed data	Notes
Current Methodology	Yes, but limited. Fixed 20-yr period; relies on	No	To some extent			Yes		Historic gage data; all uses assumed reflected in gage data; GW uses discretely reflected in lag test
NIR Consumptive Use - Statewide NIR Map	No - average value with no climatic signal	Yes	Yes - Growing/non-growing at a minimum	Yes	No	No - would identify CU uses only	Yes	Use statewide NIR and SW/GW irrigated acreage datasets to estimate CU. More complex methodology could be employed to reflect climatic signals, conservation practices, etc. Uses existing datasets, but some manipulation required.

Methodology

	(1) Reflect long-term variability (climatic/drought cycles)	(2) Reflect year to year variability	(3) Reflects seasonal variability in water supply	(4) Differentiate between SW/GW	(5) Evaluate and quantify conservation measures (for overappropriated areas)	(6) Reflects different uses (CU and Non-CU)	(7) Utilize existing datasets/observed data	Notes
Indentify SW Supplies								
Current Methodology	Yes (20-yr Period)	No	Yes	No - total flow considered	No	NA	Yes	Historic gage data (total flow, no separation of natural and storage flows) and administratvie record used
Virgin Natural Flow Hydrograph	Yes	Yes	Yes	Yes	Yes - depending on complexity of method and representation of watershed runoff	NA	Yes	Would incorporate historic diversions, reservoir operations, reach gains/losses, imported supplies, precip/irrigation runoff, etc.; partitioning of hydrograph
Virgin Flow Hydrograph (pre-development)	Not applicable - Consderation of pre-development or pre-settlement activities irrevalent							Would develop pre-settlement flow hydrographs.
Oregon-type Flow Duration Curve(FDC) - Total Flow	Approach is based and focuses on water to be left in stream and does not consider uses. Not suitable as a stand-alone approach, but could be a tool that can be useful in analyzing historical records							Total flow approach (storage and natural flows); standard approach could be defined to determine historic period of record for analysis
FDC with discrete components	Approach is based and focuses on water to be left in stream, and while it would differentiate sources of supply, does not consider uses.Not a stand-alone approach, but could be a tool that can be useful in analyzing historical records							Would separate baseflow and runoff, potentially allowing evaluation of conservation measures.
Statistical Analysis of Precip/Runoff	Not a stand-alone approach, but a tool that can be useful in analyzing cyclical effects and setting base periods for analysis							Could be used to assess impact of landuse changes
Model of SW supplies - Spreadsheet, STELLA, etc.	Not a stand-alone approach - potential tool for natural flow analysis							Complexity could vary from simple to detailed

Methodology- Overview

- Methodology for Testing
  - **Supply** - Virgin 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

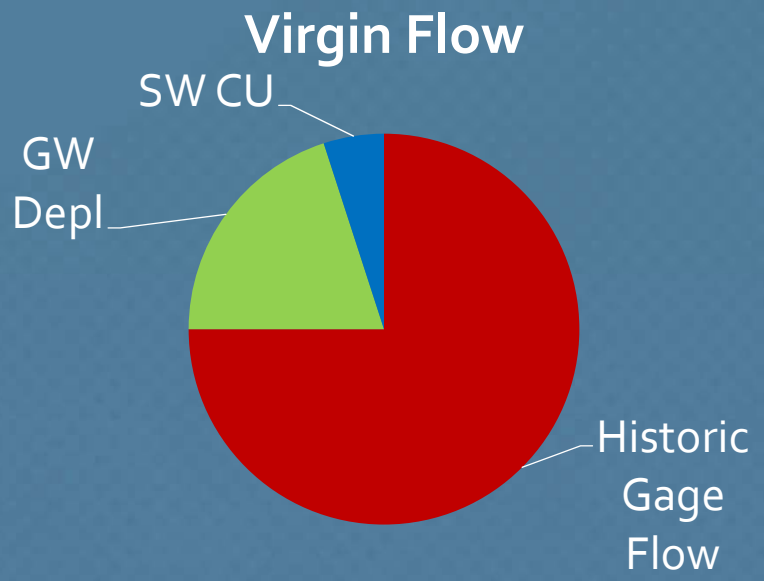
Methodology - Supply

- Virgin Flow Hydrograph
  - Estimate of streamflow hydrograph without "activities of man"
  - Historic gaged flows + upstream consumptive uses:

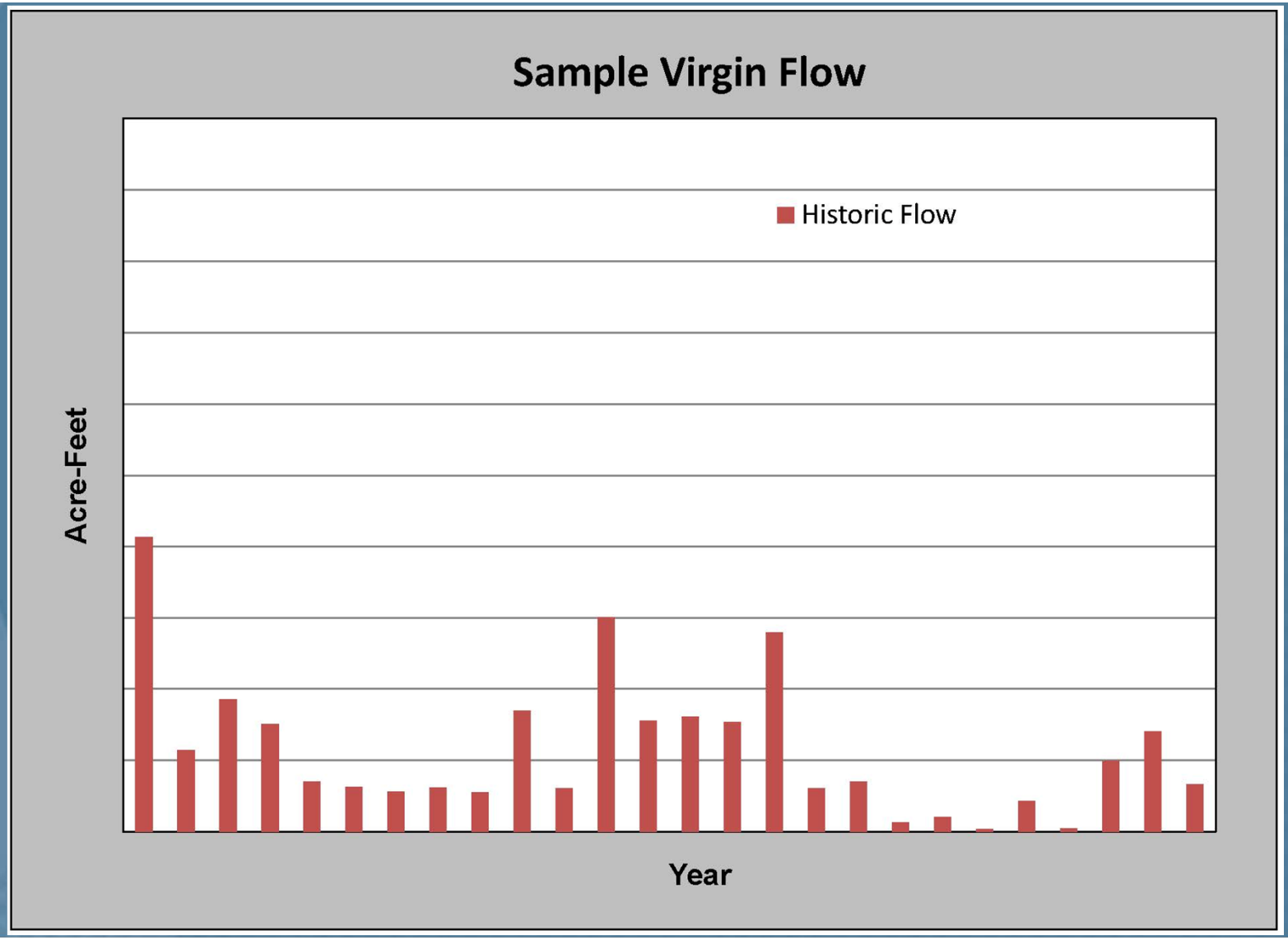
Virgin Flow = Historic flow

+ historic SW CU

+ estimated GW depletions



Methodology – Building the Virgin Flow Hydrograph



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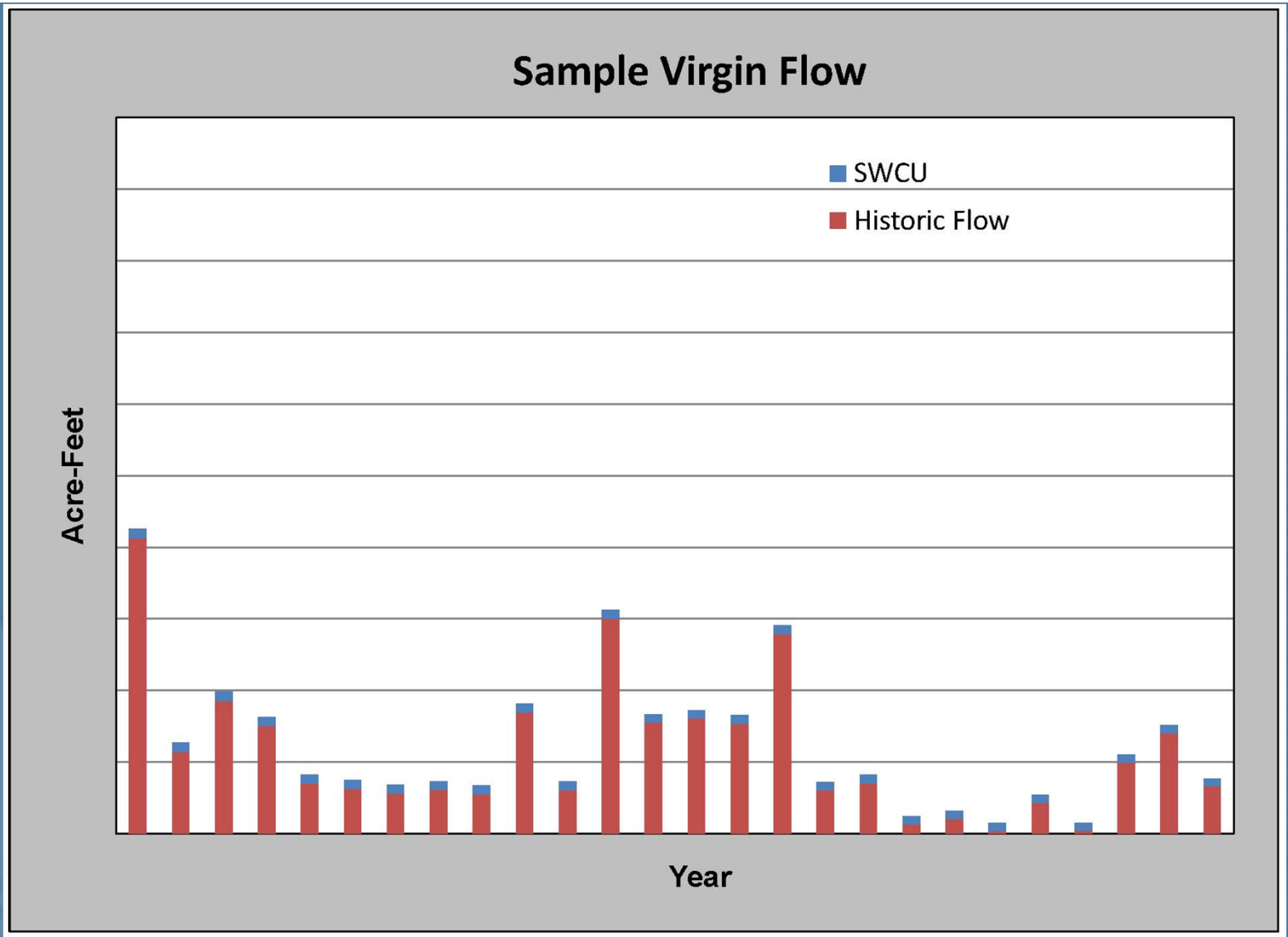

