ITERATION #2
ALTERNATIVES & COMPONENTS

General Summary of Results

Columbia River Treaty Review – Iteration 2 Results
April 10, 2013

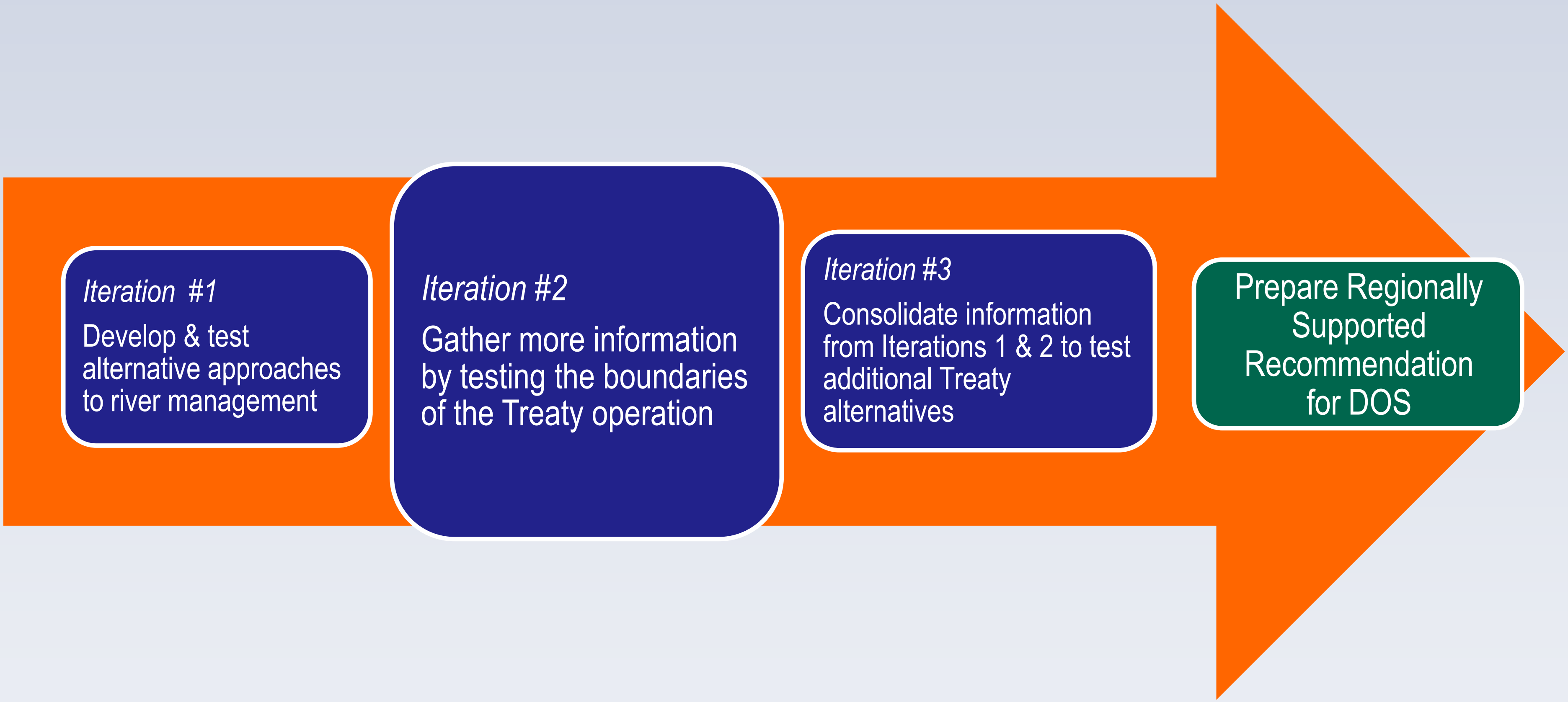
Overview of Today's Presentation

- Scope of Treaty Review Studies
- Iteration #2 Modeling Results
- Next Steps and Schedule

Scope of Treaty Review Studies

- Develop River Management Alternatives that strive to include the 3 primary driving purposes:
  - Hydropower
  - Flood risk management
  - Ecosystem-based Function
- Assess Benefits & Adverse Impacts of the future Treaty Alternatives
- Better understand sensitivity of future operation to Climate Change

Treaty Review Studies



Scope of Iteration #2 Studies

- 3 alternatives carried forward from Iteration 1 for full impact assessment
  - Treaty Continues with 450 and 600 flood flow objectives (1A-TC and 2B-TC)
  - Treaty Terminates with 450 flood flow objectives (1A-TT)
- Gather more information by analyzing specific approaches and operational bookends (components)
- 3-5 Treaty Terminates Canadian Operations scenarios
- 2 Climate Change scenarios incorporated into Treaty Continues alternatives

Current Condition (RC-CC)

- This is how the system is managed up to 2024 under current Treaty provisions
- All alternatives and components are compared to the current condition

What are Alternatives?

- Consists of a system of operational, structural and/or non-structural measures
- Designed to **include all three of the primary operational driving purposes**:
  - Ecosystem-based Function
  - Flood Risk Management
  - Hydropower

What are Components?

- Consists of a system of operational, structural and/or non-structural measures
- Formulated to **focus on only one of the primary operational driving purposes**.
- Components are **not meant to be stand-alone** alternatives that could realistically be implemented.
- Analysis to **better understand the operation and to explore the "bookends"** of the Columbia River system for a single purpose.
- Based on what is learned during Iteration #2, components may be combined during Iteration #3 to form comprehensive alternatives.

Iteration 2 Components - Ecosystem

1. **E1 – Natural Spring Hydrograph**
   Store and release water from U.S. and Canadian reservoirs to meet a natural flow based on the type of water year, no system flood control, no operation specifically for power
2. **E2 – Reservoirs as Natural Lakes**
   Generally hold reserves full and pass inflows through, no system flood control, no operation specifically for power
3. **E3 – Summer Flows**
   Store water in Canadian projects during the fall and release to augment summer flows in U.S. (Additional 2.5 Maf added to Mica)
4. **E5 – Dry Year Strategy**
   Store water in Canadian projects during the winter/early spring to augment spring flows in lowest 20% of water years (Additional 2.5 Maf added to Mica)

Iteration 2 Components – Hydropower and Flood Risk

6. **H1 – Optimize Canadian and U.S. hydropower systems**
   Optimized the Canadian and U.S. hydropower systems using current system projects
7. **H2 – Optimize the Canadian and U.S. power system with the BiOp operations included**
   Including fish operations, optimize the Canadian and U.S. hydropower system using current system projects
8. **F1 – Full Use of Authorized Storage**
   Maximize use of authorized U.S. storage (full draft as needed)
9. **F2 – No Called Upon Flood Storage**
   No use of Canadian storage for U.S. flood risk management
10. **F3 – Modify U.S. Levees to perform to Authorized Level**
    Evaluate the ability to reduce U.S. flood risk if all levees in U.S. perform to authorized level

