

NON-TREATY STORAGE AGREEMENT

“Introduction to Operations and the Non Treaty Storage Scenarios”

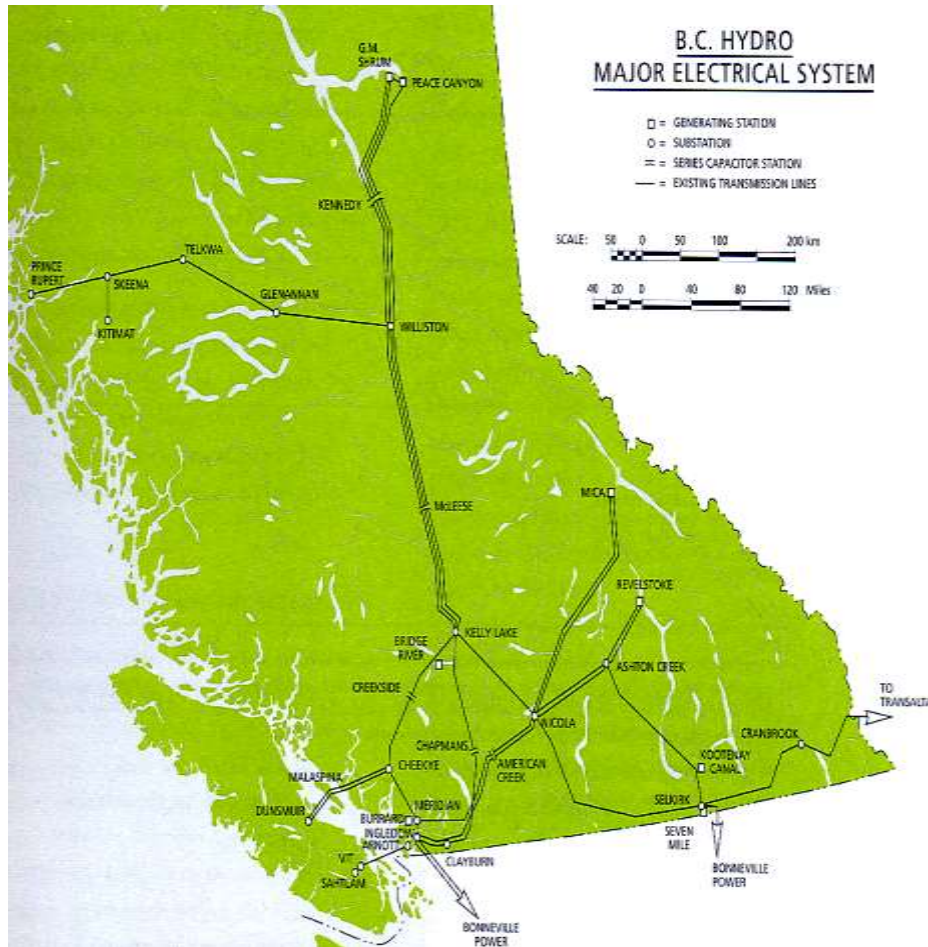
Presenter: Jim Gaspard

Content:

- System Overview
- Treaty Overview
- Modifications to Operation
 - Supplemental Agreements
 - Non-Treaty Storage Operations
- Modeling Process
 - NTSA Scenarios
 - Modeling of Scenarios
 - System Modeling

System Overview

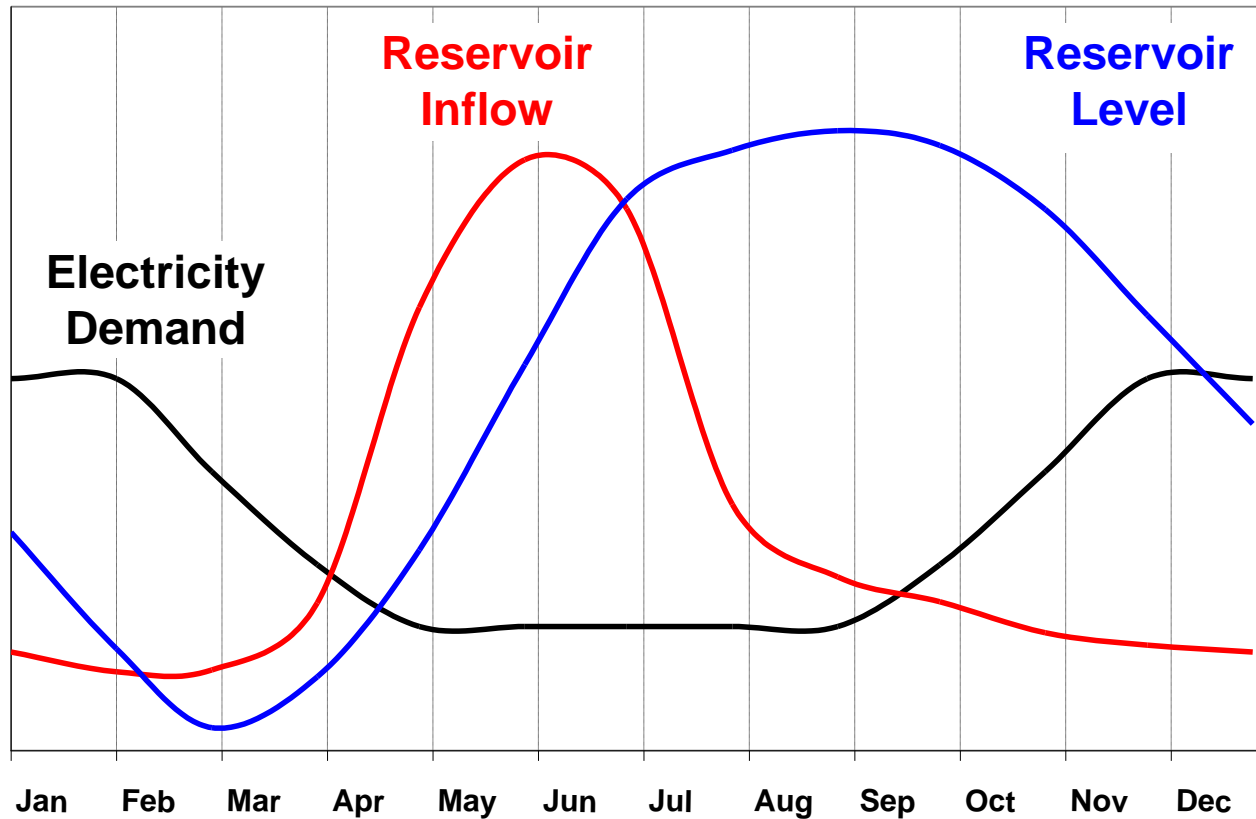
Overview of the BC Hydro System



FOR GENERATIONS

- Electricity supplied to 94% of BC's population
- 61 dams & 44 hydro generating stations
- Source of Electricity:
 - 30% Peace
 - 25% Mica and Revelstoke
 - 25% Smaller Hydro
 - 20% IPP energy purchases
- BC Hydro system connected to:
 - US
 - Alberta
 - Fortis BC

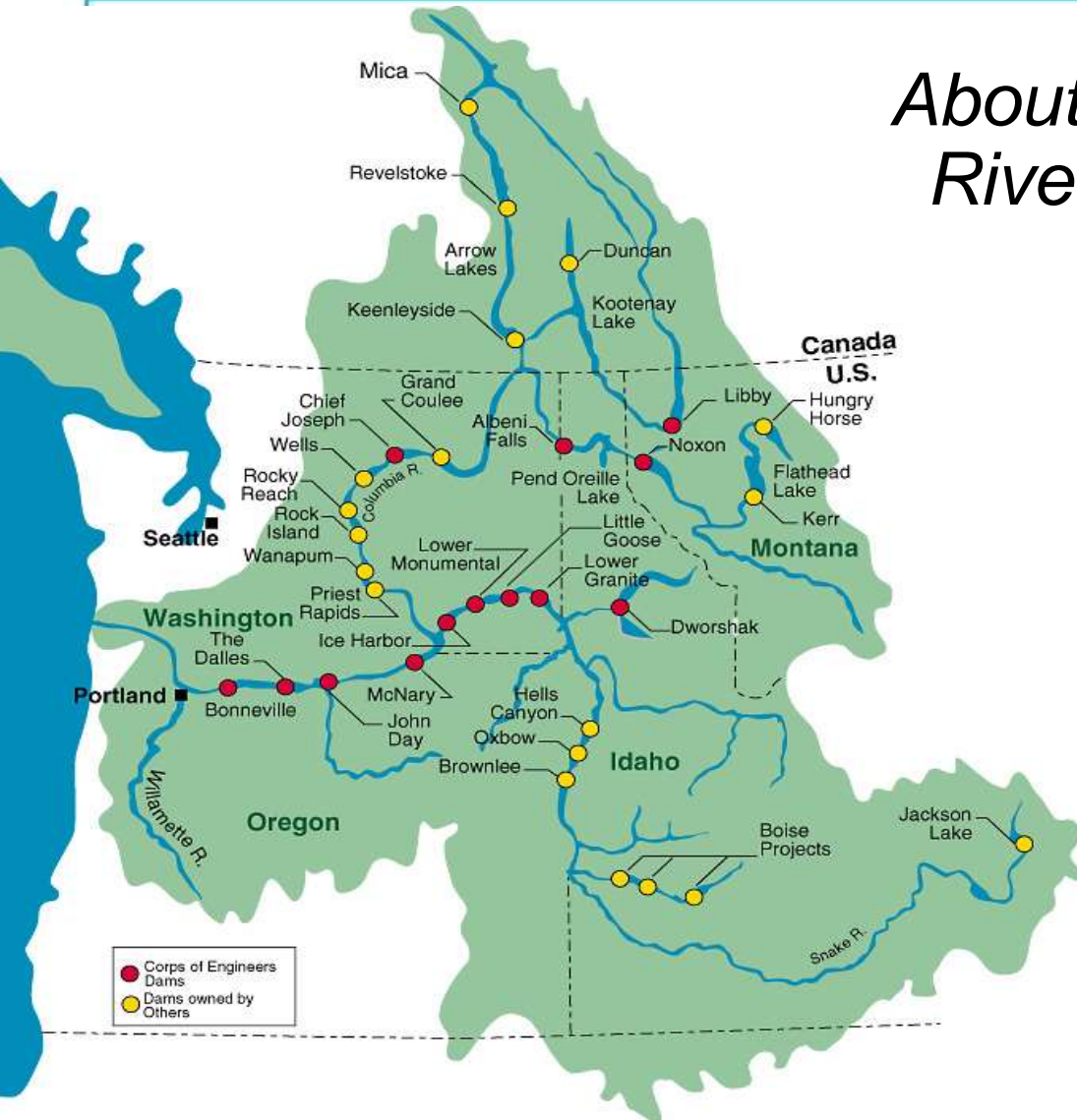
The Role of Reservoir Storage



Treaty Overview

Why do we have a Treaty?