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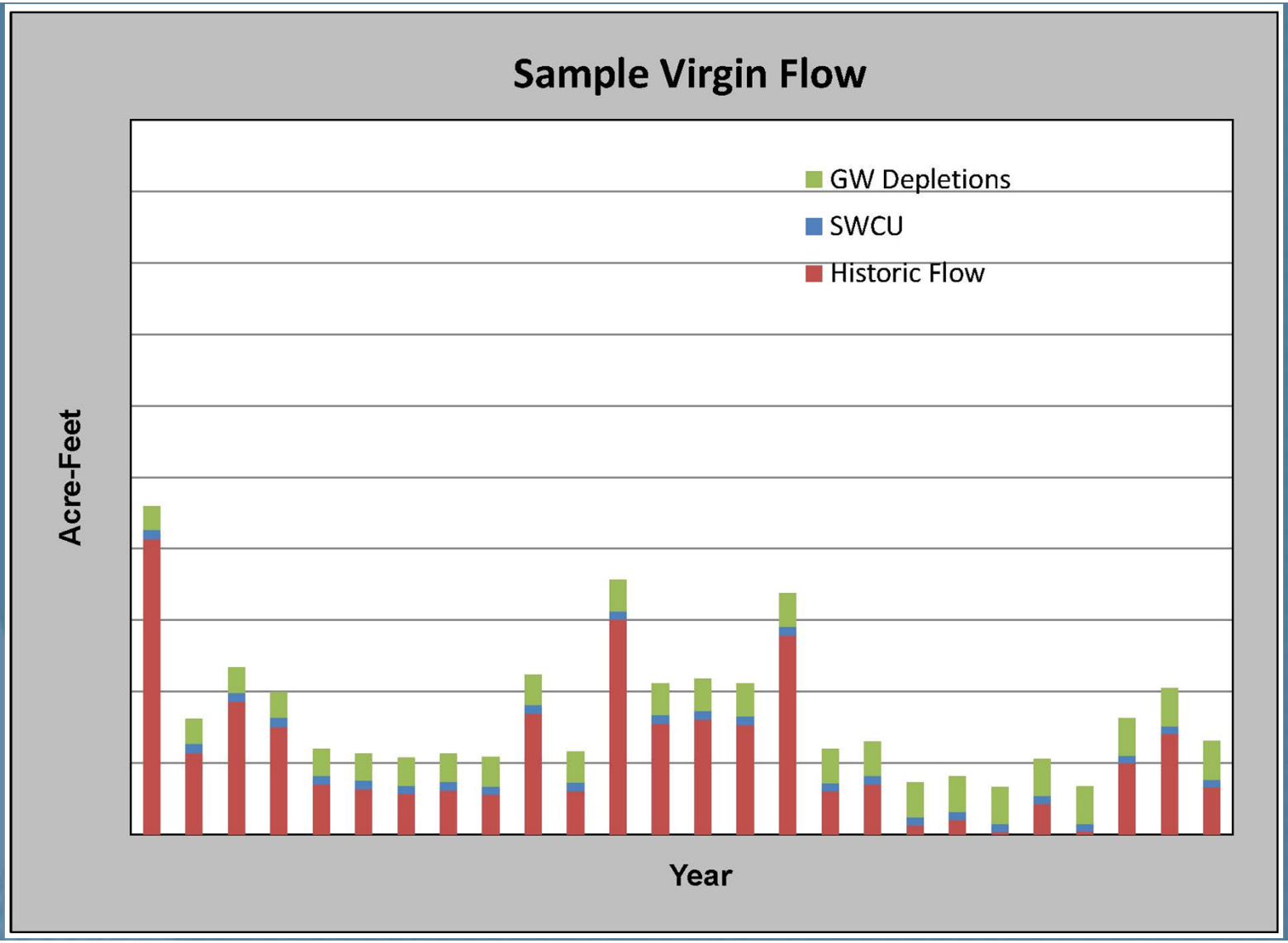

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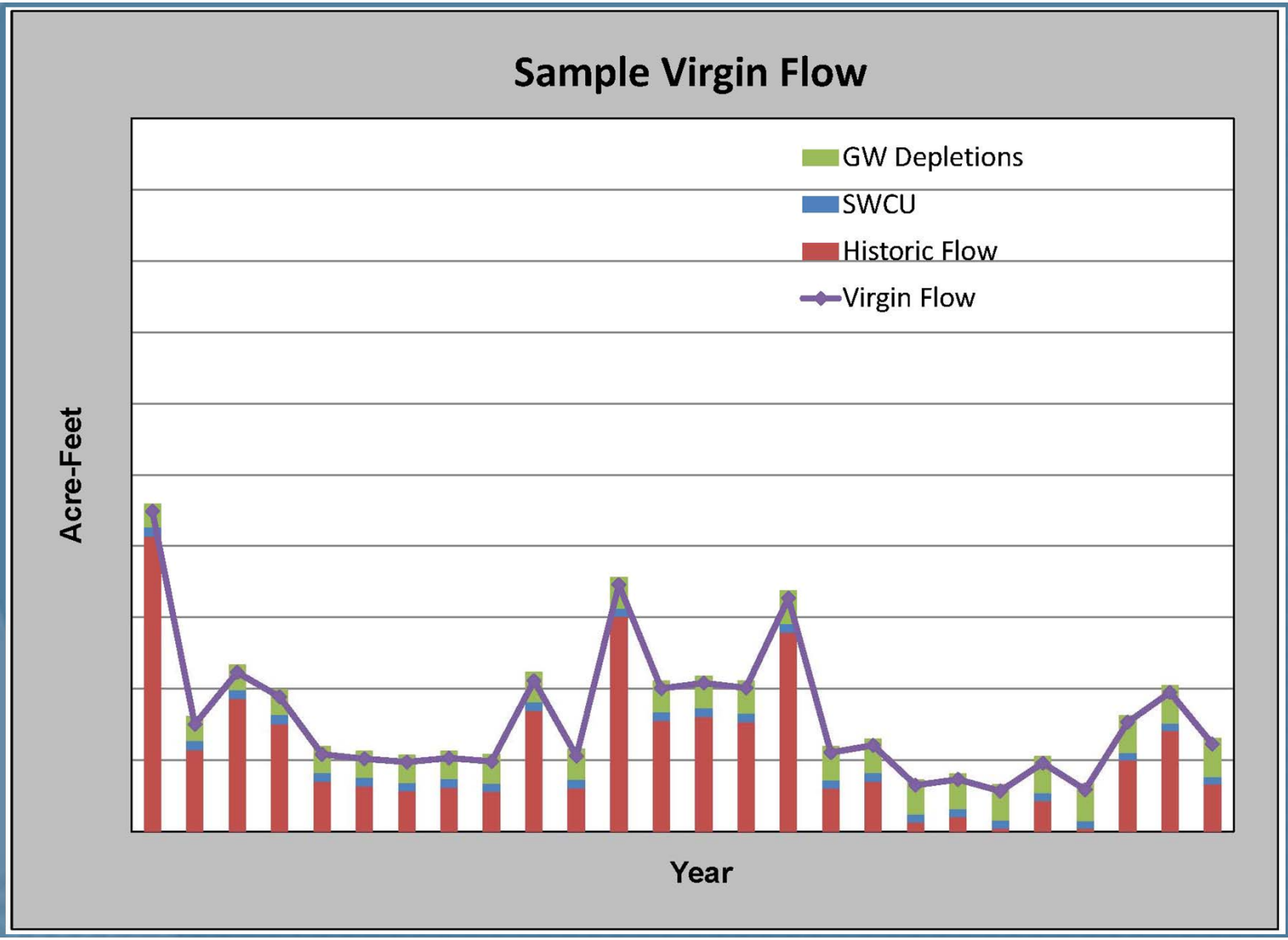
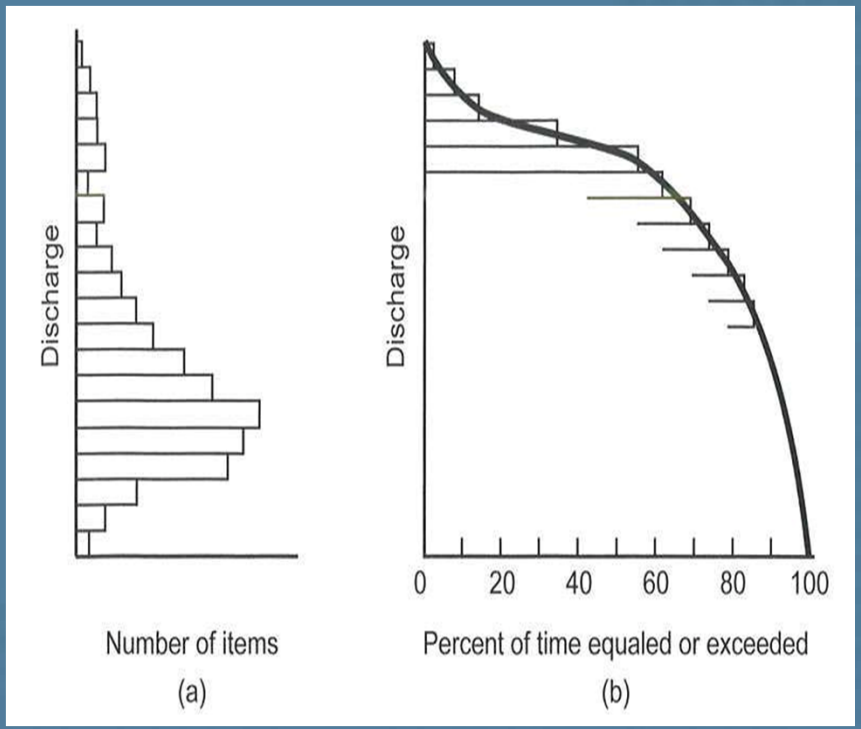
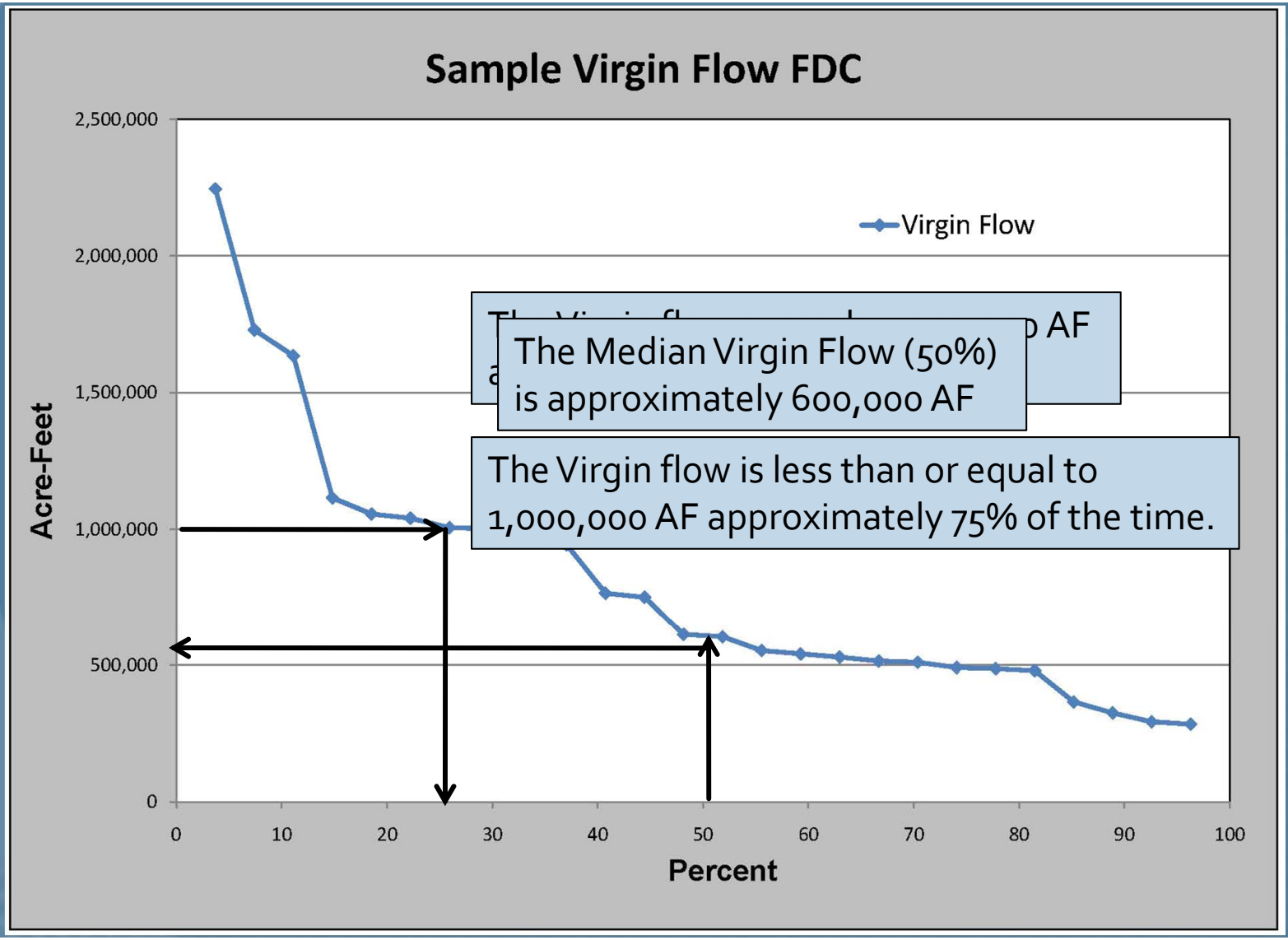