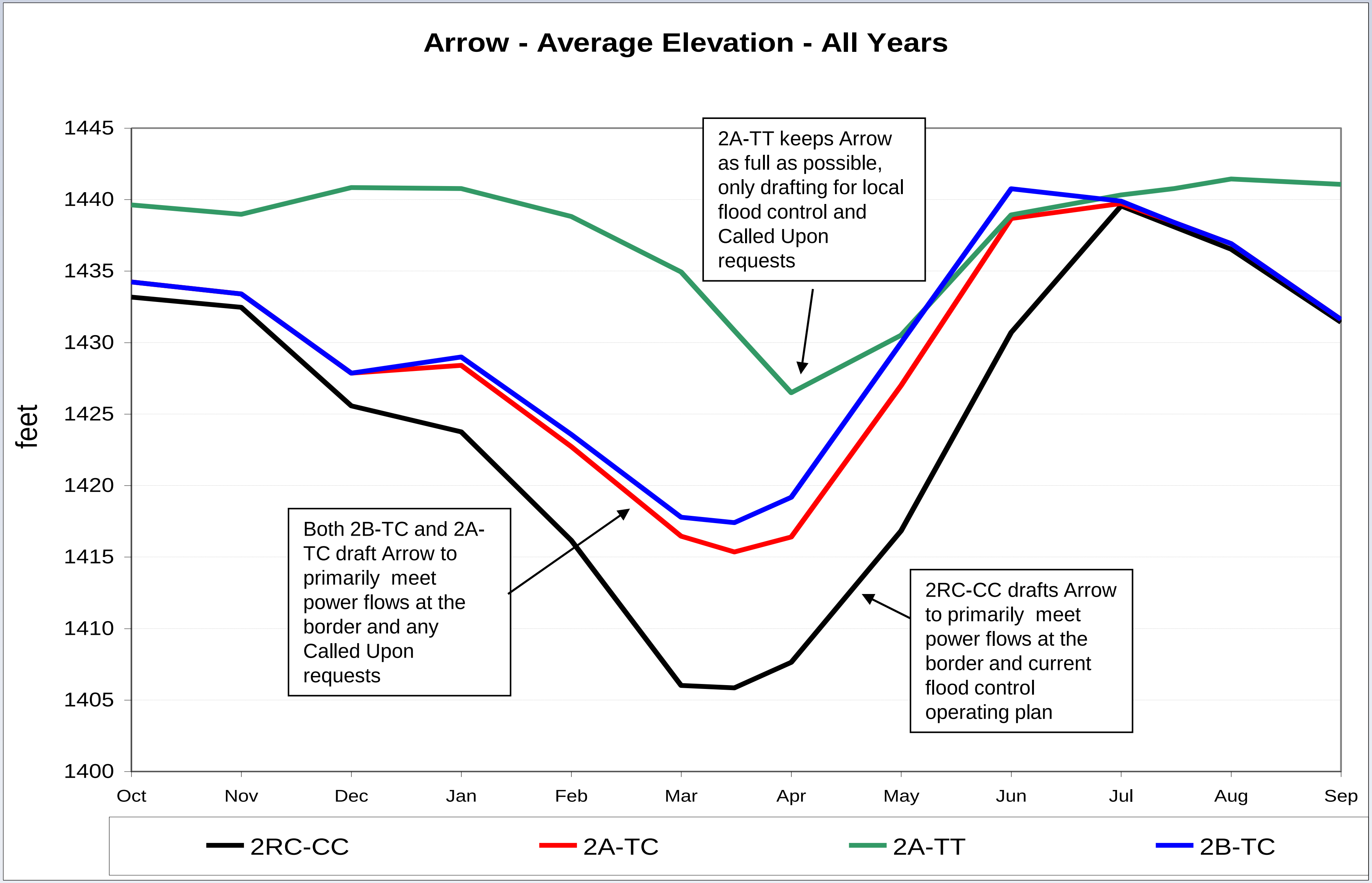
Iteration #2 Impact Assessment

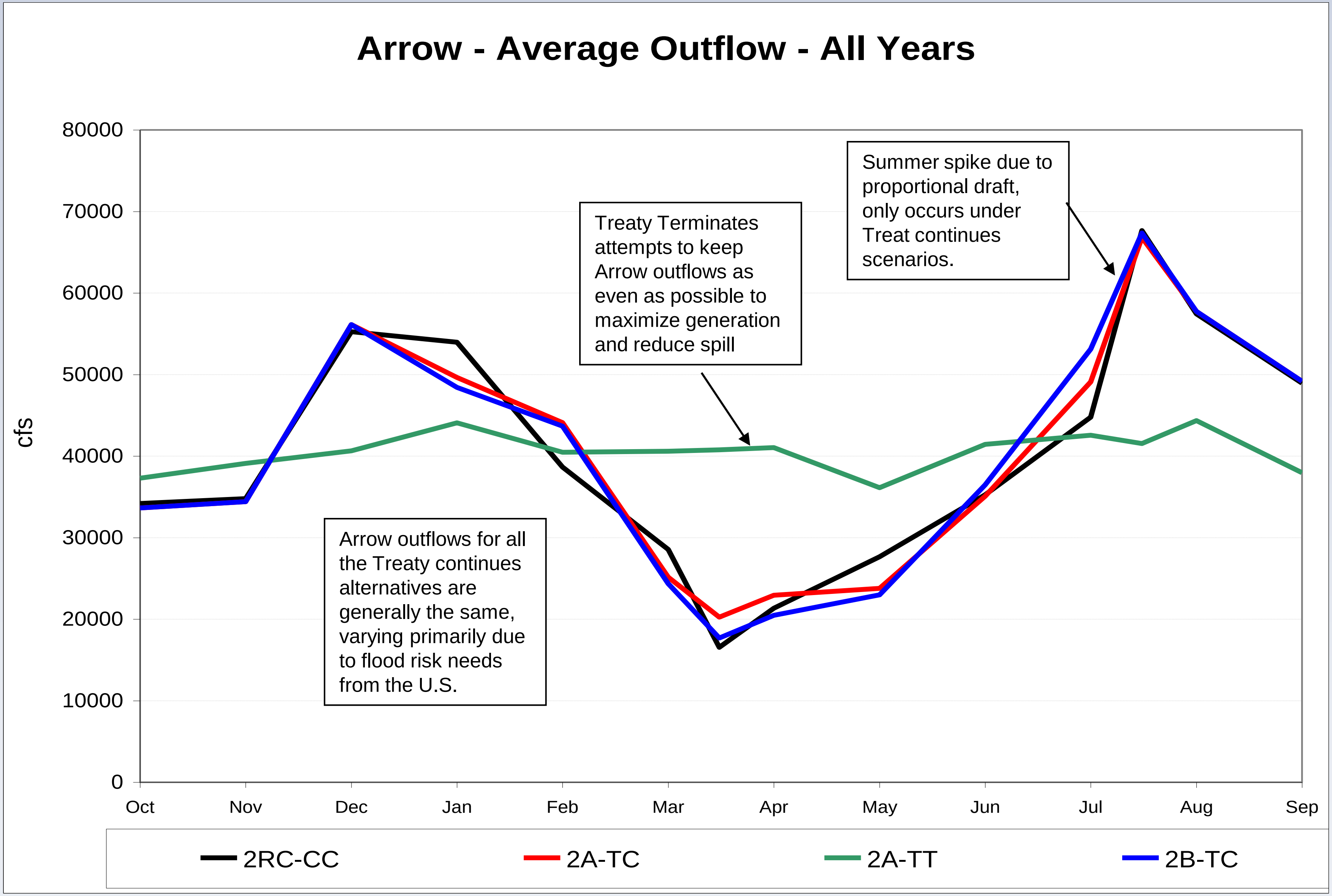
- Ecosystem based Function
  - Water Quality
  - Resident Fish
  - Anadromous Fish
  - Estuary
  - Wildlife
  - Cultural Resources
- Flood Risk Management
- Hydropower
- Water Supply
- Recreation
- Navigation
- Sediment and Toxics
- Climate Change