About 1/3 of the Columbia River water comes from Canada.



- Canada has 15% of the basin area, but produces, on average, 38% of the runoff for the total basin.

- 50% of water from worst Columbia flood at Portland (1894) came from Canada.

1948 Flood

- *1,000 kcfs at Portland:*
 - *Current flood damage: ~450 kcfs*

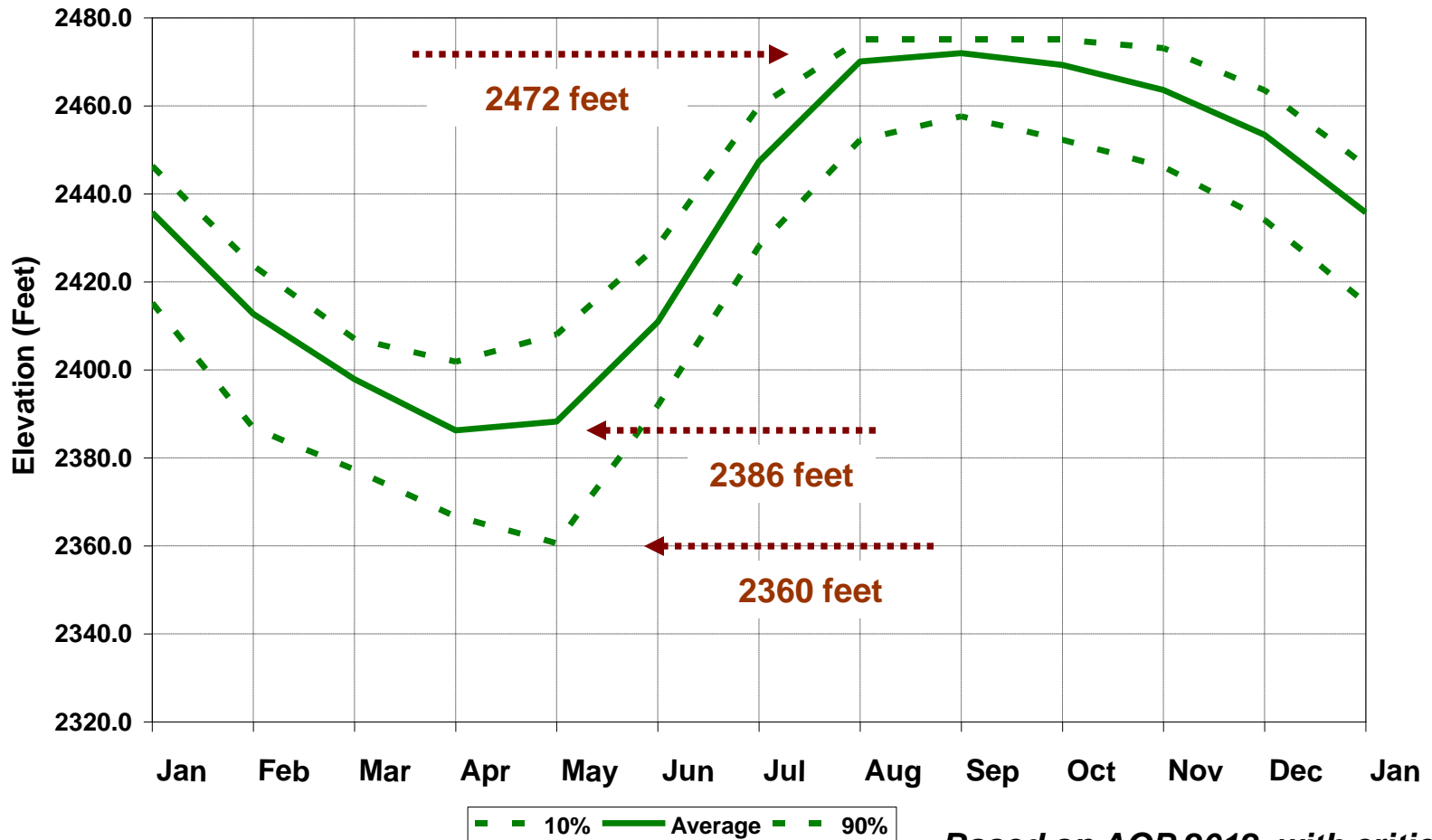
- *370 kcfs at Trail:*
 - *1997 flood: 160 kcfs*



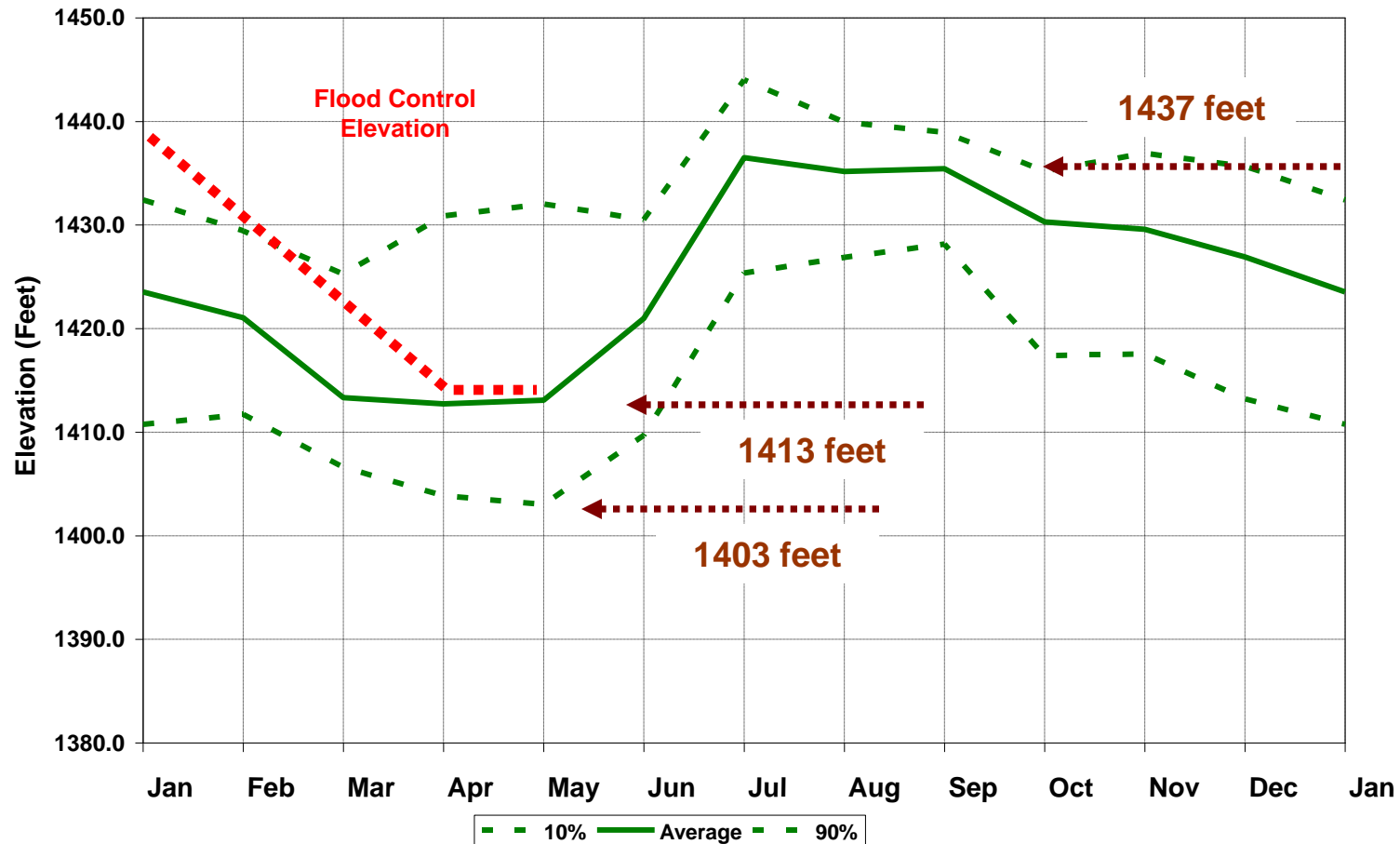
Columbia River Treaty

- *Canadian Obligation:*
 - *Build 15.5 MAF of storage*
 - *Operate storage for optimal power generation and flood control.*
- *US Obligation:*
 - *Pay Canada 50% future flood control benefits.*
 - *Deliver to Canada 50% of the increased power generated at U.S. plants*
- *Other Provisions:*
 - *US can construct and operate the Libby*
 - *Canada can divert Kootenay river at Canal Flats*