Methodology Tools – Flow Duration Curves

- Flow Duration Curves (FDC) plot flow and percent of time that discharge is equaled or exceeded in a stream
- FDC useful in predicting supply/demand



Methodology – Virgin Flow Duration Curve



Break

Methodology - Demands

- Differentiate between SW and GW uses

GROUND WATER DEMANDS

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

SURFACE WATER DEMANDS

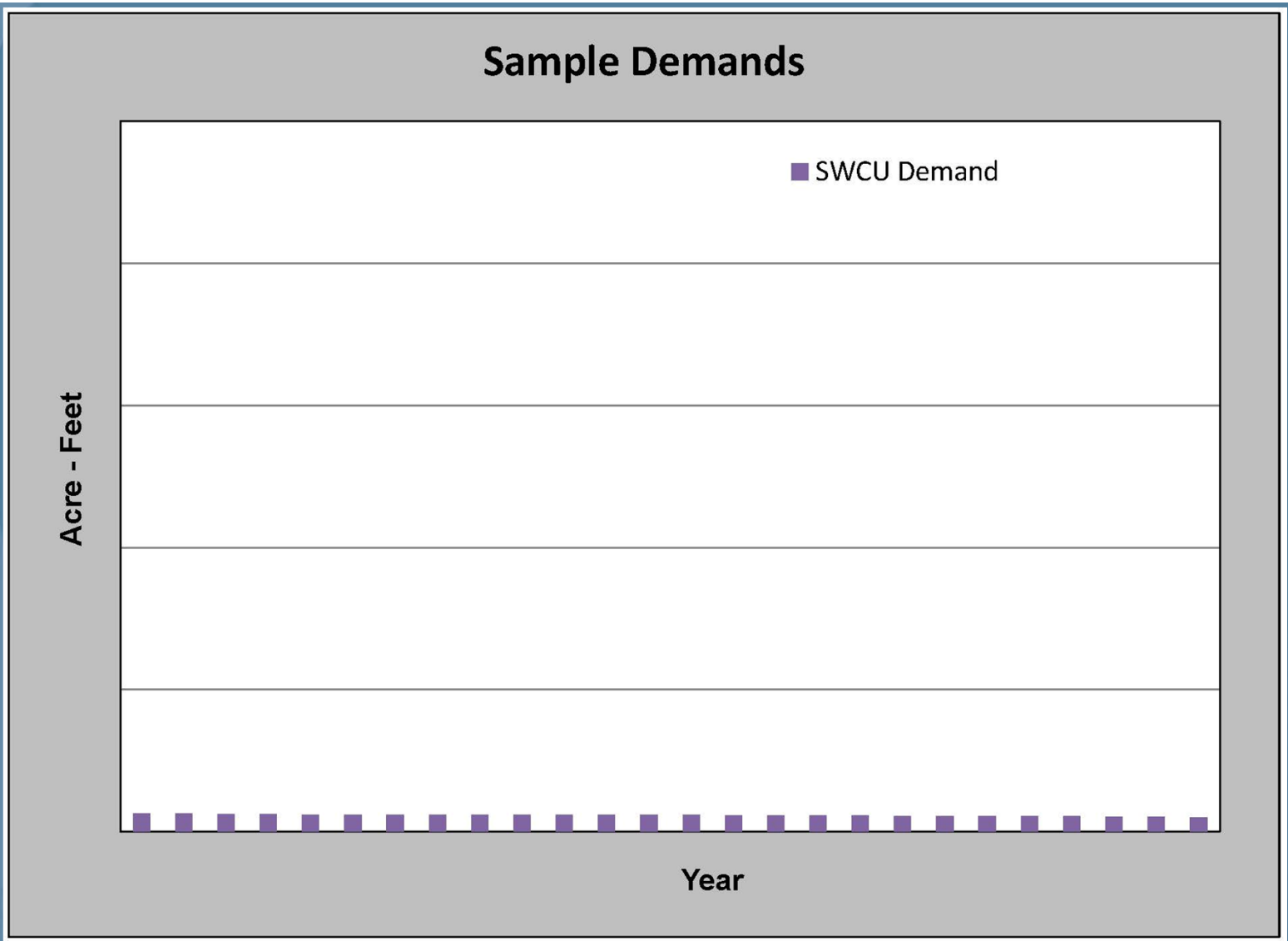
Irrigation Canal Diversions (CU)
Individual irrigation appropriators (CU)
Hydropower (NonCU)
Instream flow appropriations (NonCU)
Reservoir evaporation (CU)

Methodology - Demands

- Two levels of groundwater demands
  1) GW use represented by Depletions (current level of impacts)
  2) Full GW consumptive use (accounts for lag effect)

Snapshot of where we are and where we are headed

Methodology-
Building the Demand Curve



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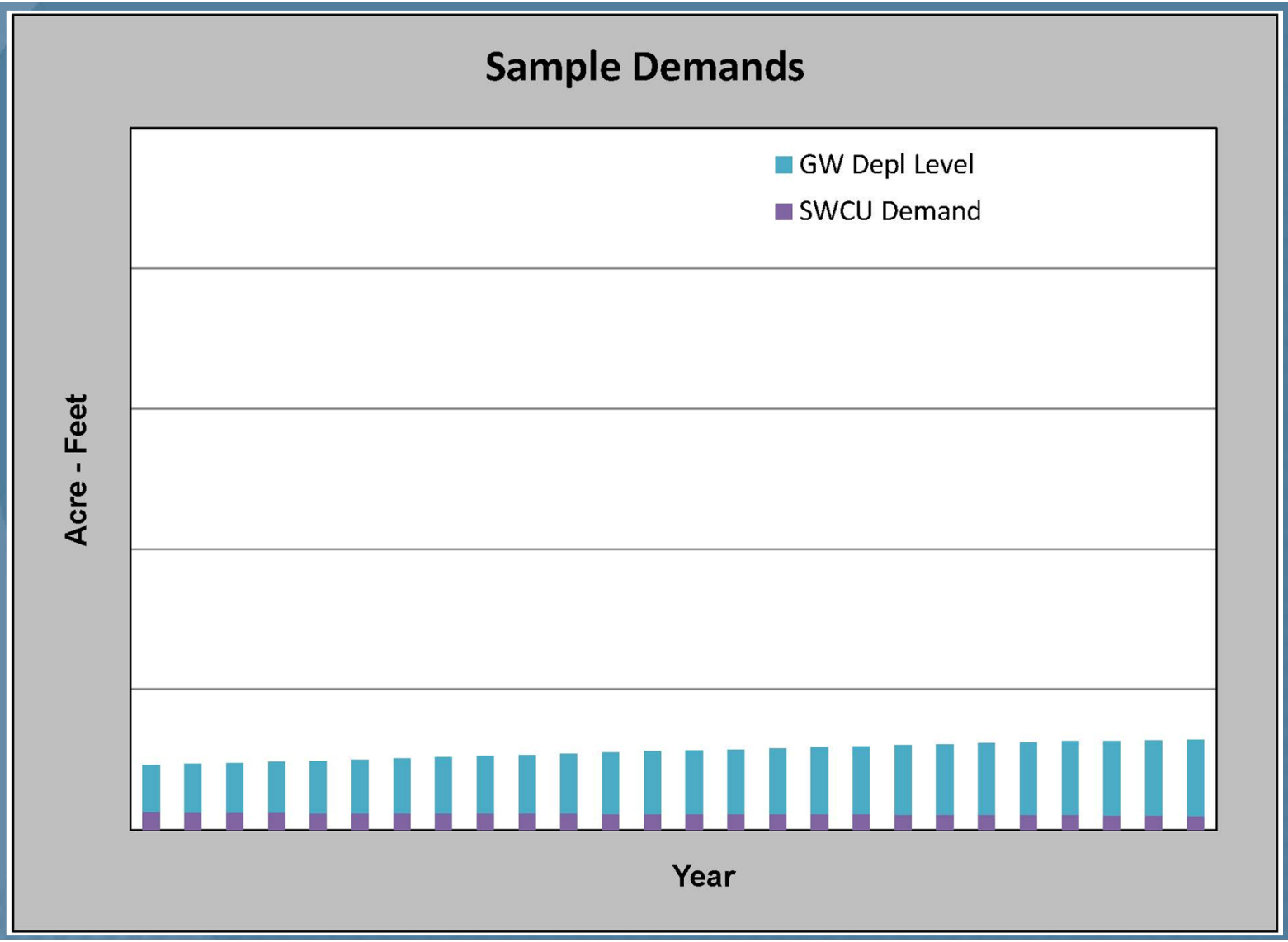