Flow and Reservoir Results: *Alternatives*

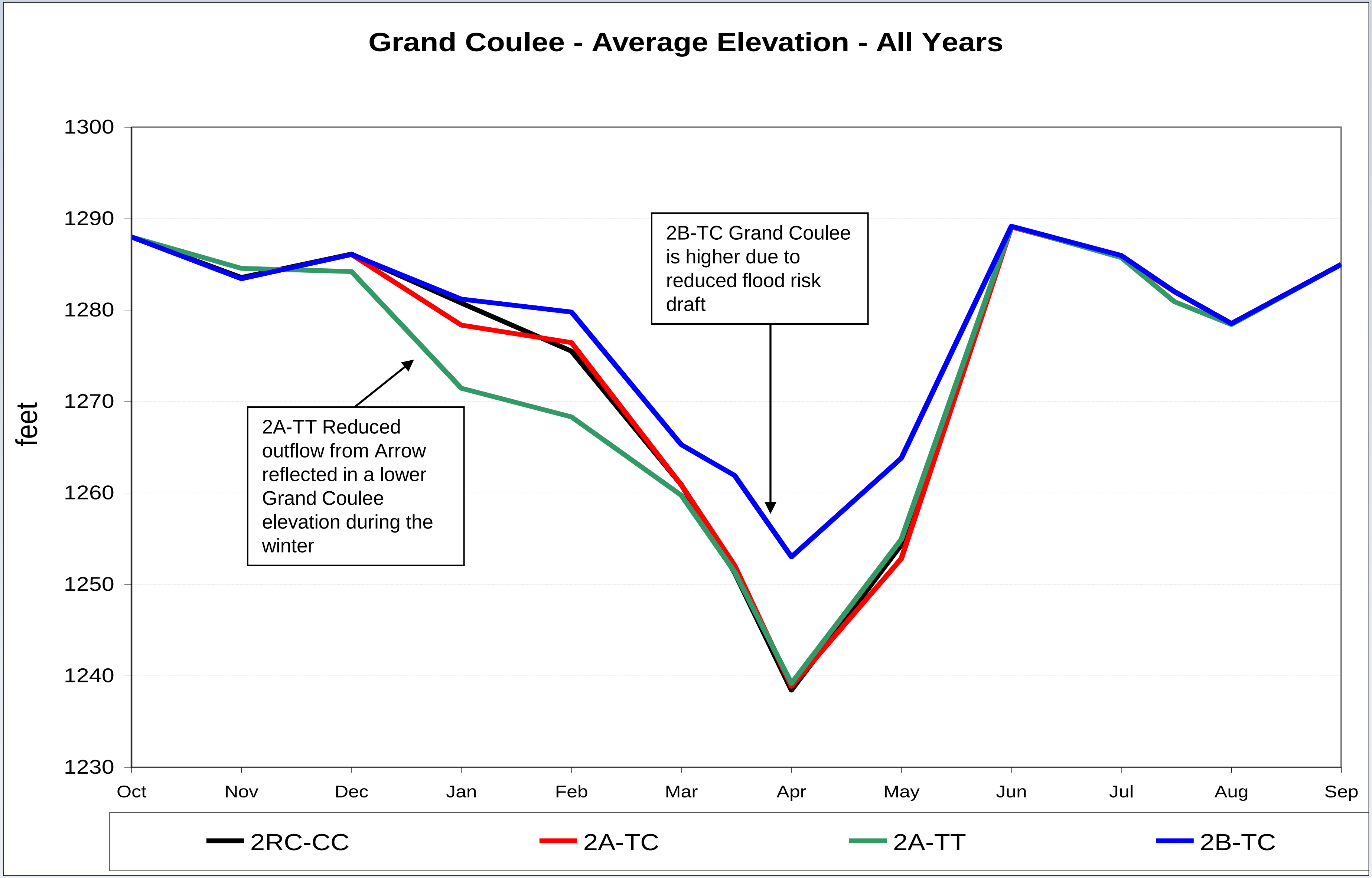
Iteration #2
General Summary of Results

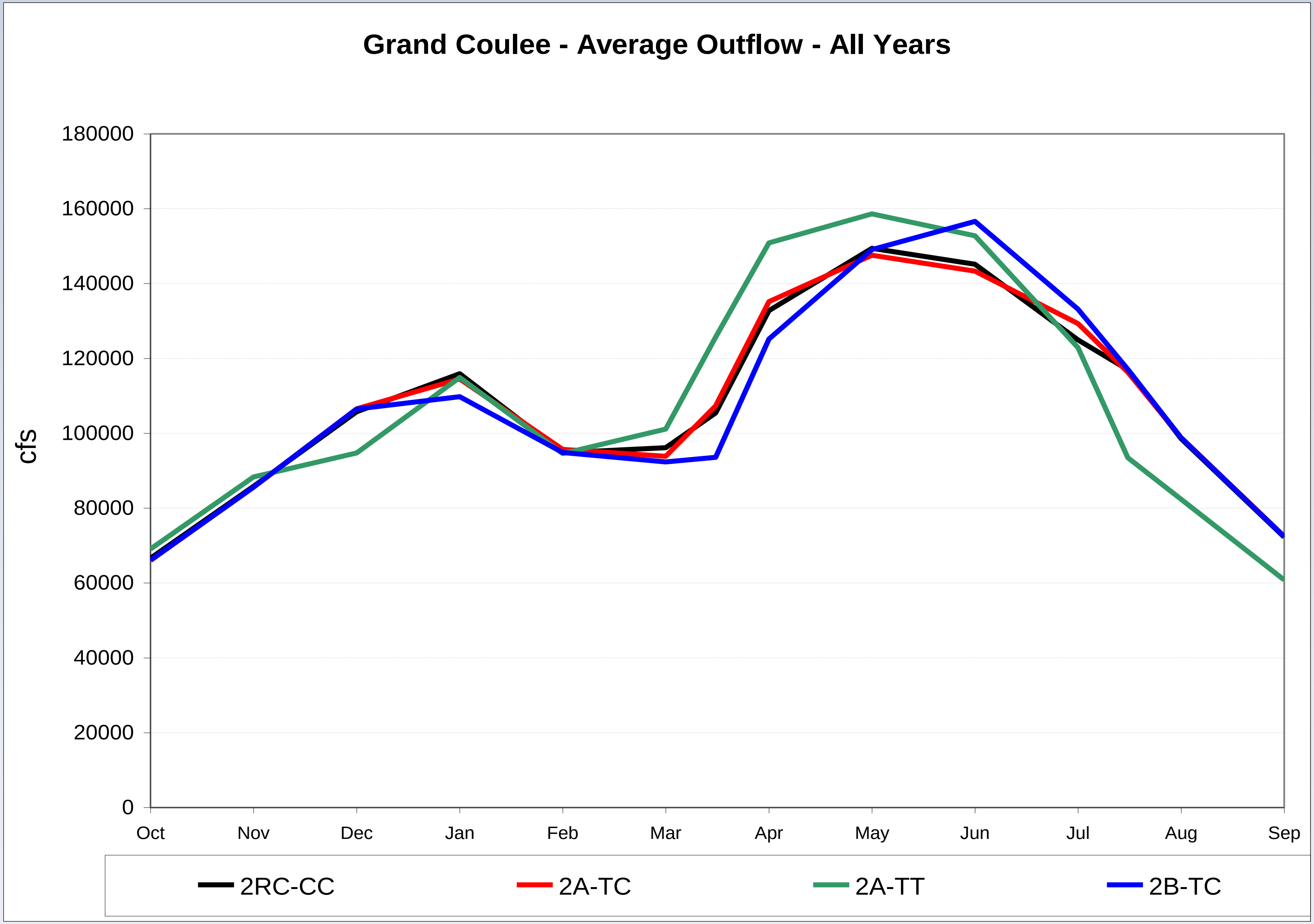
Columbia River Treaty 2014/2024 Review

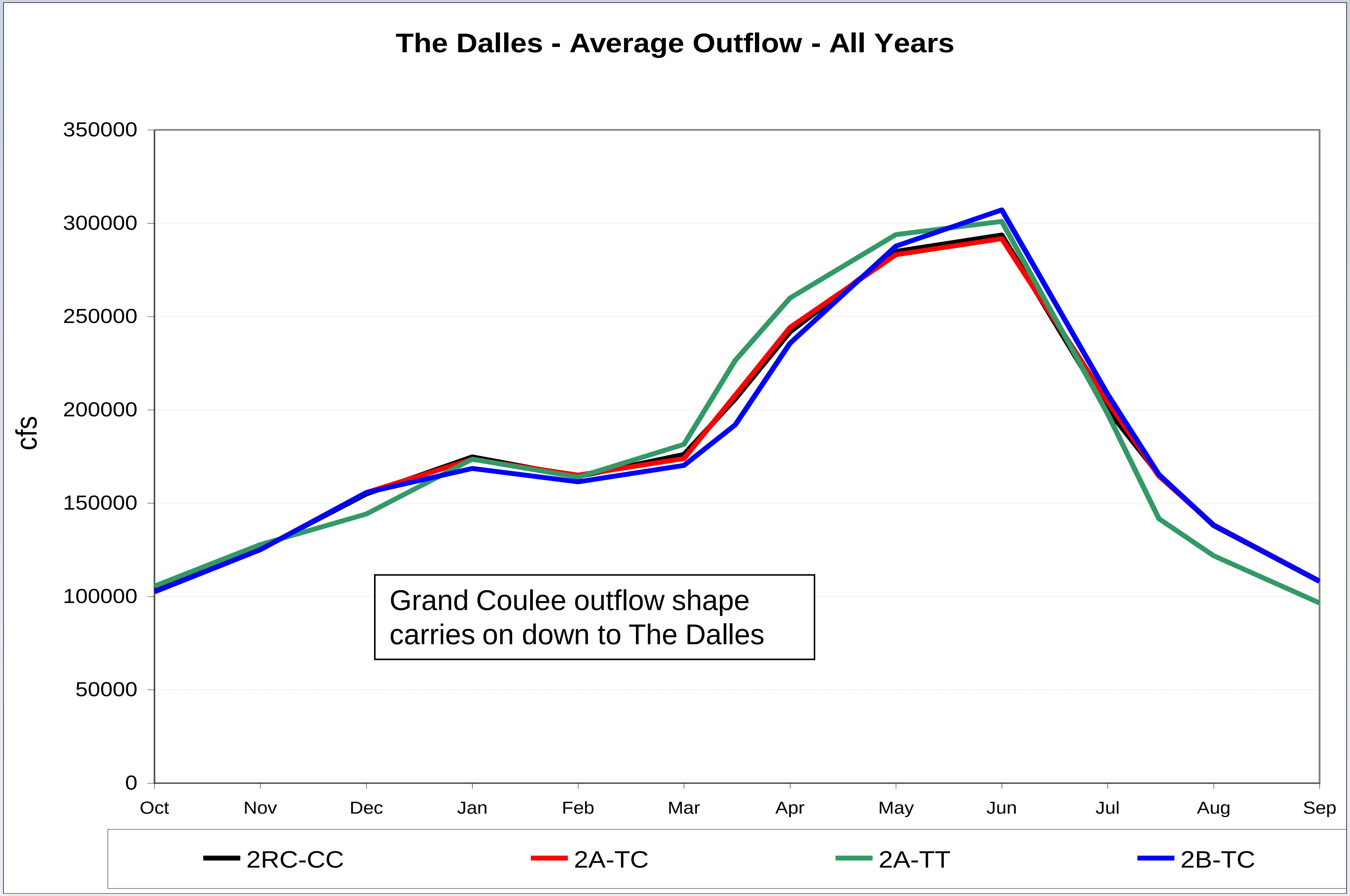


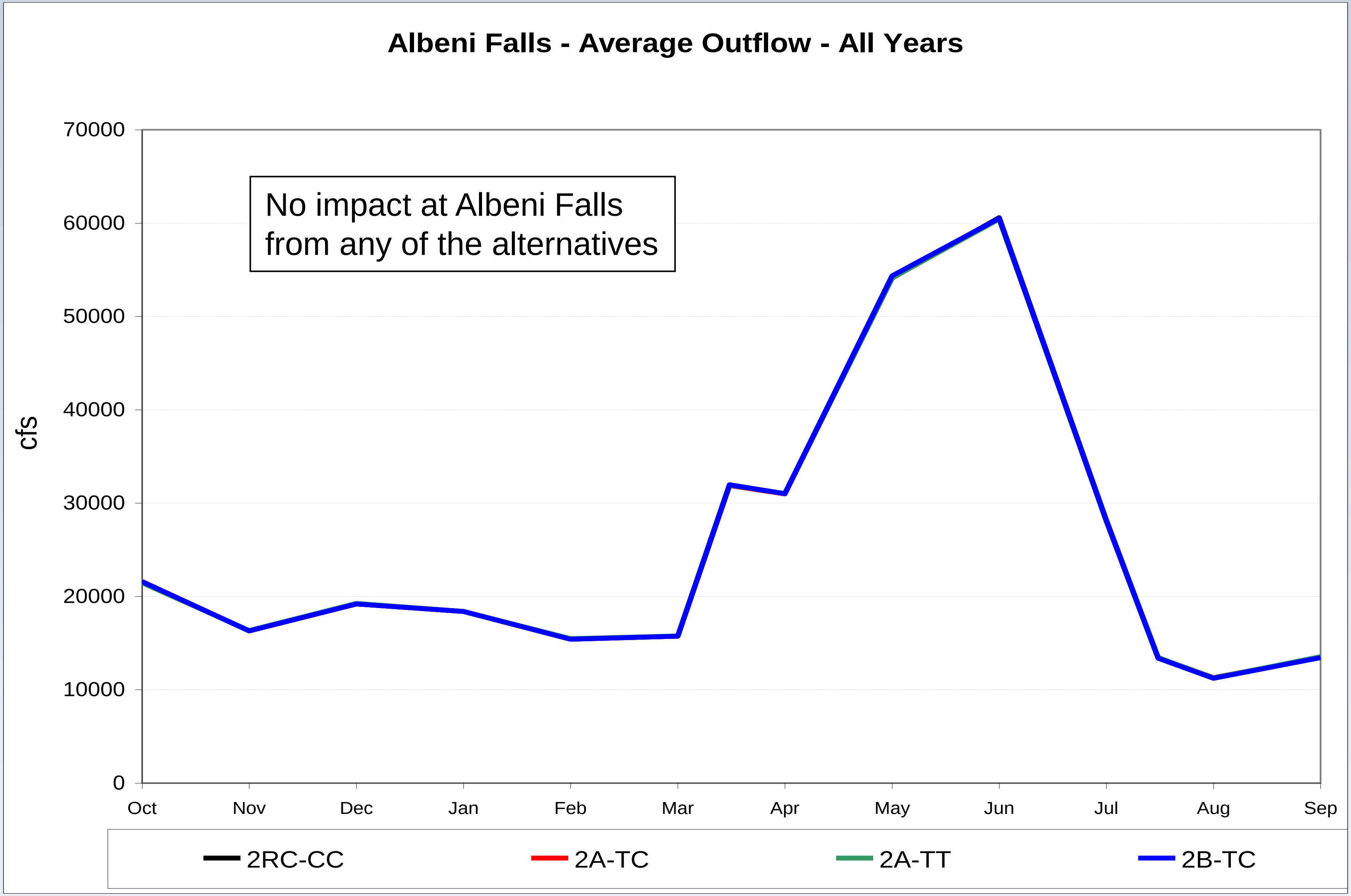

Arrow - Average Outflow - All Years
80000
70000
60000
50000
40000
30000
20000
10000
0
cfs