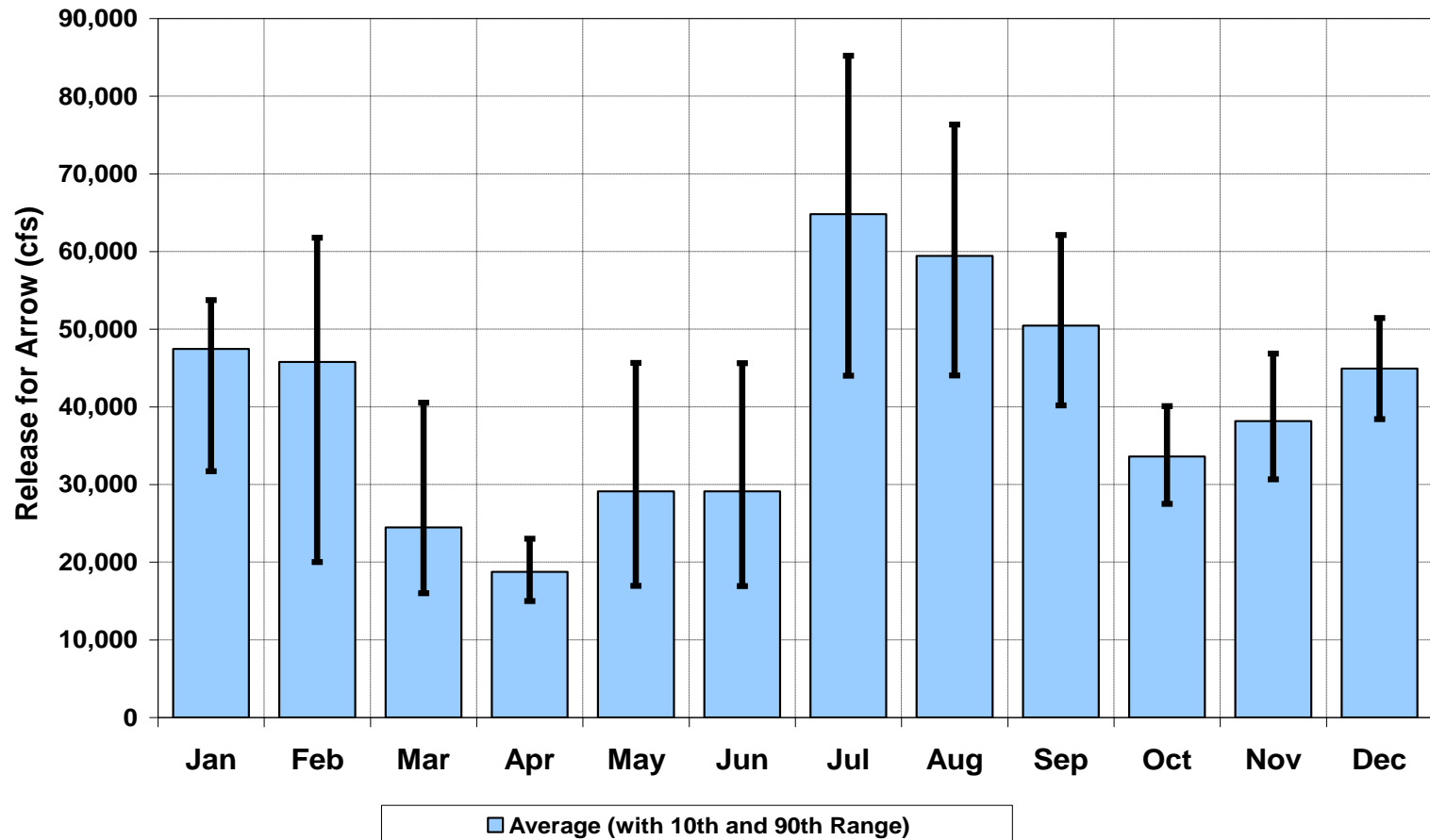
Treaty Operations (modeled): Kinbasket Reservoir



Treaty Operations (modeled): Arrow Reservoir



Treaty Operations (modeled): Arrow Releases



Modifications to Operations

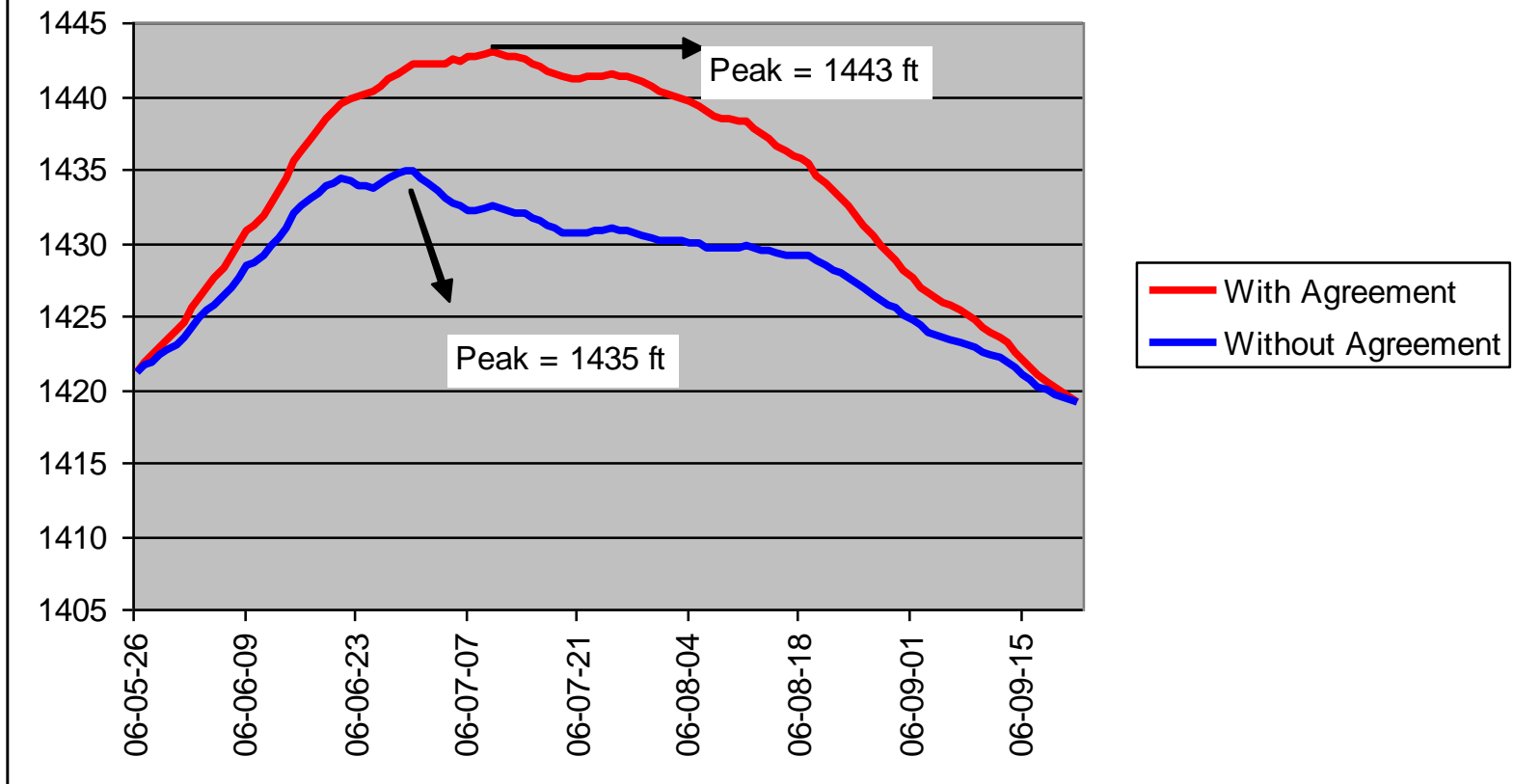
Supplemental Agreements

Supplemental Agreements

- ***A mutual agreement between BCH and BPA/COE to:***
 - ***Adjust the level of storage in a reservoir, or***
 - ***Adjust flows at Arrow***
- ***Purpose:***
 - ***To increase power benefits, and***
 - ***Improve the non-power outcome in Mica and/or Arrow.***