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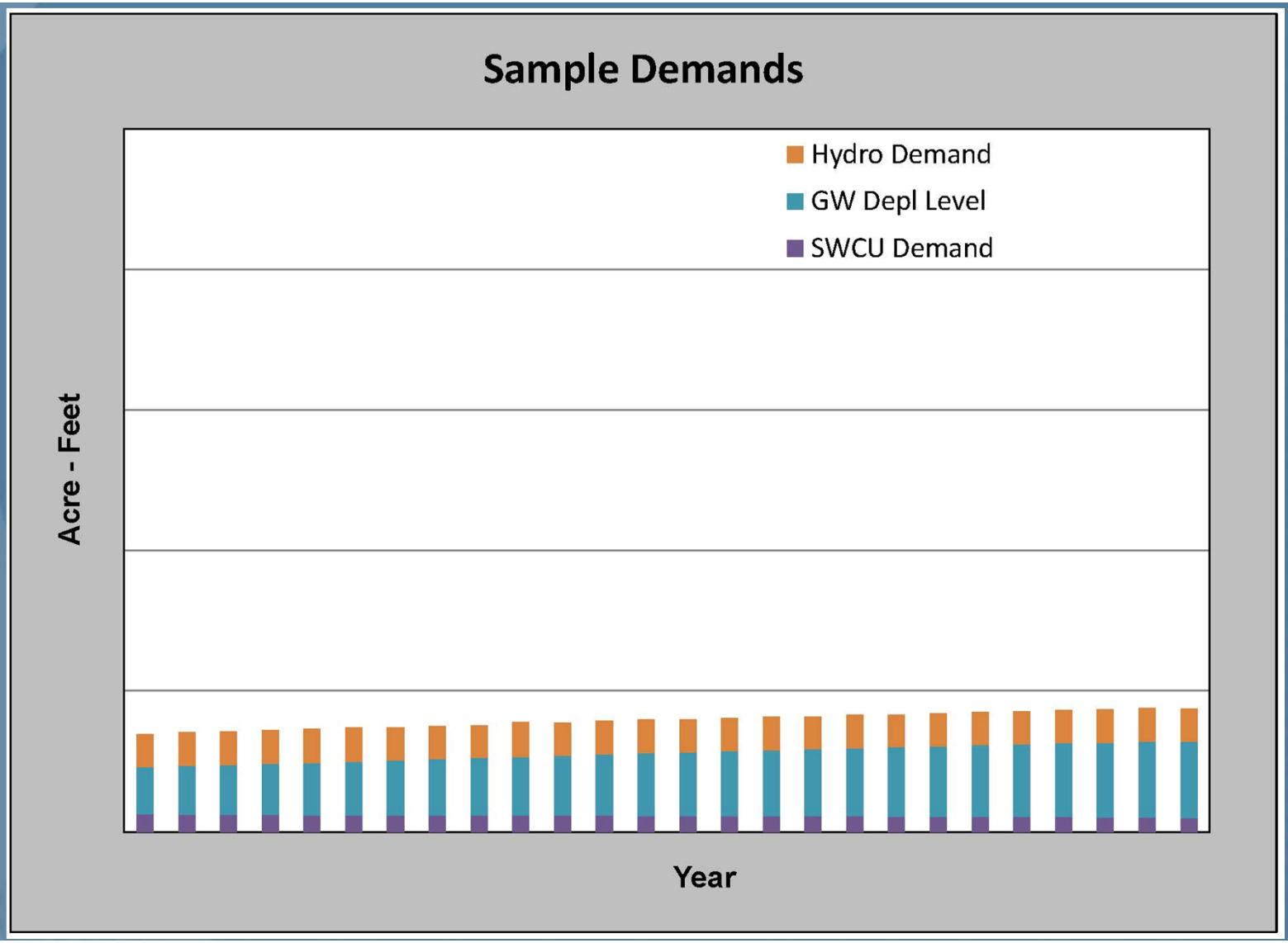

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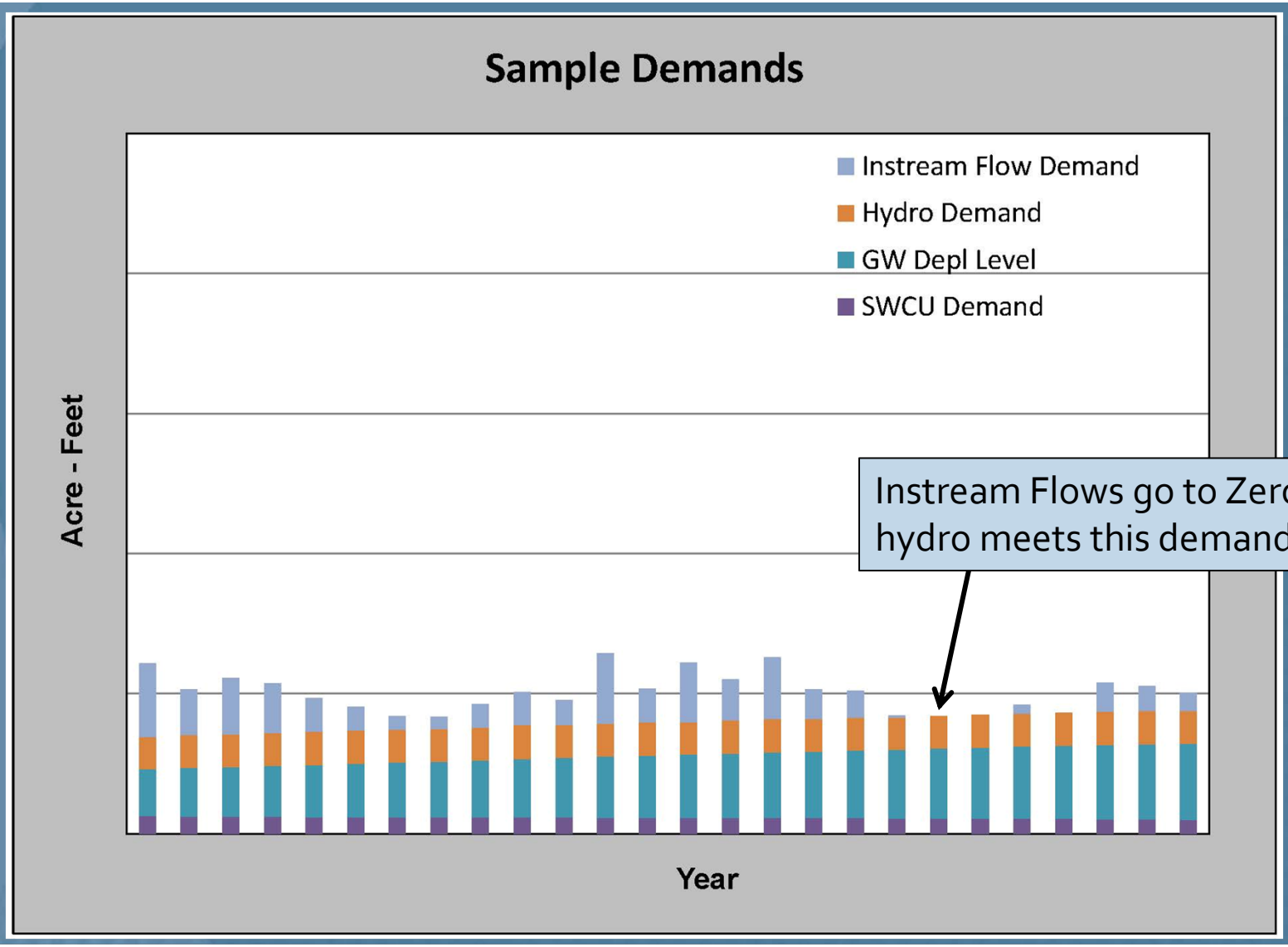

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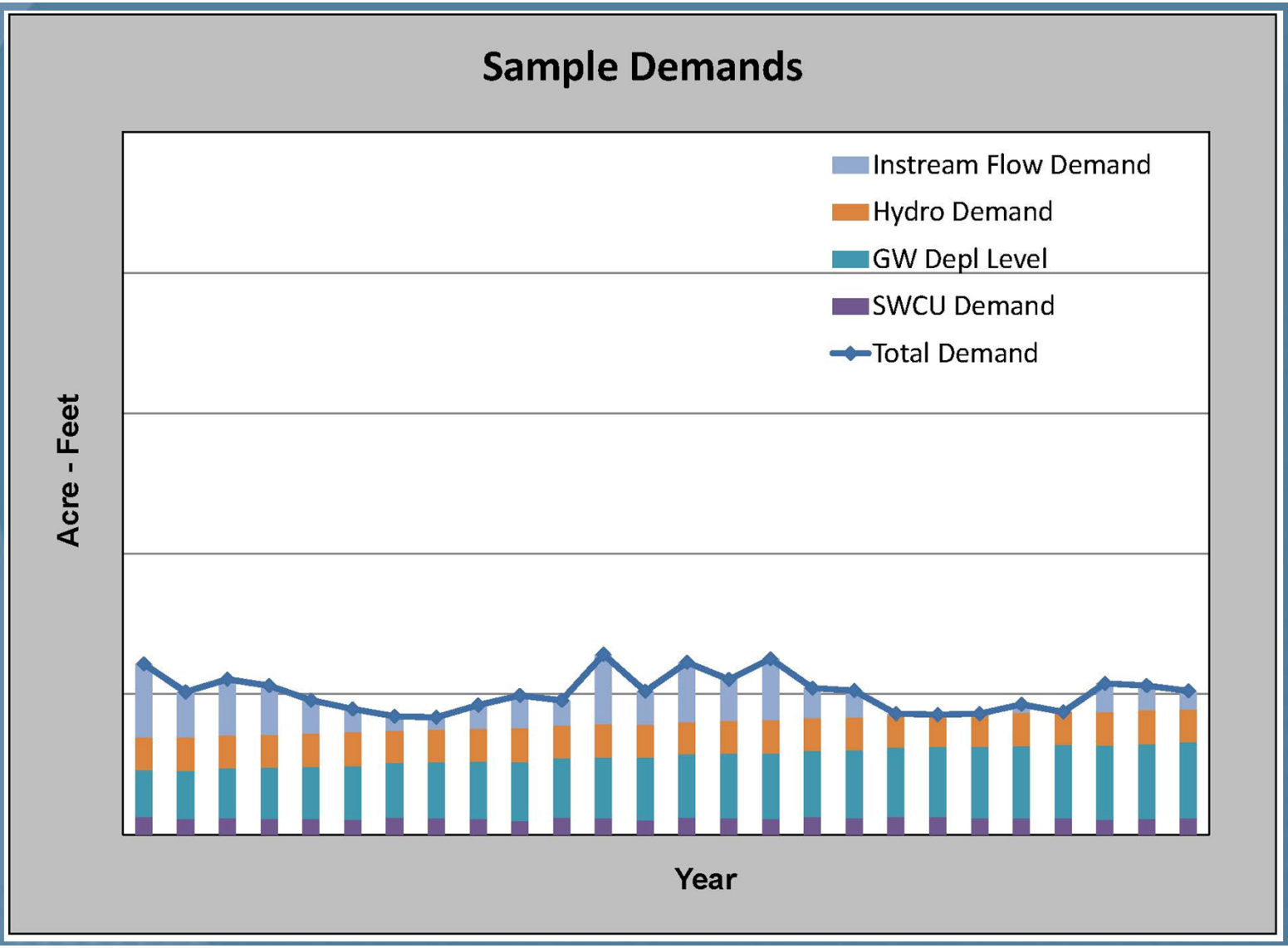
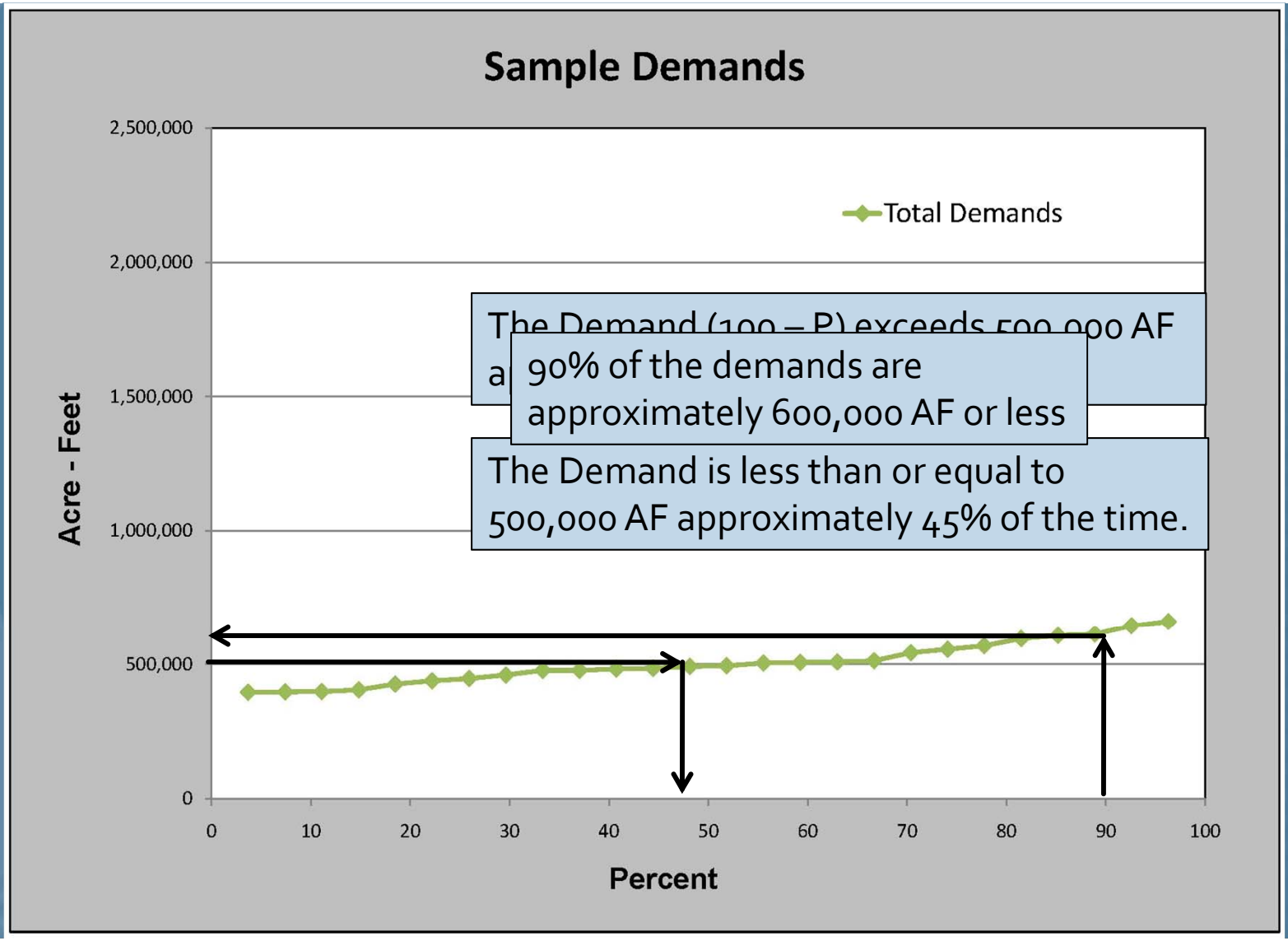
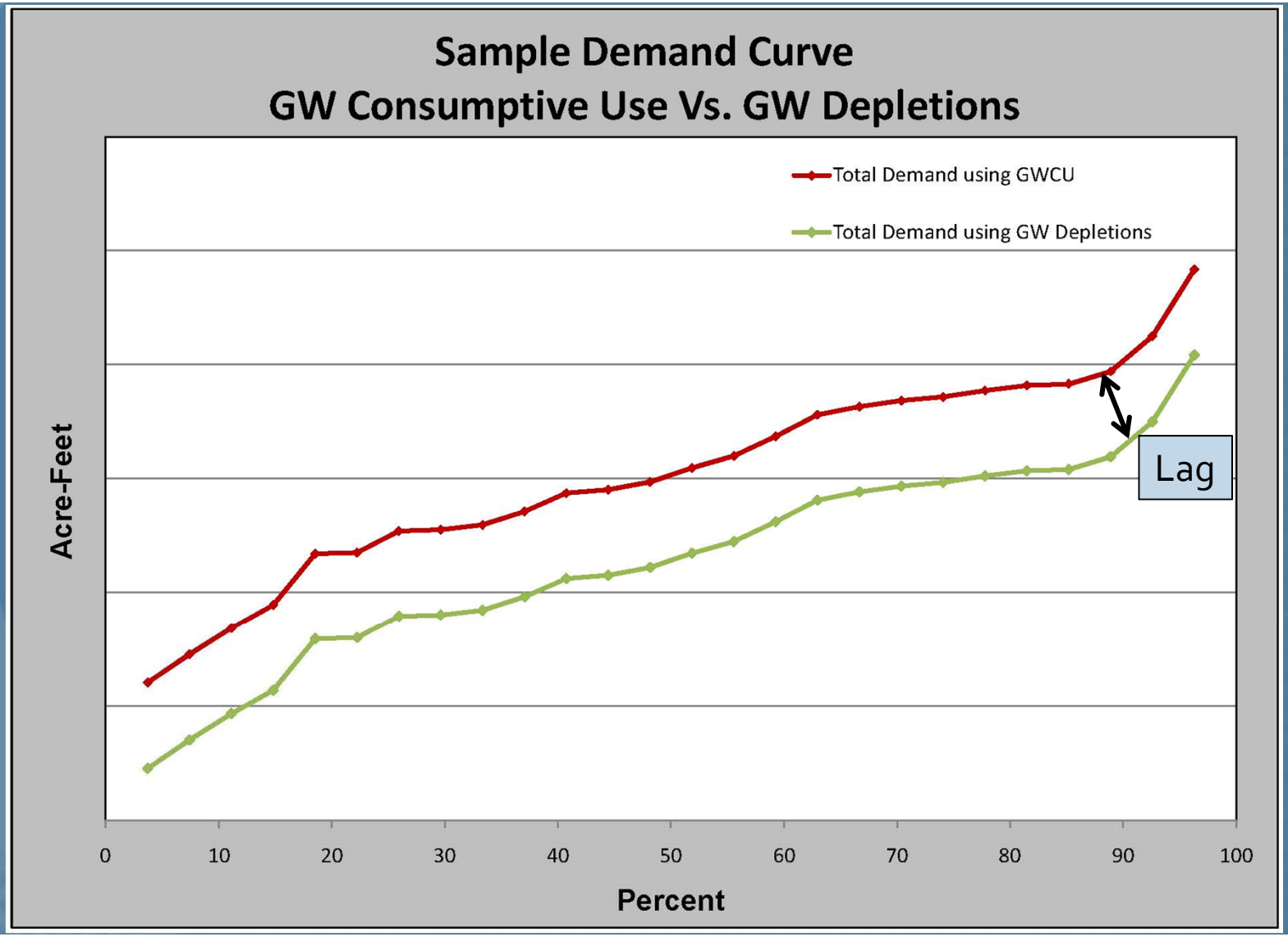