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Treaty Terminates attempts to keep Arrow outflows as even as possible to maximize generation and reduce spill
Summer spike due to proportional draft, only occurs under Treat continues scenarios.
Arrow outflows for all the Treaty continues alternatives are generally the same, varying primarily due to flood risk needs from the U.S.
2RC-CC
2A-TC
2A-TT
2B-TC

Columbia River Treaty 2014/2024 Review




Grand Coulee - Average Outflow - All Years
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
cfs
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
2RC-CC
2A-TC
2A-TT
2B-TC

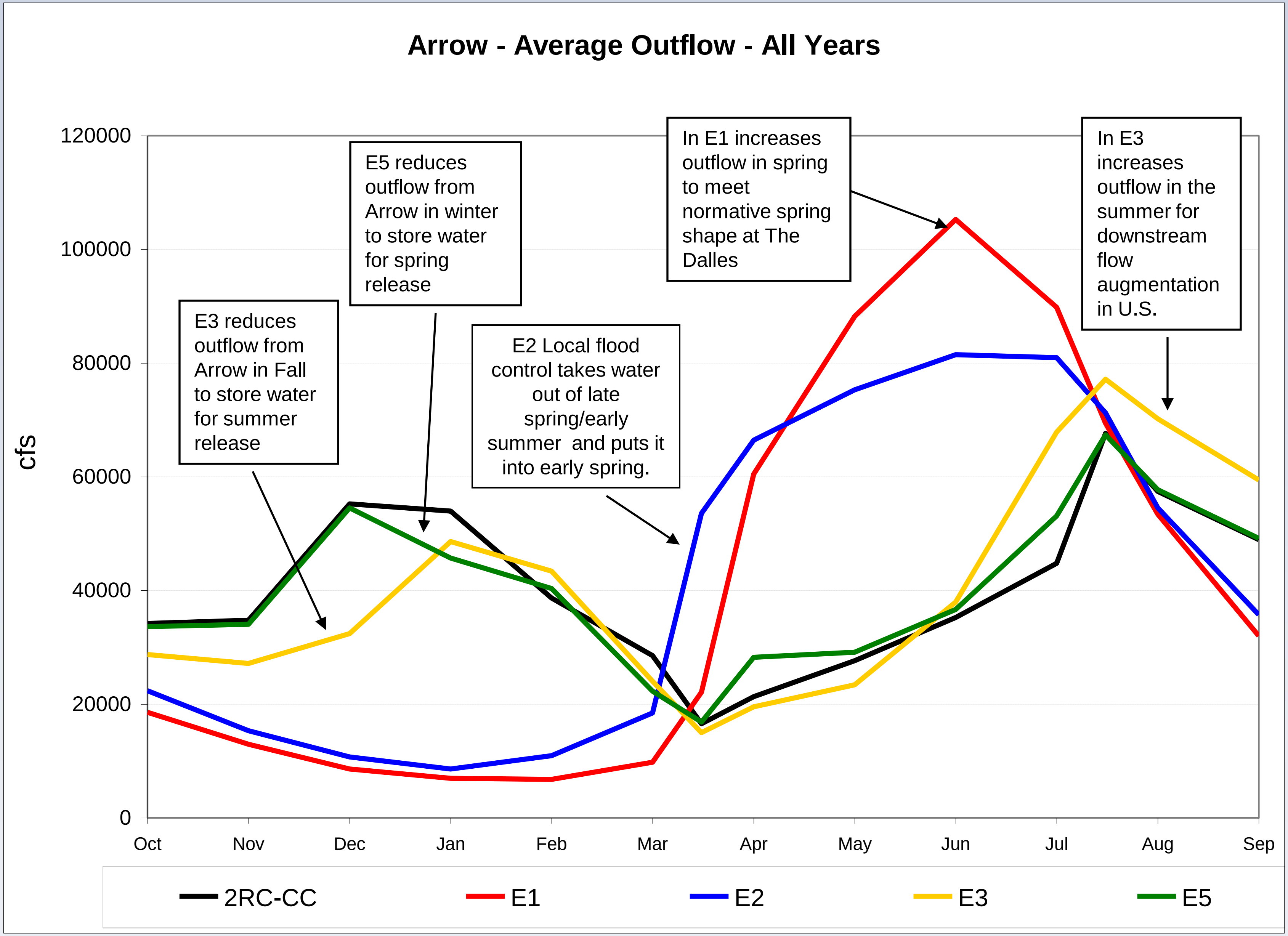

The Dalles - Average Outflow - All Years
cfs
350000
300000
250000
200000
150000
100000
50000
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Grand Coulee outflow shape carries on down to The Dalles
2RC-CC
2A-TC
2A-TT
2B-TC