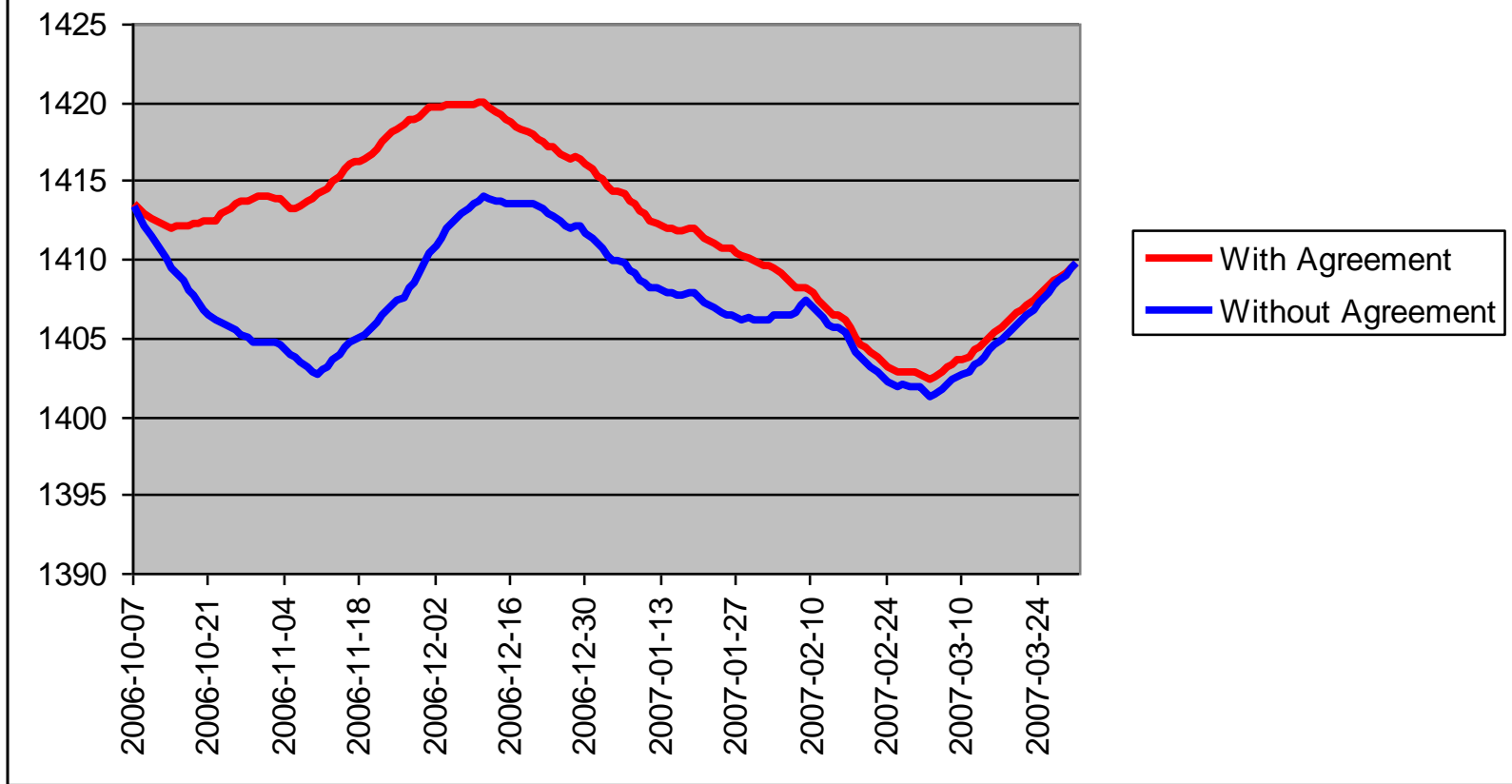
Summer Storage Agreement (2006)

Arrow Reservoir level Comparison (ft)



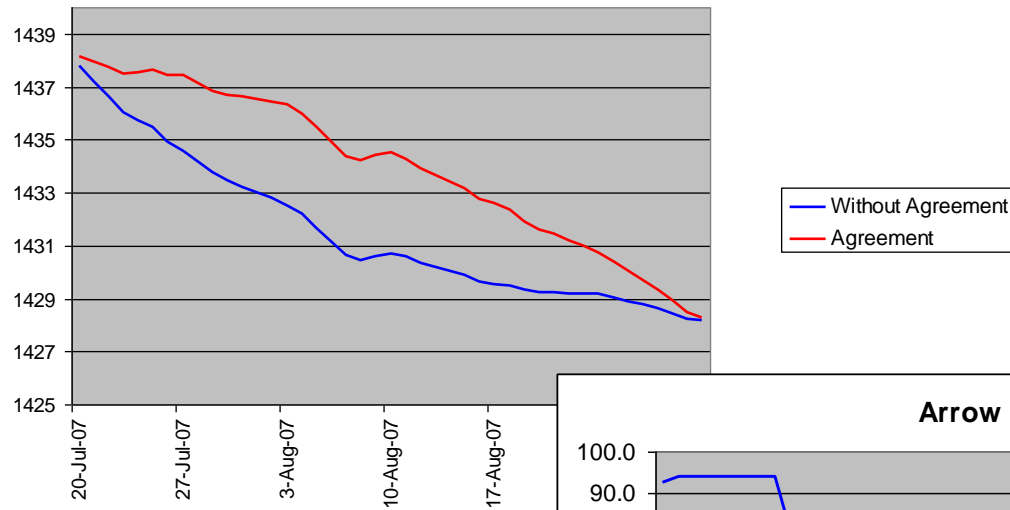
Fall Storage Agreement (2006/07)

Arrow Reservoir level Comparison (ft)

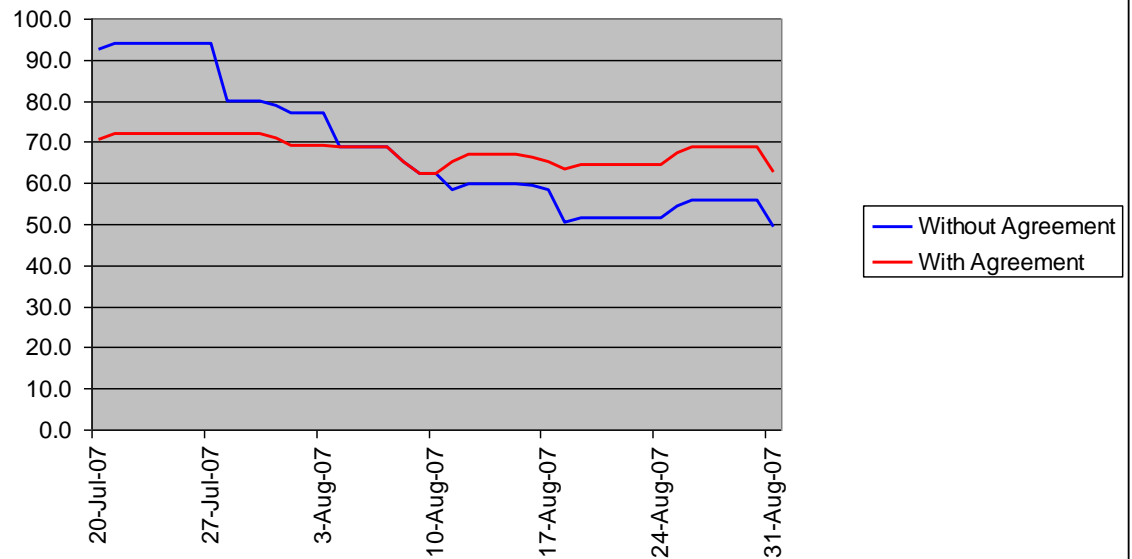


Arrow Flow Shaping Agreement (2007)

Arrow Reservoir level Comparison (ft)



Arrow Flow Comparison (kcfs)



Modifications to Operations

Non-Treaty Storage Operations

Non-Treaty Storage Usage in Operations

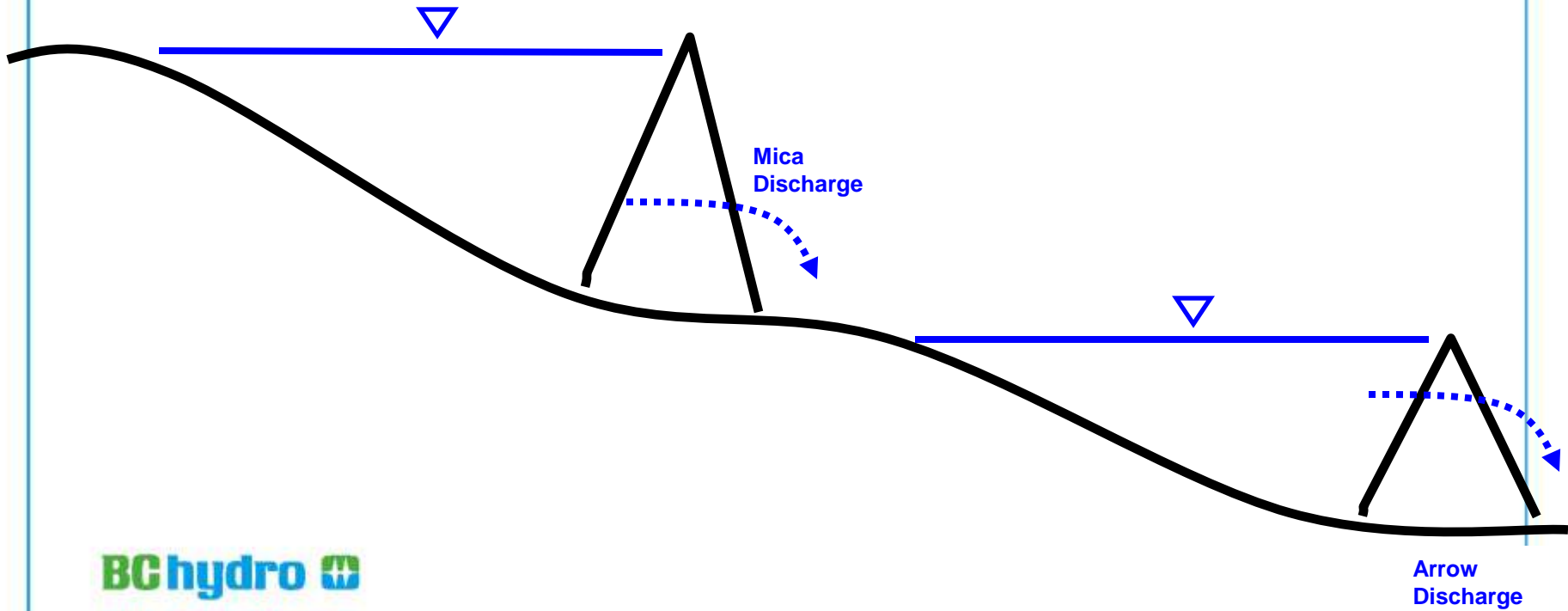
- Used to capture *Downstream Power Benefits*:
 - Releasing water during periods of energy shortages (high energy value)
 - Storing water during periods of energy surplus (low energy value)
- Used to capture *System Operations Benefit*.
Provides flexibility to:
 - Reduce frequency of full pool and spill at Mica
 - Manage Arrow Soft Constraints, and other system objectives
 - Draft Kinbasket deeper in Fall/Winter to serve load
 - System commonly short of energy in Fall/Winter
 - Option to draft has a reliability benefit (even if not used)