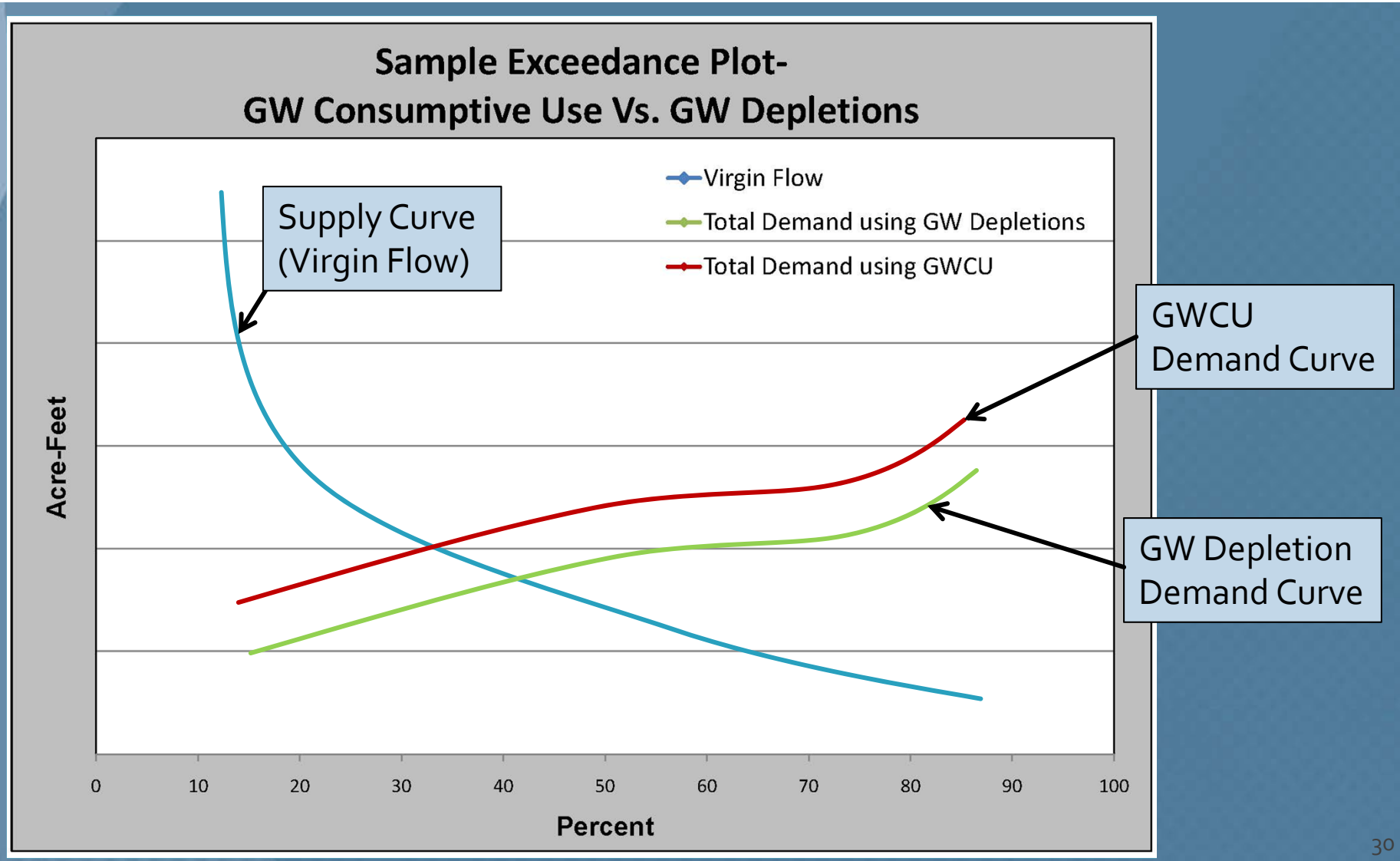
Methodology-
Demand Flow Duration Curve



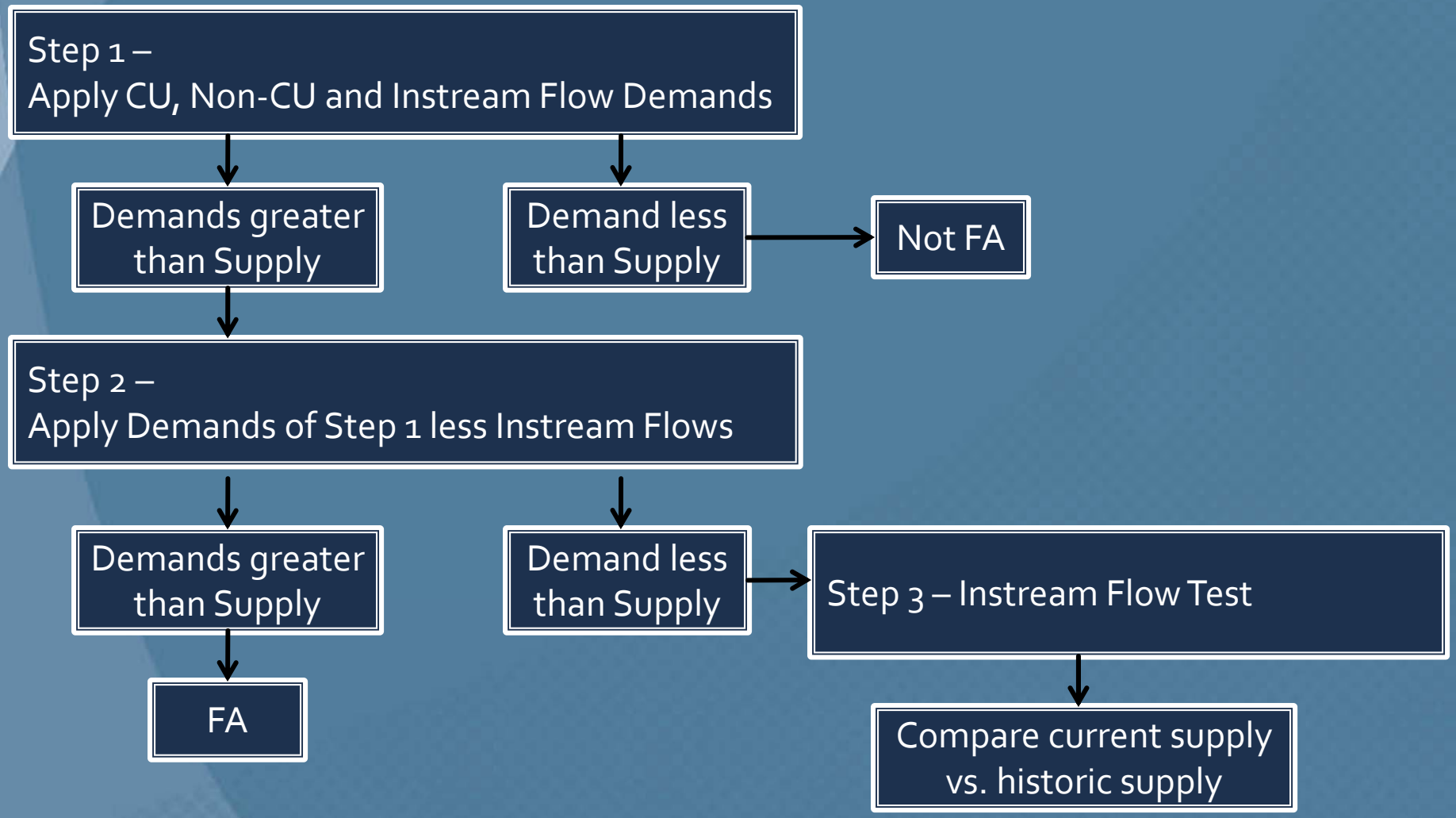
Comparison of Demands - Depletions vs. Consumptive Use