Albeni Falls - Average Outflow - All Years
No impact at Albeni Falls
from any of the alternatives
cfs
70000
60000
50000
40000
30000
20000
10000
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
2RC-CC
2A-TC
2A-TT
2B-TC

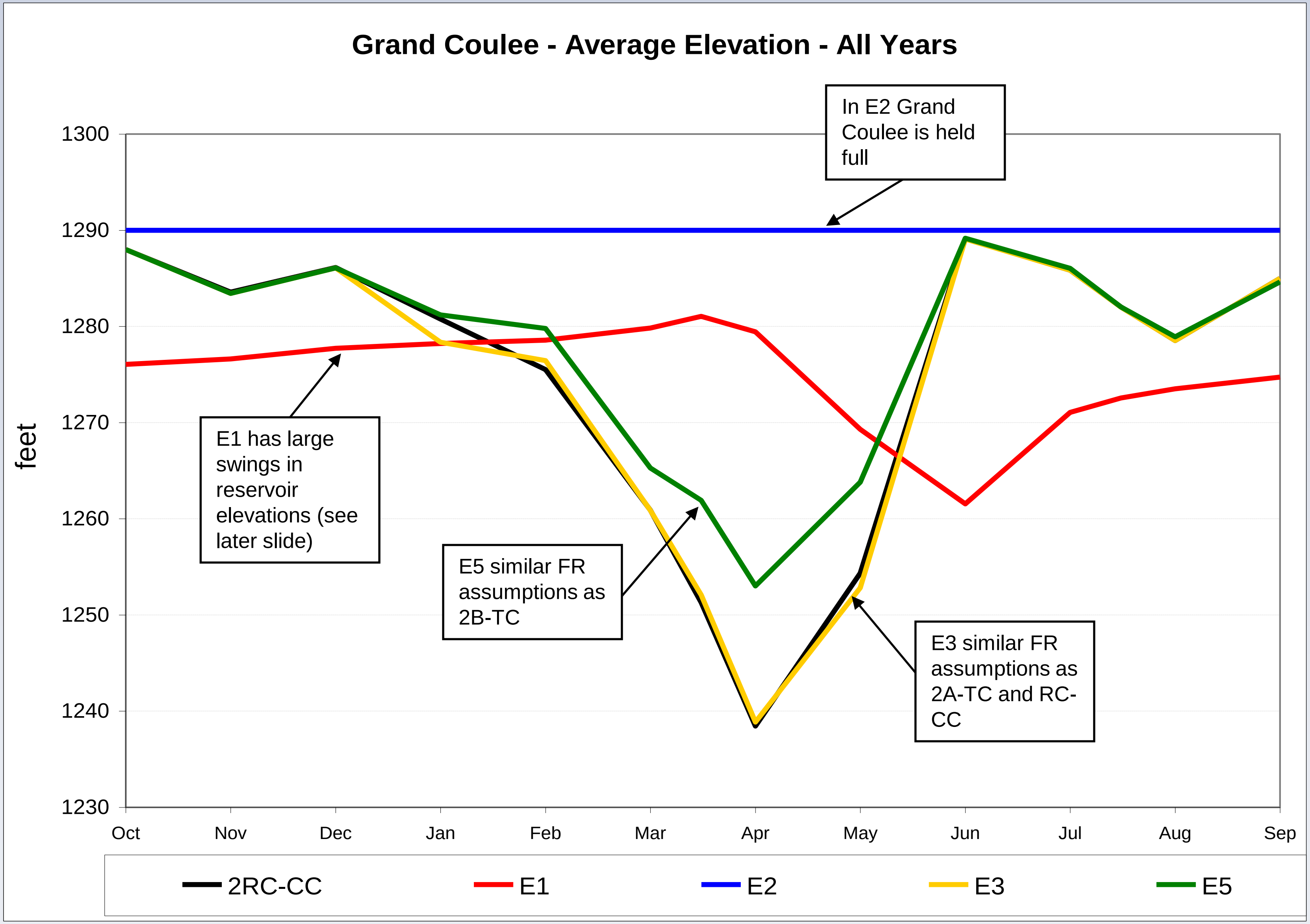
Flow and Reservoir Results: *Components*