Non-Treaty Storage – Fall/Winter Draft

Storage Operation

- Initial -

- **Summer: Treaty storage typically filled to at/near full**

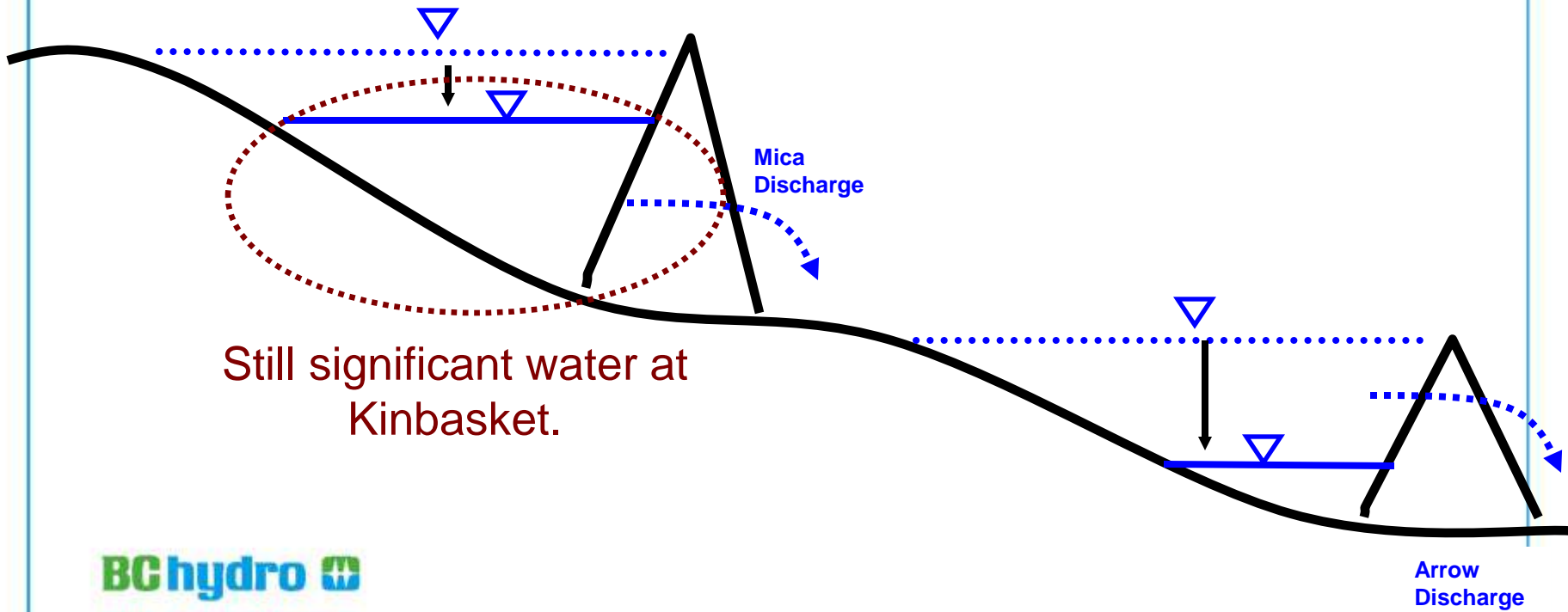


Non-Treaty Storage – Fall/Winter Draft

Storage Operation

- Winter Draft -

- **Late Winter Treaty storage drafted to near empty.**

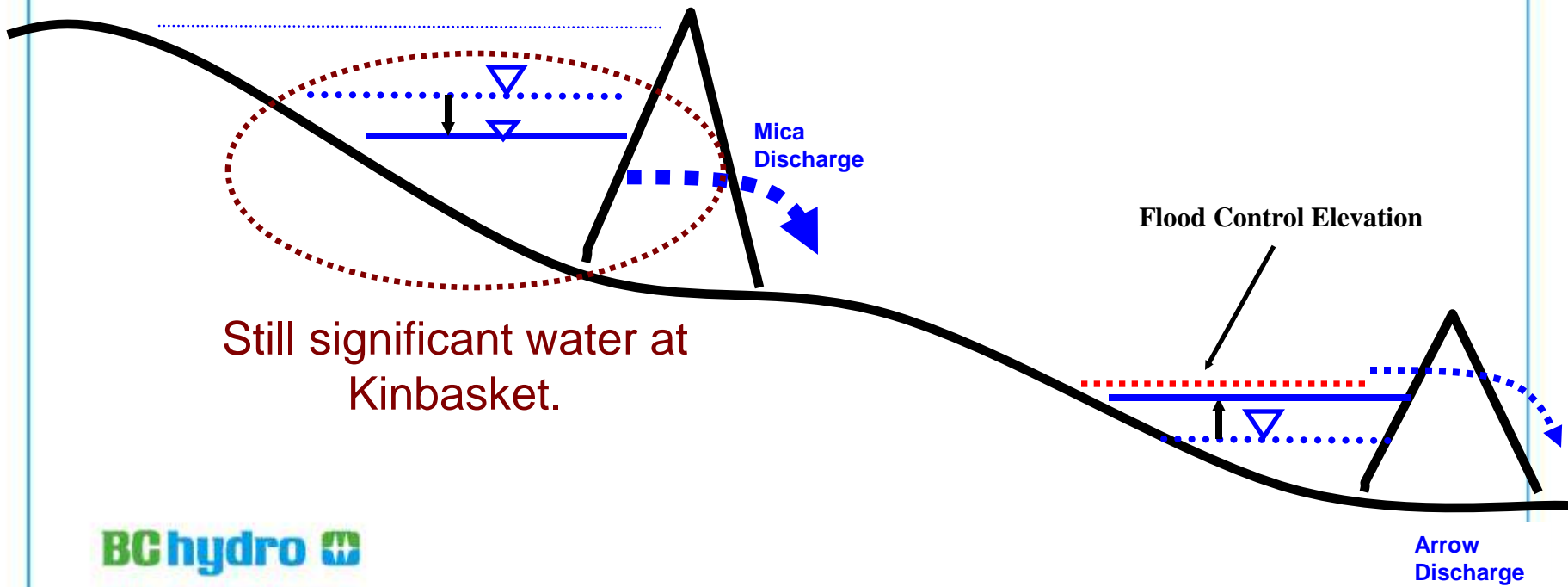


Non-Treaty Storage Seasonal Operation

Storage Operation

- Utilize Flex -

- ***BCH can draft more than Specified Treaty Q from Mica (Flex).***

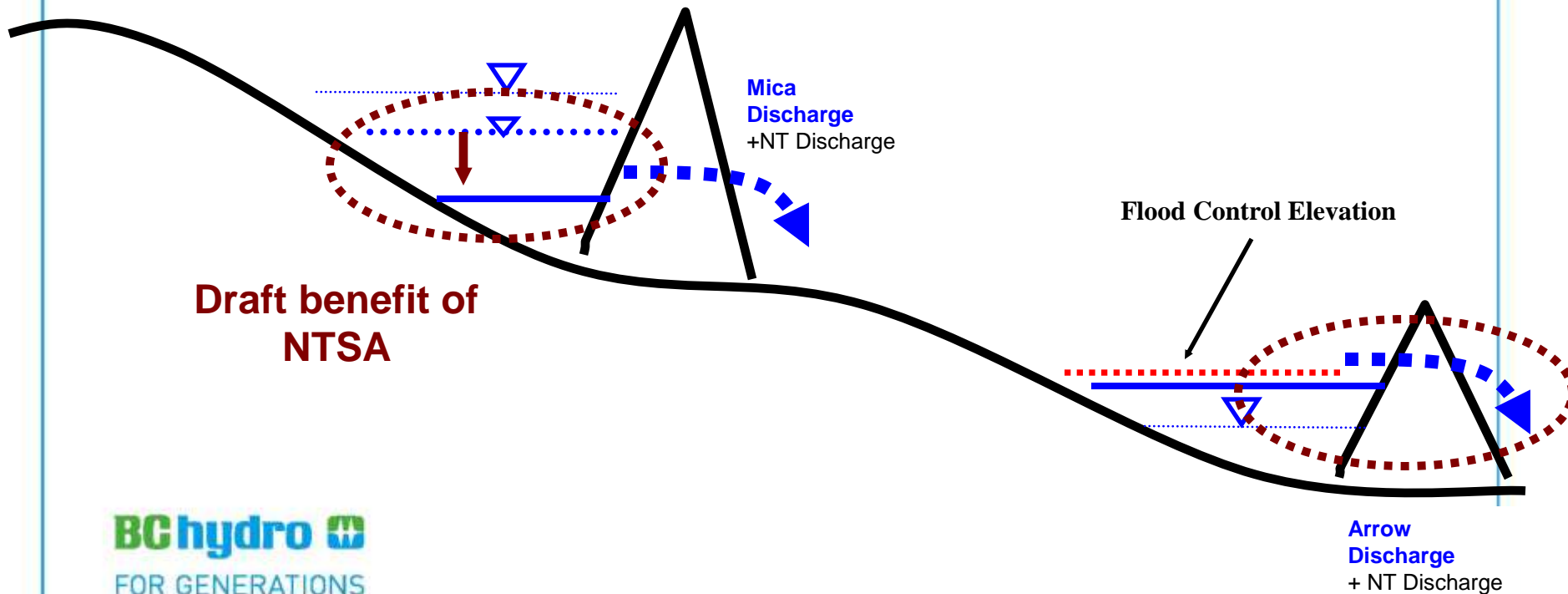


Non-Treaty Storage Seasonal Operation

Storage Operation

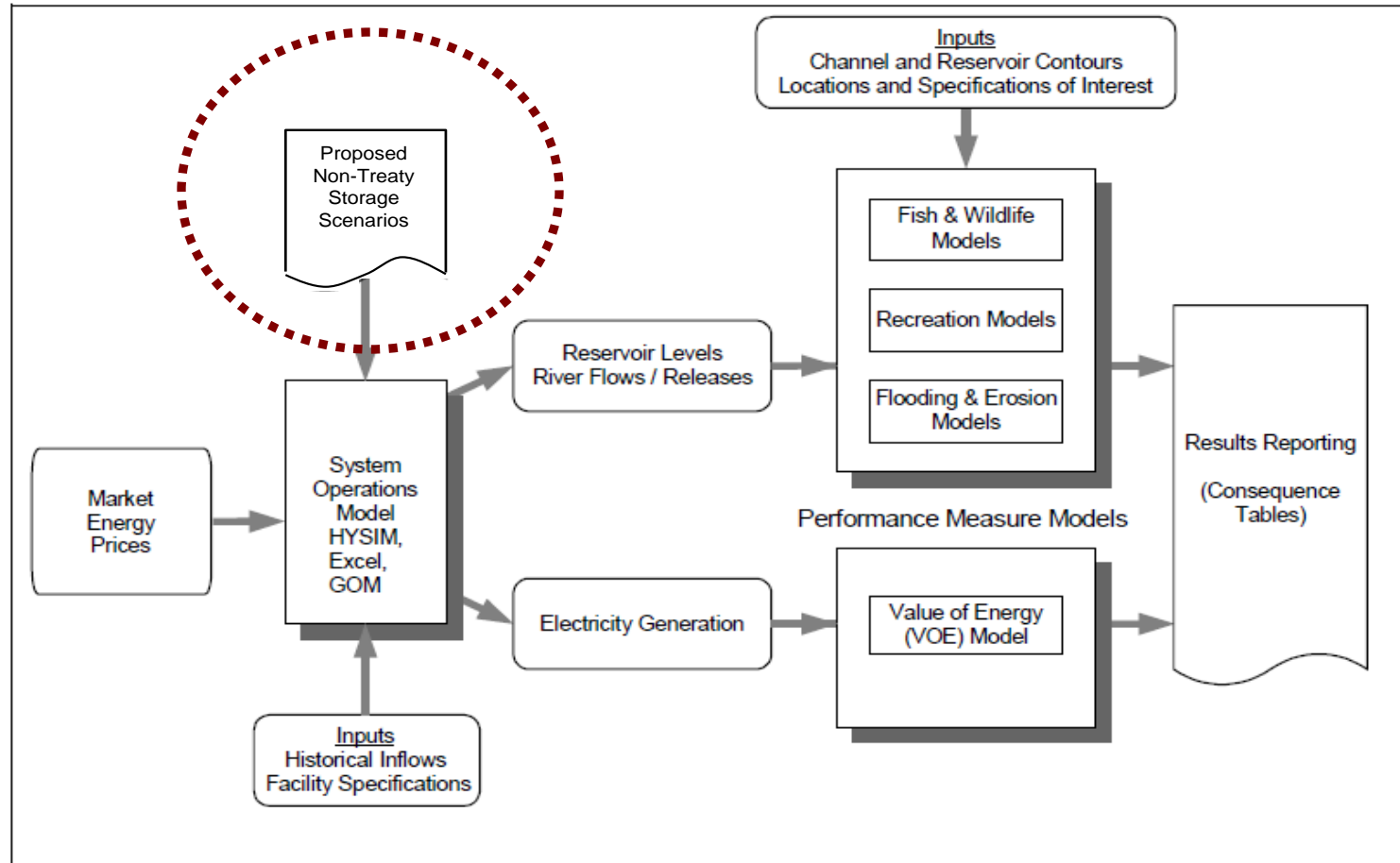
- NTSA Release -

- *NTSA release facilitates greater draft at Mica*



Modeling Process

Modeling Process



Non-Treaty Storage Utilization Scenarios

Four scenarios considered:

- Scenario A: High Potential Utilization (4.5 MAF Max)
- Scenario B: Mod Potential Utilization (3.0 MAF Max)
- Scenario C: Low Potential Utilization (2.0 MAF Max)
- Scenario D: No Utilization

Non-Treaty Storage Utilization Scenarios

- Four scenarios considered:
 - Scenario A: High Potential Utilization (4.5 MAF Max)
 - Scenario B: Moderate Potential Utilization (3.0 MAF Max)
 - Scenario C: Low Potential Utilization (2.0 MAF Max)
 - Scenario D: No Utilization
- Scenario A: (4.5 MAF max utilization)
 - Approximates operation of Non-Treaty Storage under the 1990 Agreement
 - Provides similar flexibility to that which was modeled in the Columbia Water Use Plan
 - Achievable through:
 - Large account volume in renegotiated agreement, and
 - No restrictions placed on operation of the large accounts.

Non-Treaty Storage Utilization Scenarios

- Four scenarios considered:
 - Scenario A: High Potential Utilization (4.5 MAF Max)