Methodology-
The Big Picture



Methodology – Process

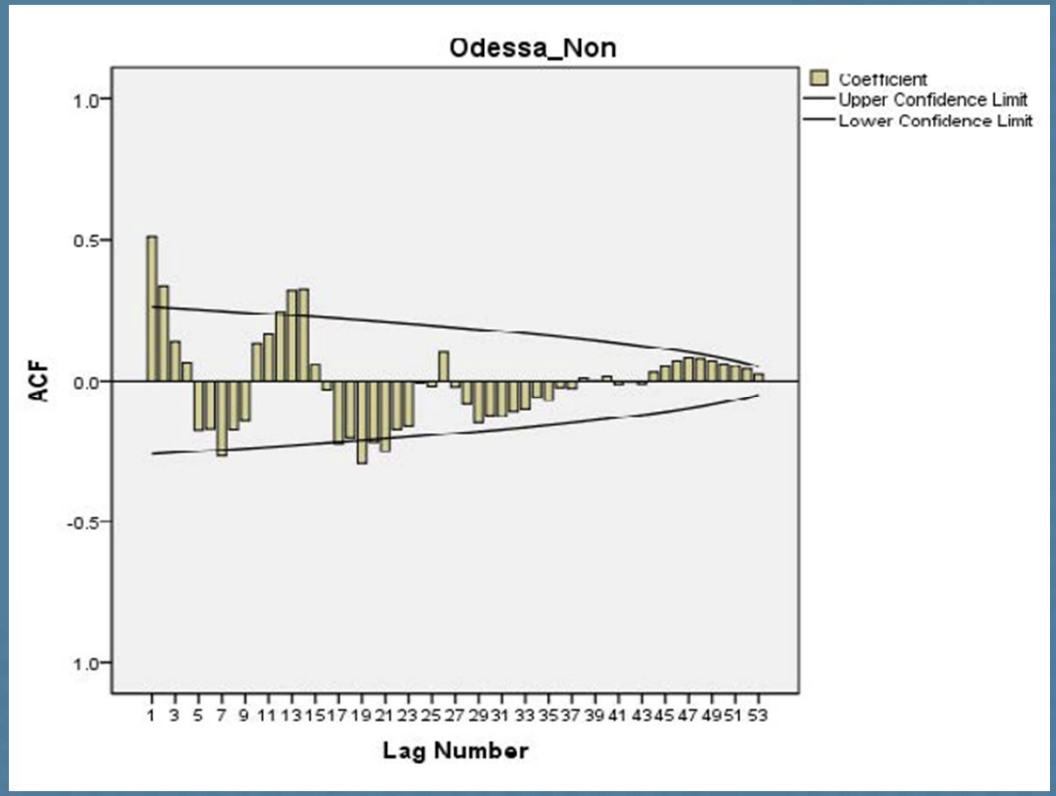


Methodology- Instream Flow Test

- Exceedance Plots
  - 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 or instream flow appropriation.

Methodology Tools- Statistical Analysis

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



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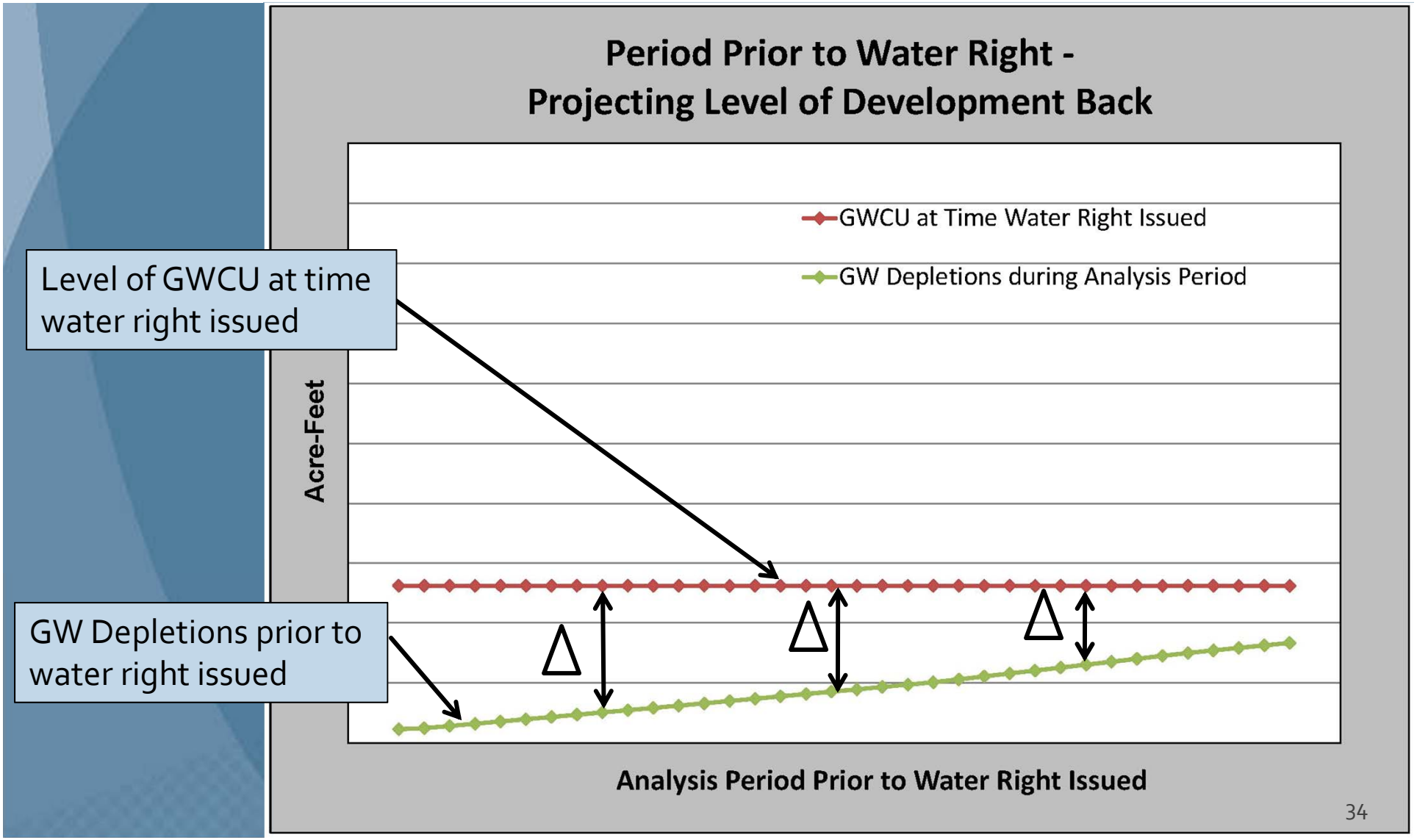

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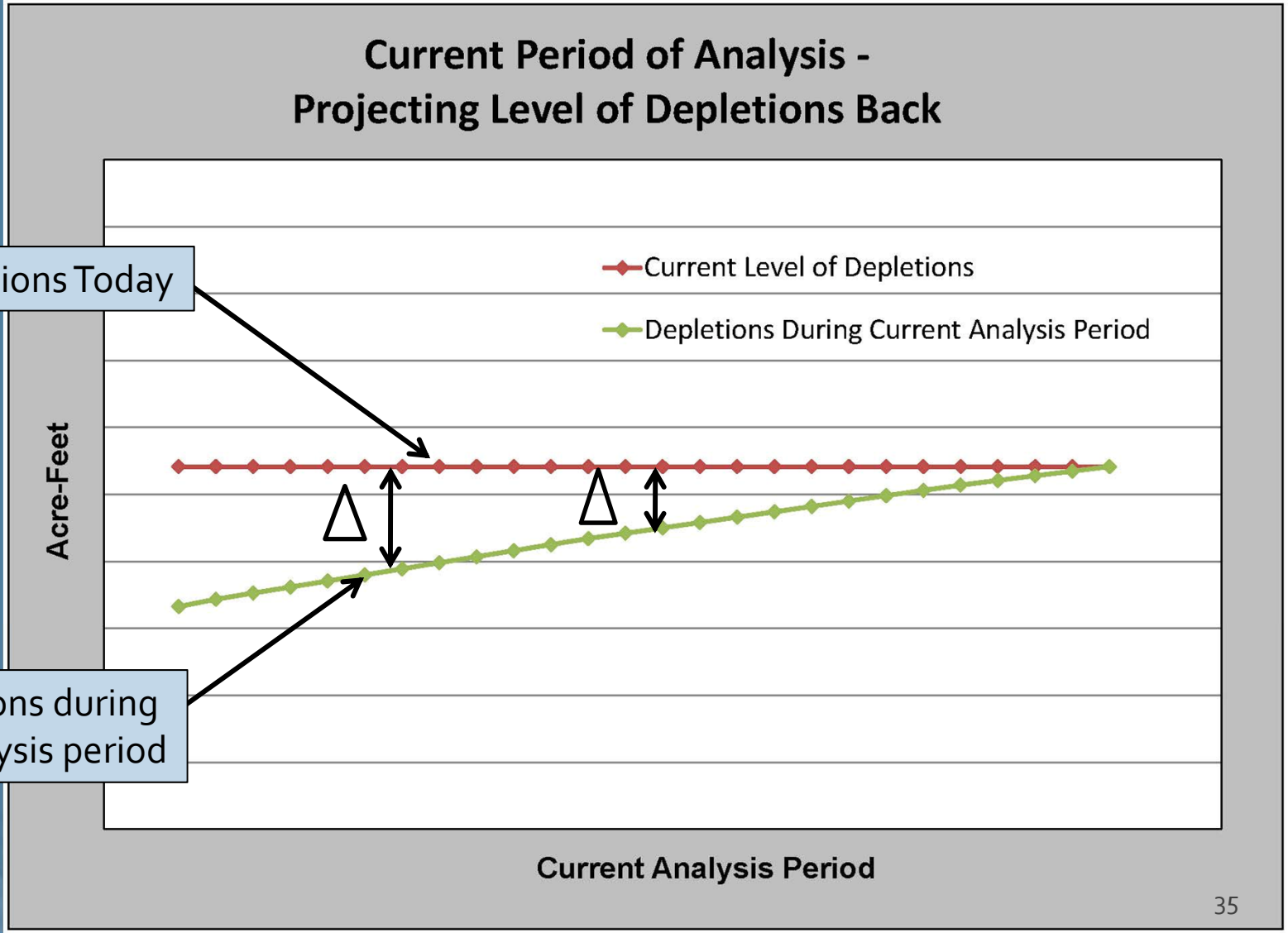
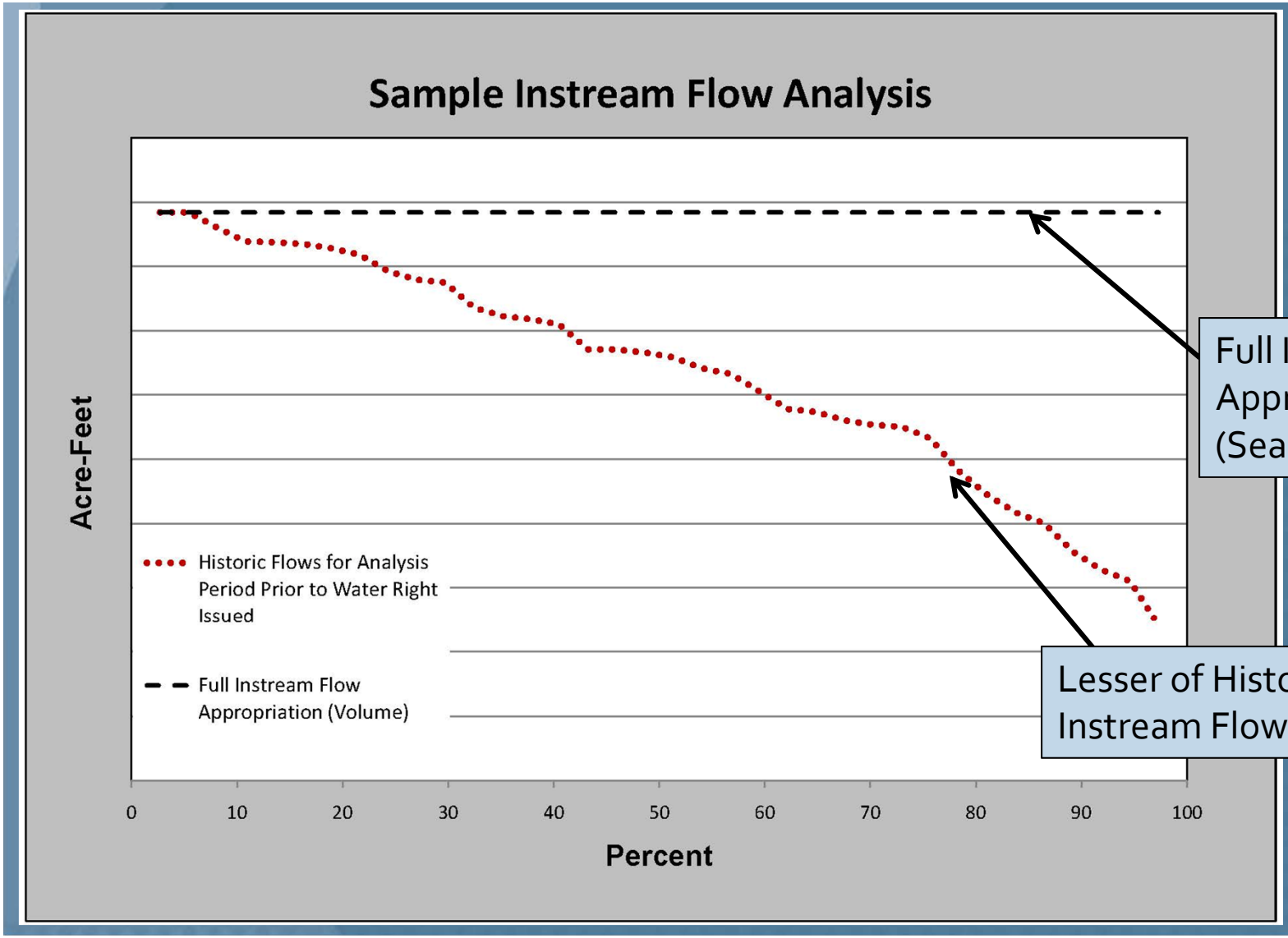