 - Scenario B: Moderate Potential Utilization (3.0 MAF Max)
 - Scenario C: Low Potential Utilization (2.0 MAF Max)
 - Scenario D: No Utilization

- Scenario D: (no utilization of NTS)
 - Approximates operation that would be dictated by the Treaty
 - Achievable through:
 - No Non-Treaty Storage Agreement, or
 - BC Hydro fully restricting usage of storage

Non-Treaty Storage Utilization Scenarios

- Four scenarios considered:
 - Scenario A: High Potential Utilization (4.5 MAF Max)
 - Scenario B: Moderate Potential Utilization (3.0 MAF Max)
 - Scenario C: Low Potential Utilization (2.0 MAF Max)
 - Scenario D: No Utilization

- Scenario C: (2.0 MAF max utilization)
 - Restrictive operation of Non-Treaty Storage
 - Considered to be low end volume that will:
 - Facilitate fall/winter draft at Kinbasket to serve system load.
 - Facilitate key fisheries/power benefit in spring/summer, and
 - Provide flexibility to manage Kinbasket Reservoir, in exceptionally high inflow years.
 - Achievable through:
 - Account volume in agreement restricted, **or**
 - BC Hydro restriction placed on usage of storage.

Non-Treaty Storage Utilization Scenarios

- Four scenarios considered:
 - Scenario A: High Potential Utilization (4.5 MAF Max)
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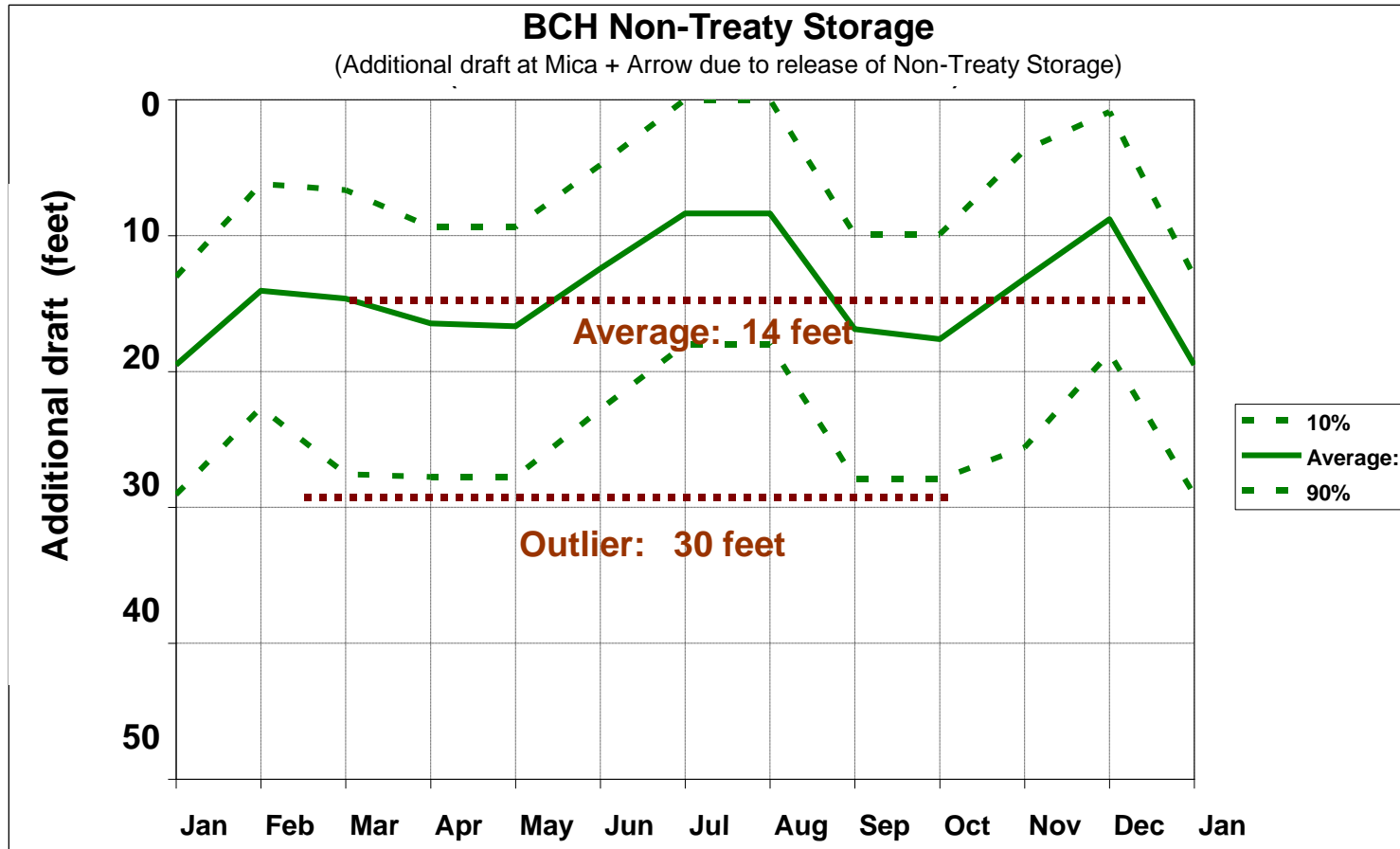
- Scenario B: (3.0 MAF max utilization)
 - BPA proposed operation
 - Flexibility for release of additional water in summer to aid salmon out-migration in the US Columbia
 - 0.5 MAF release in May/June during dry years
 - Return of storage in upcoming year (if above average inflows)
 - Achievable through:
 - Account volume in agreement restricted, or
 - BC Hydro restriction placed on usage of storage
 - Release option for BPA under highly prescriptive conditions

Modeling of Scenarios

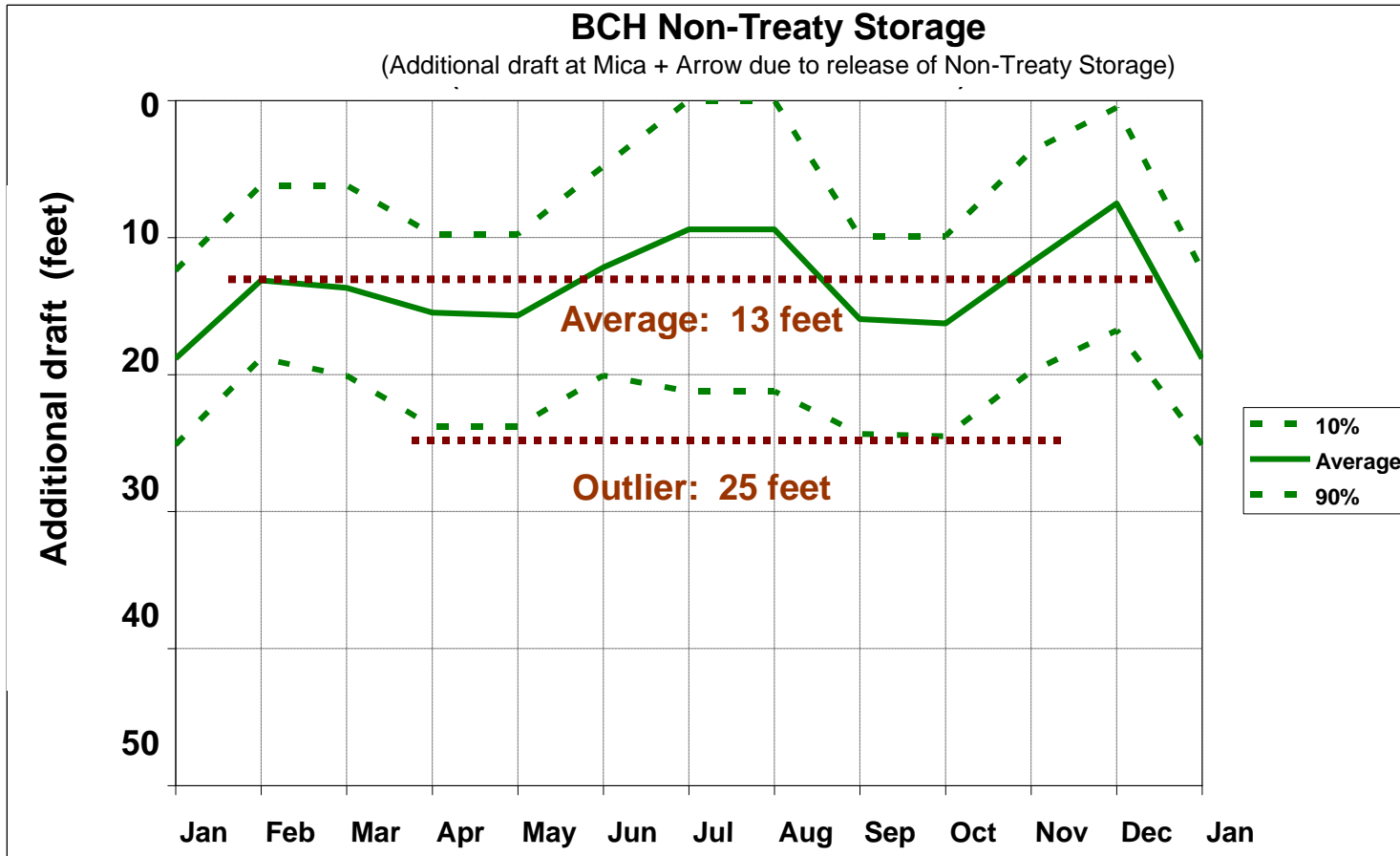
Modeling of Scenarios

- Spreadsheet model used
- Modeling Assumptions:
 - Restrictions in release and storage to meet:
 - Long standing BCH and US fisheries objectives
 - Treaty obligations
 - Scenarios operated to maximize economic value, given:
 - BC Hydro 2008 LTAP electricity price forecasts
 - US plant efficiencies as per 2012 Treaty Assured Operating Plan
 - Monthly time-step for 60 year period (compatible with HYSIM)
- NTS scenario transferred to System Modeling

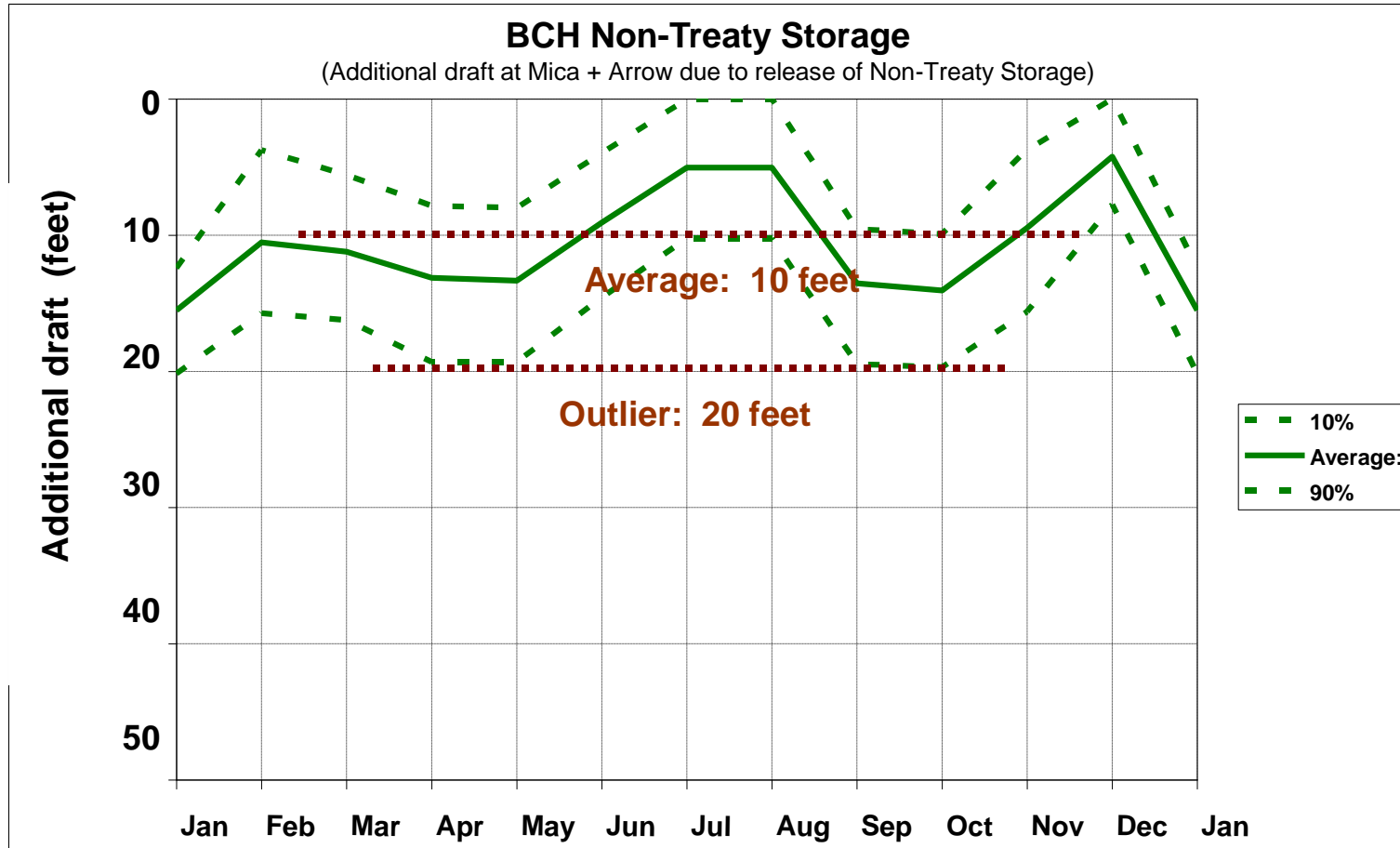
Scenario A (4.5 MAF Maximum Utilized)