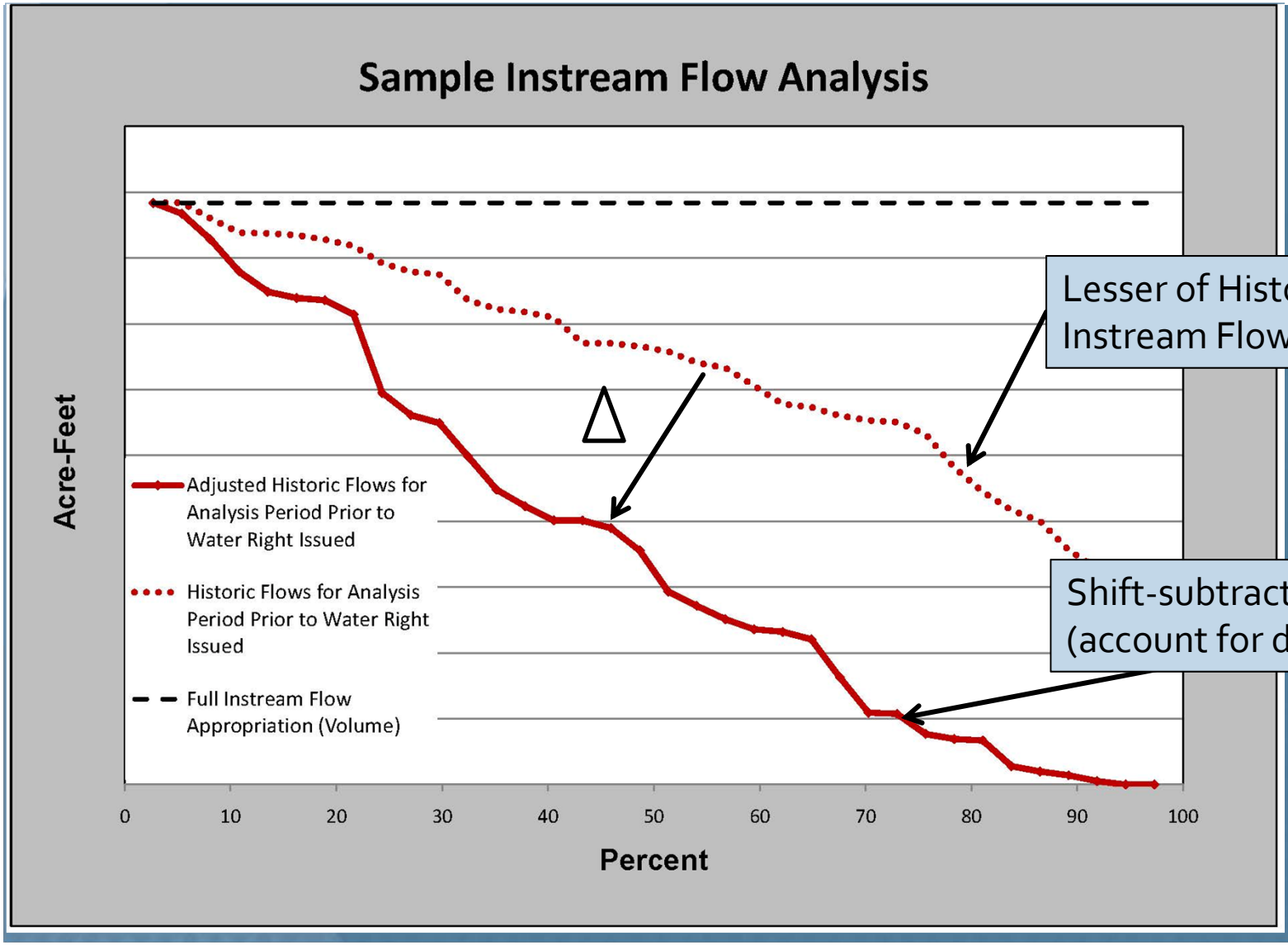
Instream Flow Test Comparison Plot



Full Instream Flow Appropriation (Seasonal Volume)

Lesser of Historic Flow and Instream Flow Appropriation

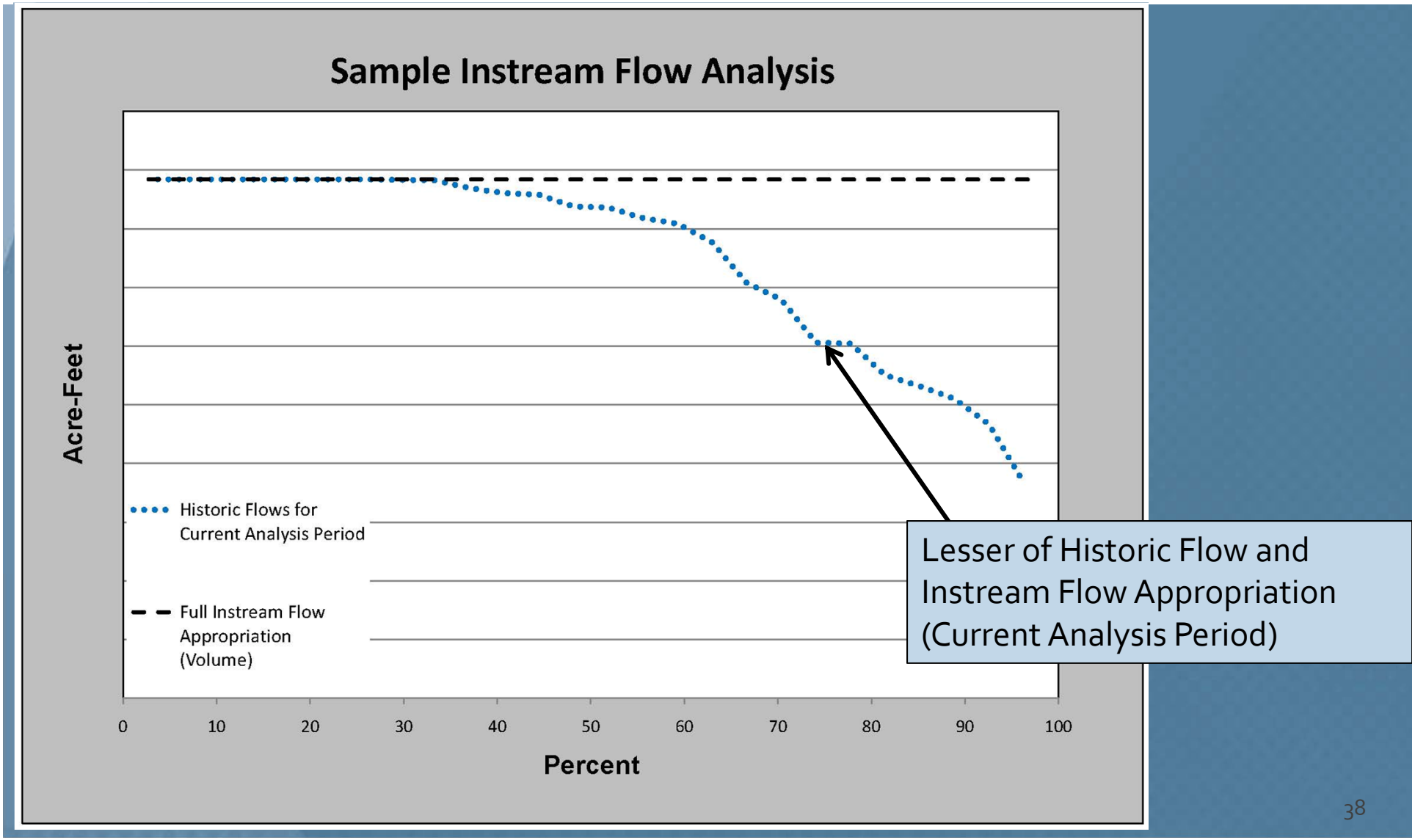
Instream Flow Test Comparison Plot



Lesser of Historic Flow and Instream Flow Appropriation

Shift-subtract off Δ (account for development)