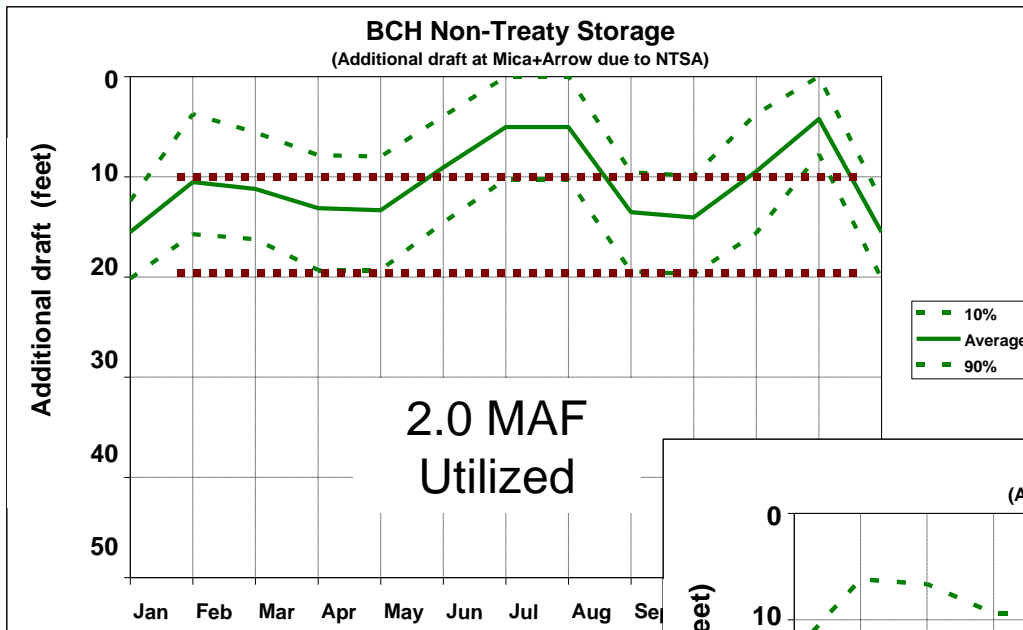
Scenario B (3.0 MAF Maximum Utilized)



Scenario C (2.0 MAF Maximum Utilized)

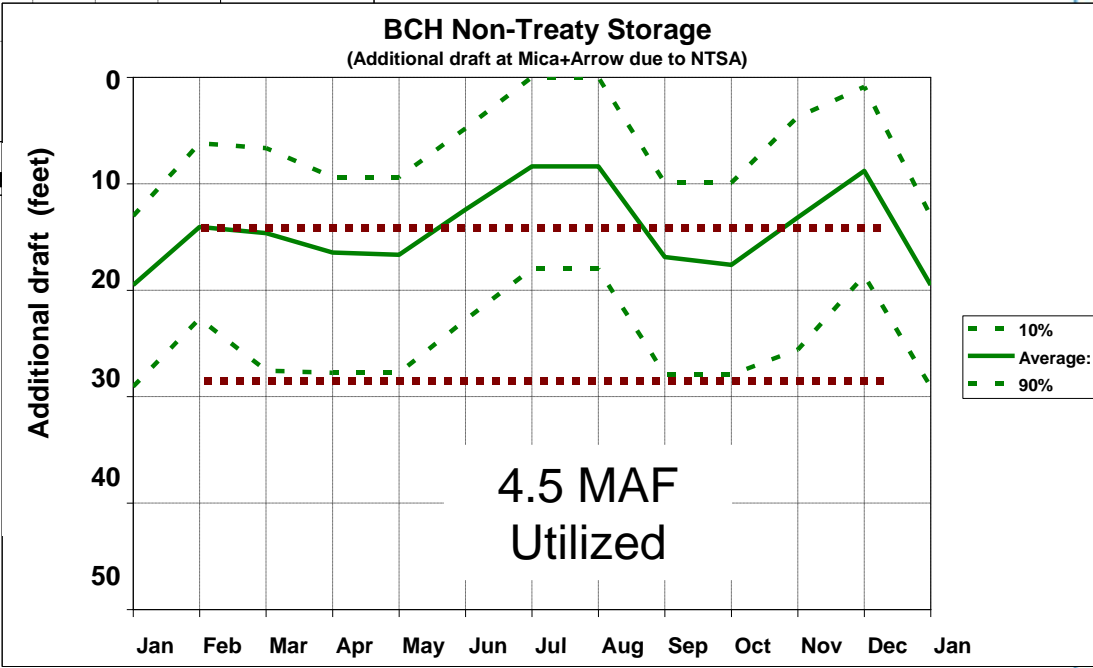


Scenario C (2.0 MAF) vs A (4.5 MAF)

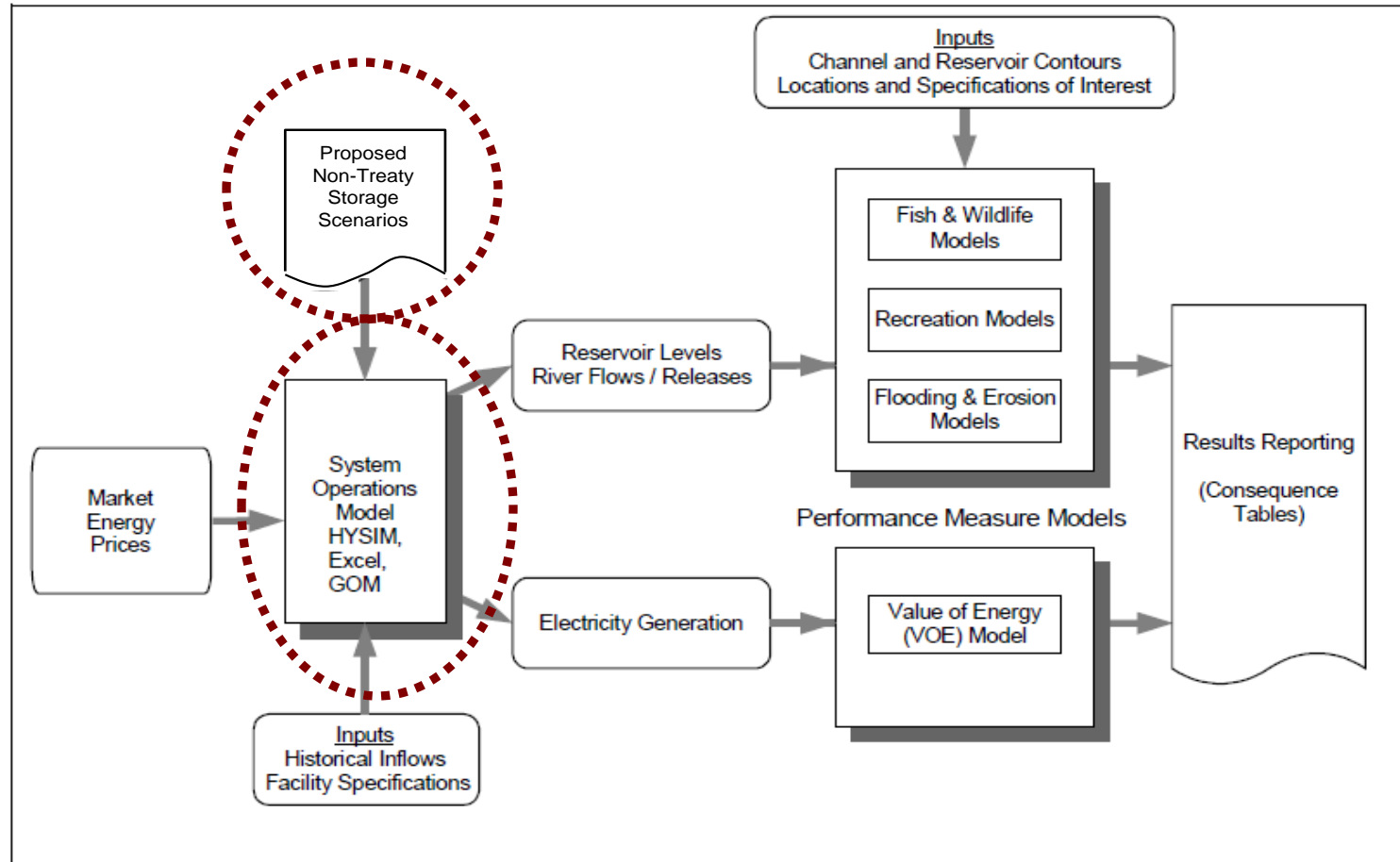


Modest change in overall average usage

More significant change in outlier events



Modeling Process



System Modeling Overview

- System modeling:
 - Using standard computer models used in BC Hydro long term planning.
 - HYSIM (60 year, monthly time-step simulation)
 - GOM (10 year, bi-hourly simulation)
 - Outputs: Revelstoke Release and Reservoir

System Modeling Overview

- **Key Assumptions:**
 - 60 year streamflow extending from Oct 1940 to Sep 2000
 - Includes Non-Treaty Storage scenario
 - Gas and electricity price forecast as per Long Term Acquisition Plan (LTAP) 2008
 - Loads and resources for 2016/17
 - REV 5, MCA 5 & 6
 - Treaty operation based on 2012 Assured Operating Plan
 - Critical fisheries agreements included.

System Modeling Overview

- Modeling provides:
 - Economic optimal operation of BC Hydro system, given constraints.
- Modeling does not provide:
 - Wind integration impacts to operations
 - Operational adjustments that may be made to manage non-power issues, including:
 - Managing flood control events.
 - Enhancing Arrow Soft Constraints or other system objectives
 - Managing non-power issues in other basins.
 - Implementing discretionary supplemental agreements, for power or non-power benefit.

Modeling Process