Instream Flow Test Comparison Plot



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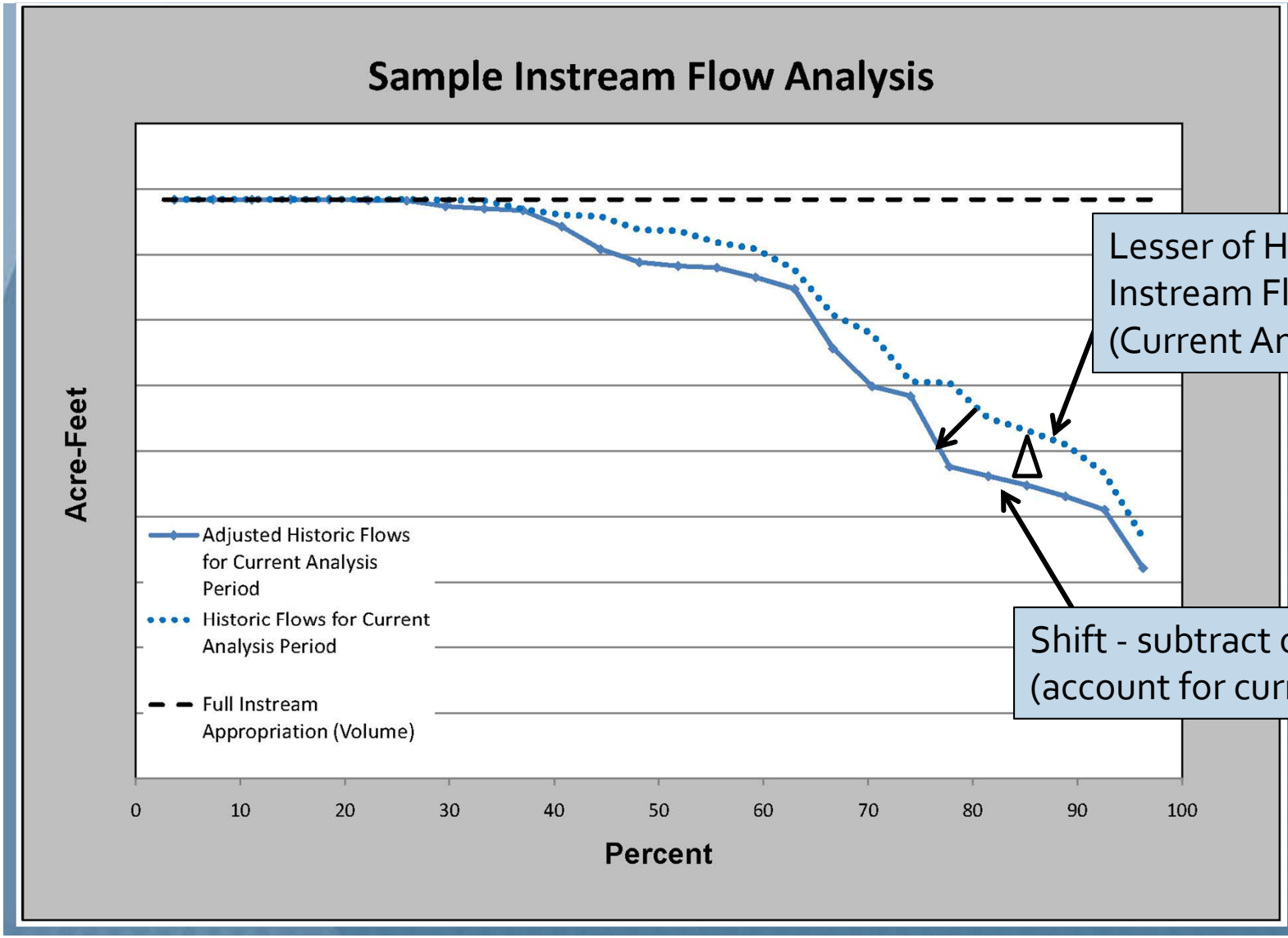

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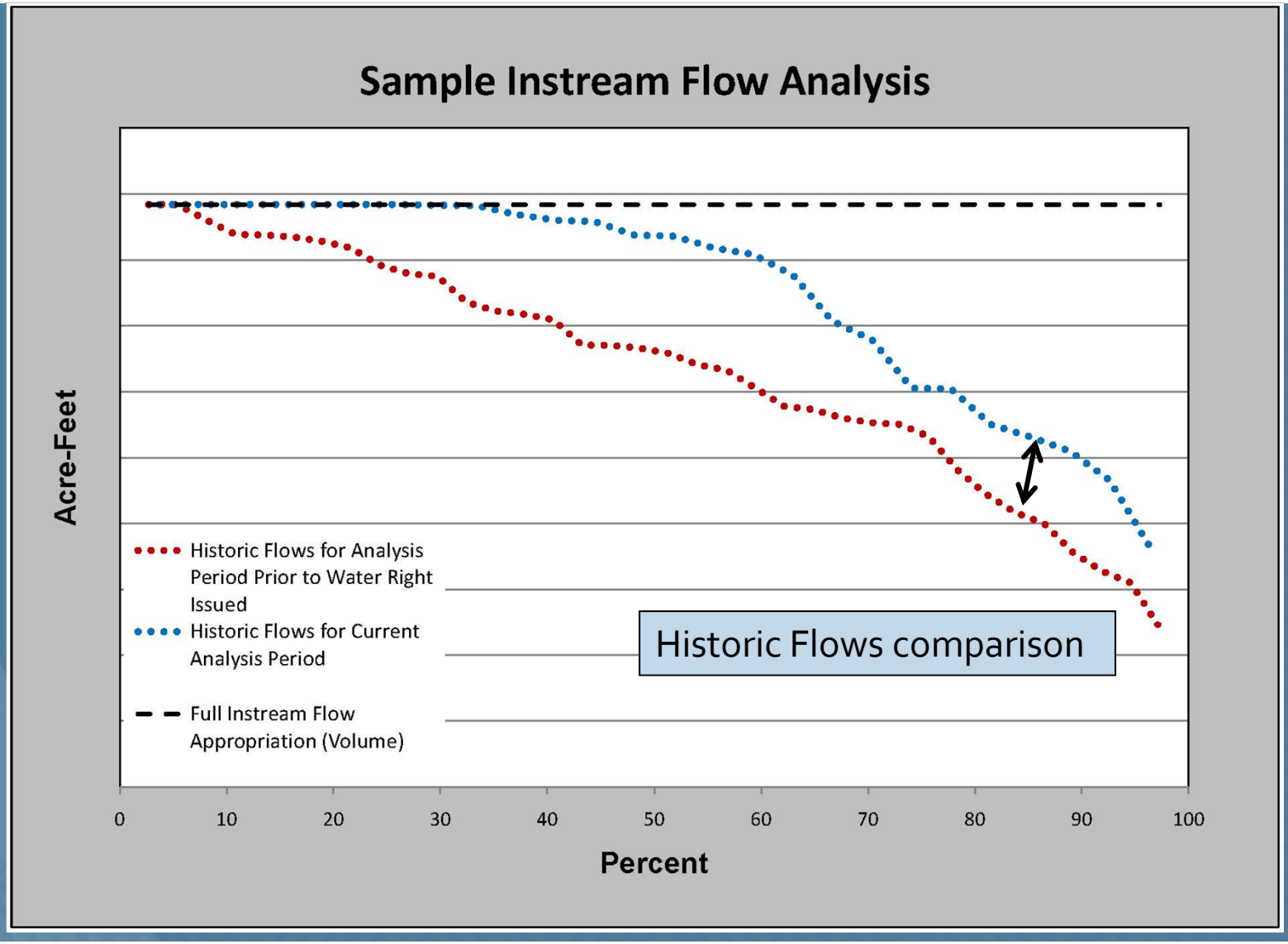

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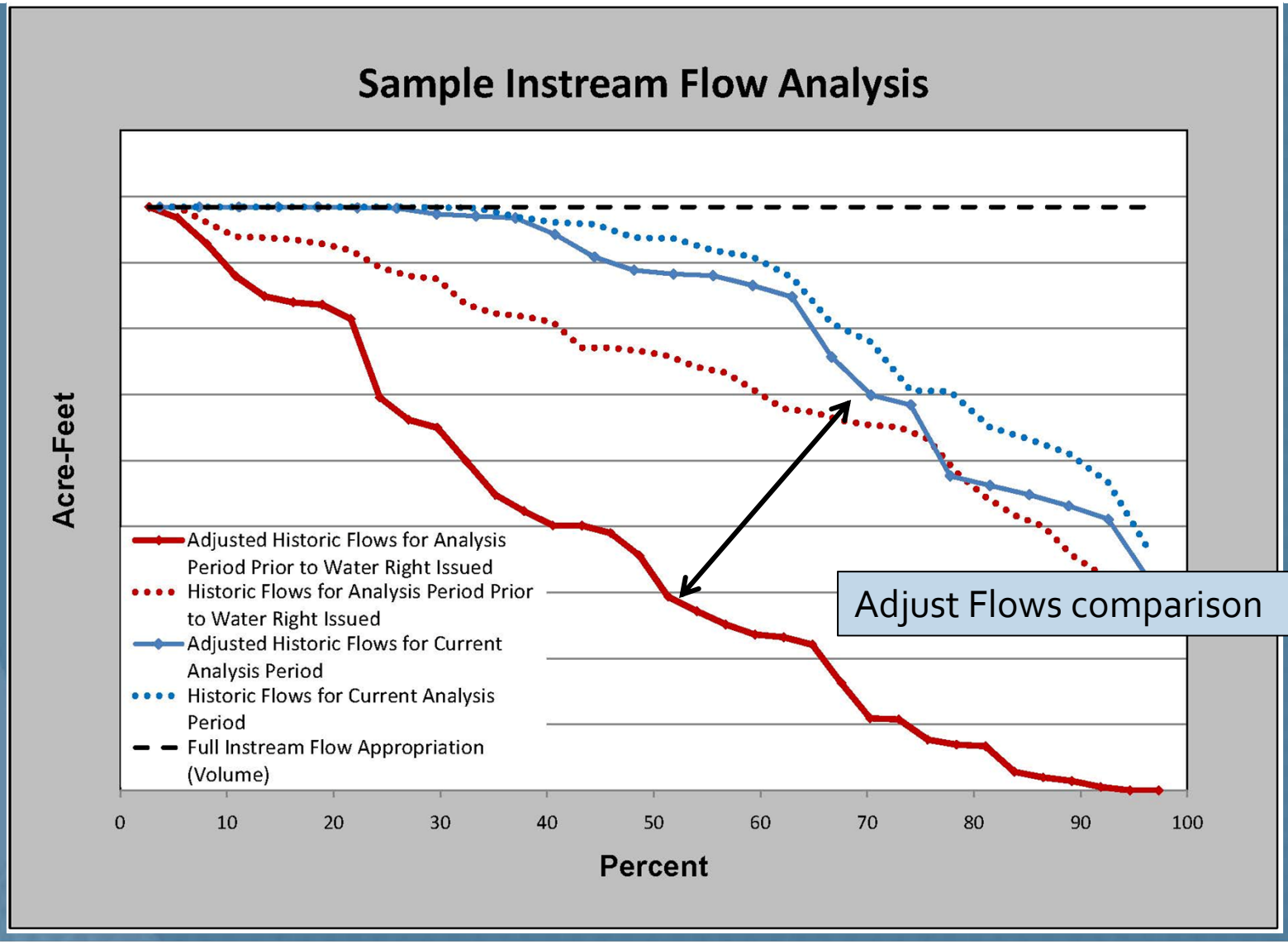

Comparison of Methodology Differences

Current Methodology	Proposed Methodology
Uses Historic gage records adjusted for lag effects as supply	Estimates Virgin Water Supply
Looks at single point user (most junior water right)	Better represents GW and SW supplies as well as demands
Uses 25-yr period to project lag effect of GW use	Compares GW depletions to GW CU to account for lag effect
For instream flow test, uses static 20-yr period	Statistical analysis to determine period of analysis
Instream flow test uses historic gage records (lag-adjusted) for comparison	Historic gage records adjusted for consumptive use at time of appropriation and current level of depletions
No linkage of Evaluation to IMP Process	Evaluation directly ties to IMP process

Next Steps

- Interim Report on Literature Review and Proposed Methodology Concepts
- Opportunity for Review and Comments
- Two parallel activities
  - Analysis of Platte River
  - Begin rulemaking process