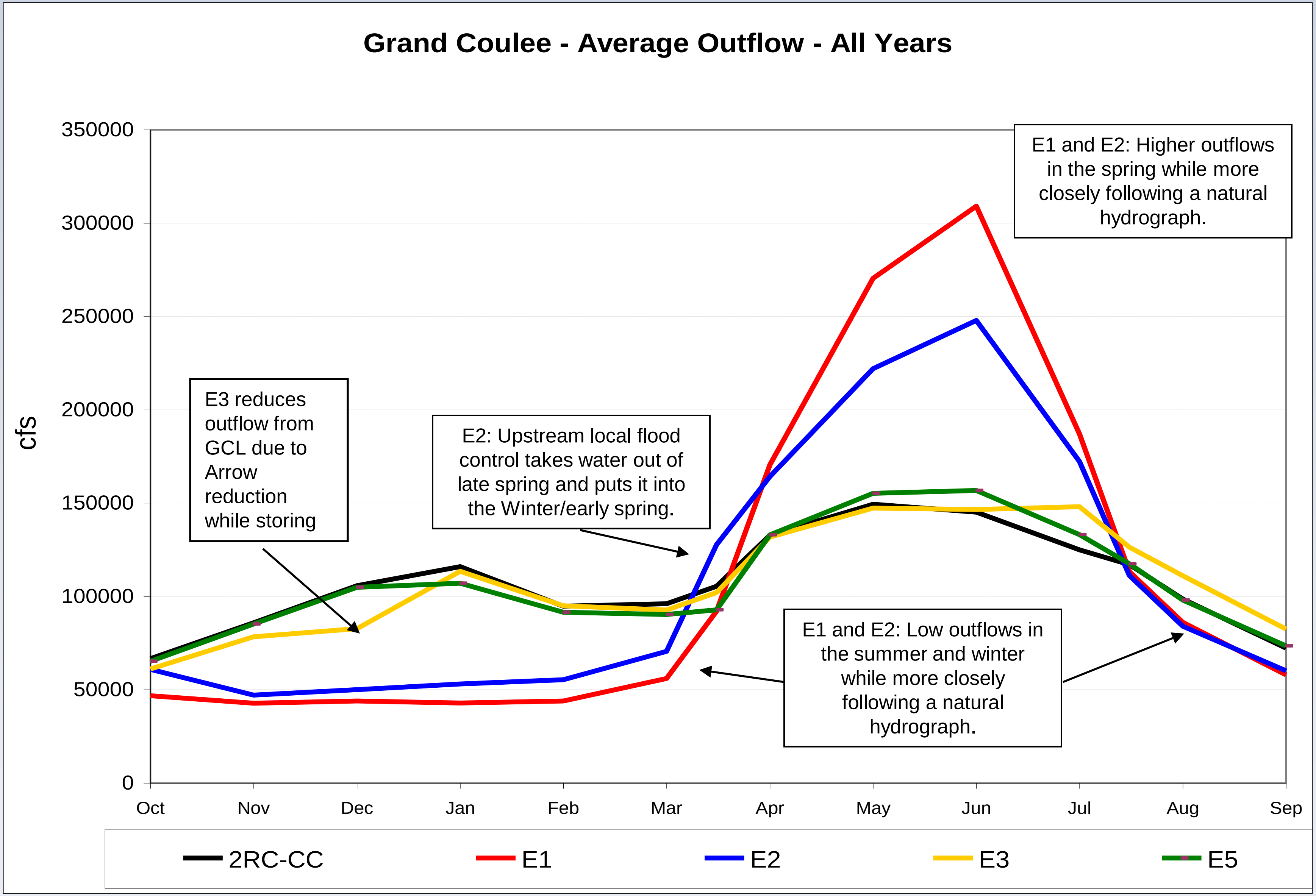
Iteration #2
General Summary of Results

Columbia River Treaty 2014/2024 Review

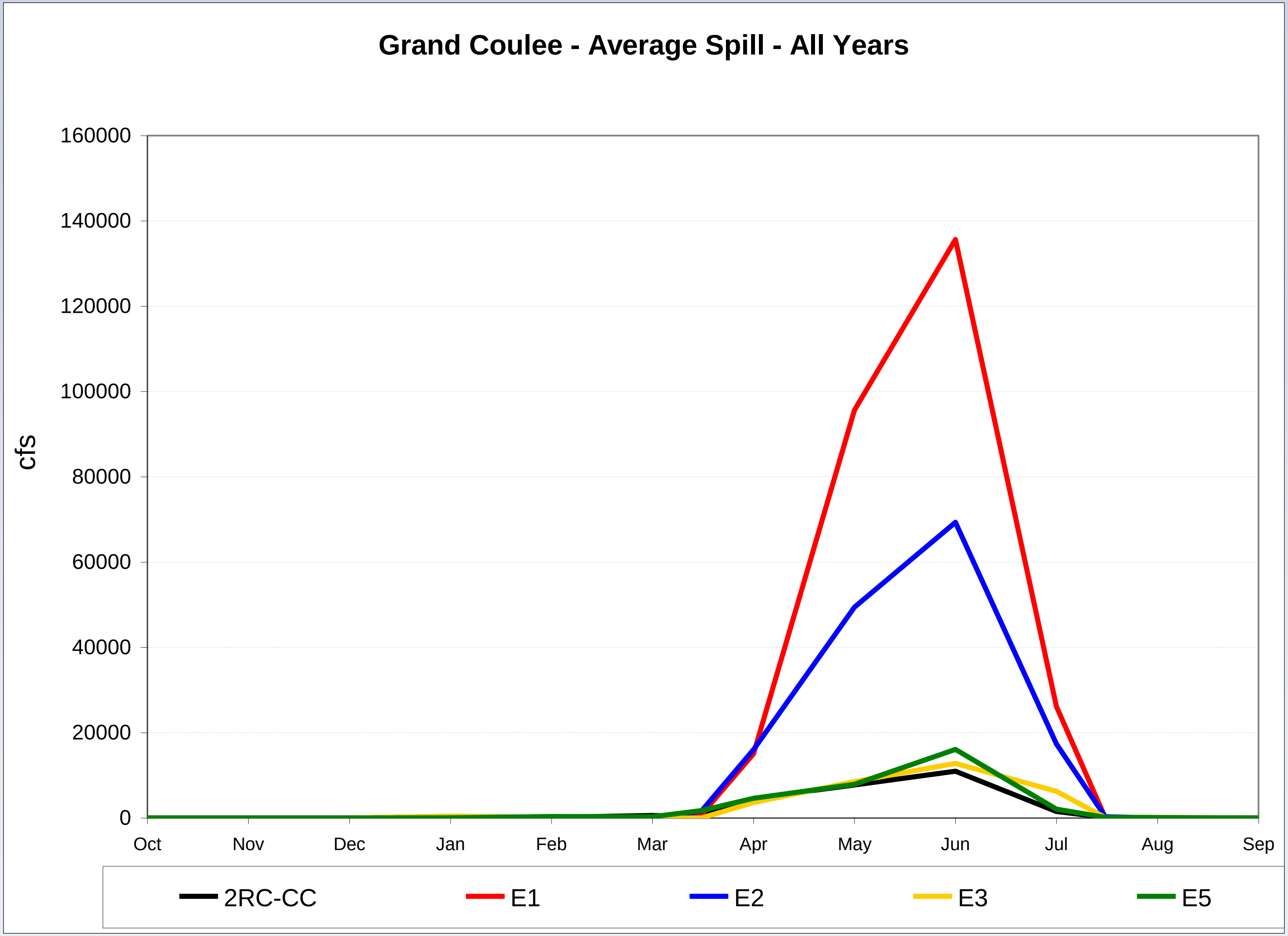


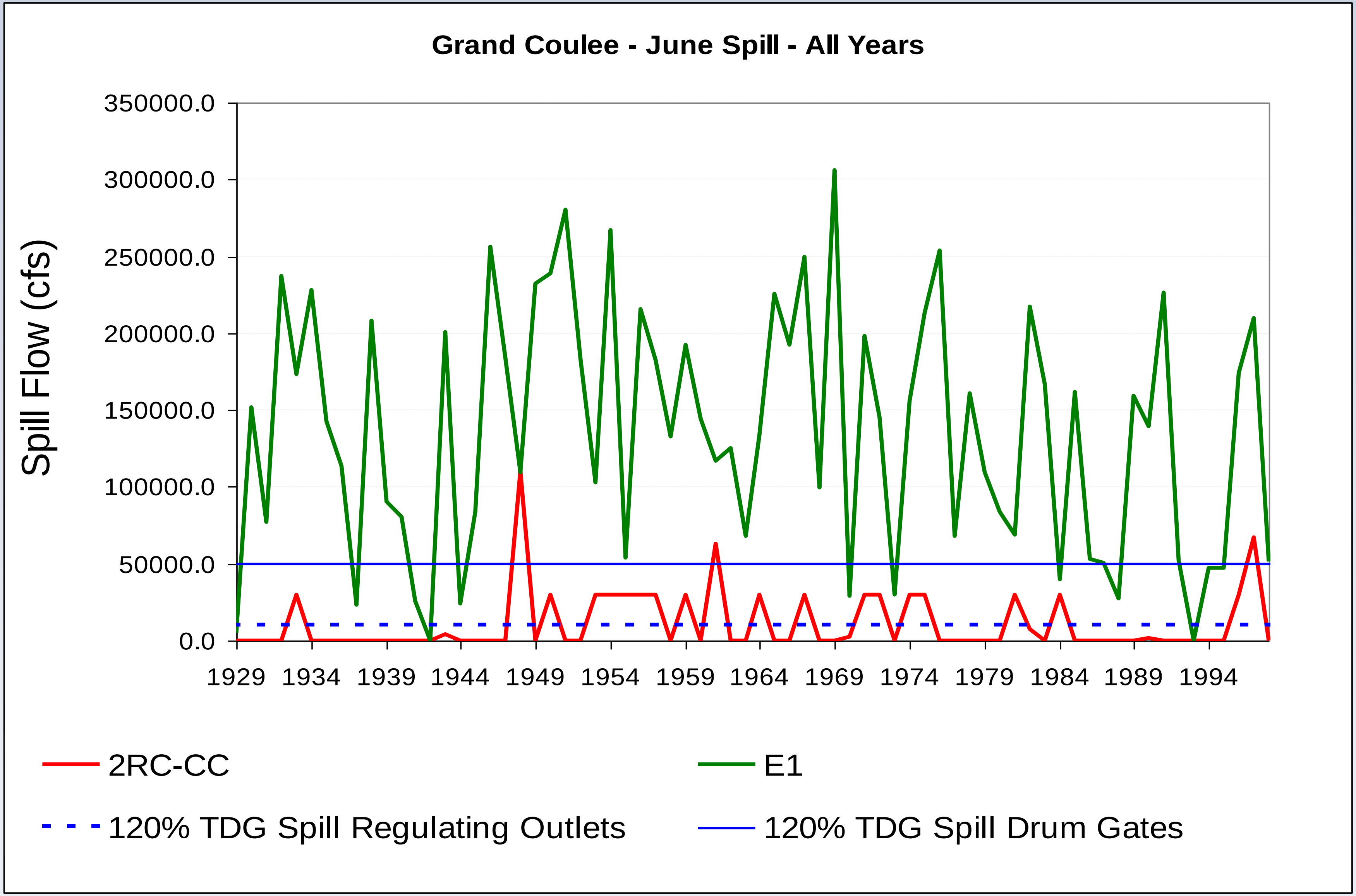
Columbia River Treaty 2014/2024 Review



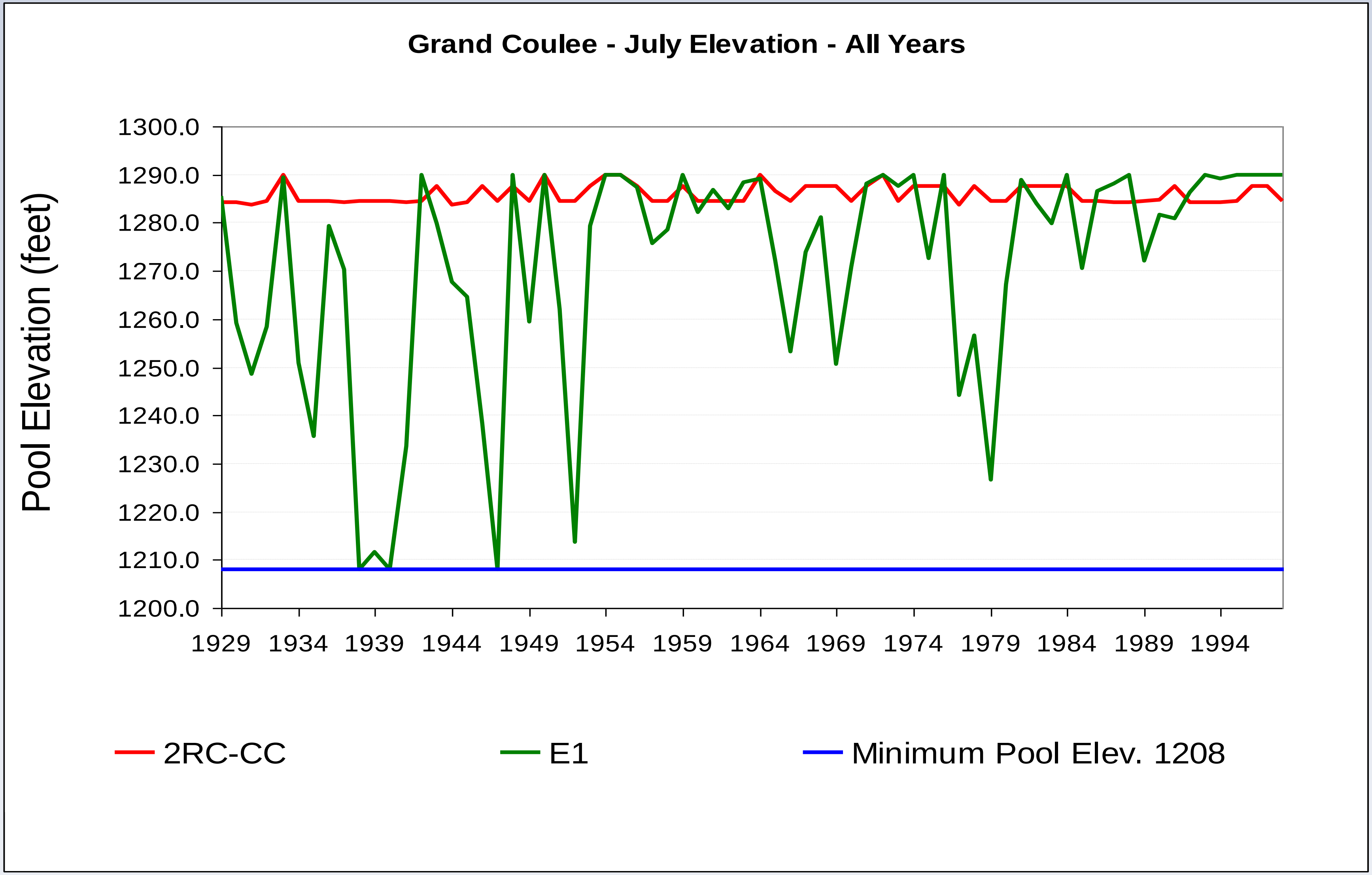

Grand Coulee - Average Outflow - All Years
cfs
350000
300000
250000
200000
150000
100000
50000
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
E1 and E2: Higher outflows in the spring while more closely following a natural hydrograph.
E3 reduces outflow from GCL due to Arrow reduction while storing
E2: Upstream local flood control takes water out of late spring and puts it into the Winter/early spring.
E1 and E2: Low outflows in the summer and winter while more closely following a natural hydrograph.
2RC-CC
E1
E2
E3
E5

Columbia River Treaty 2014/2024 Review

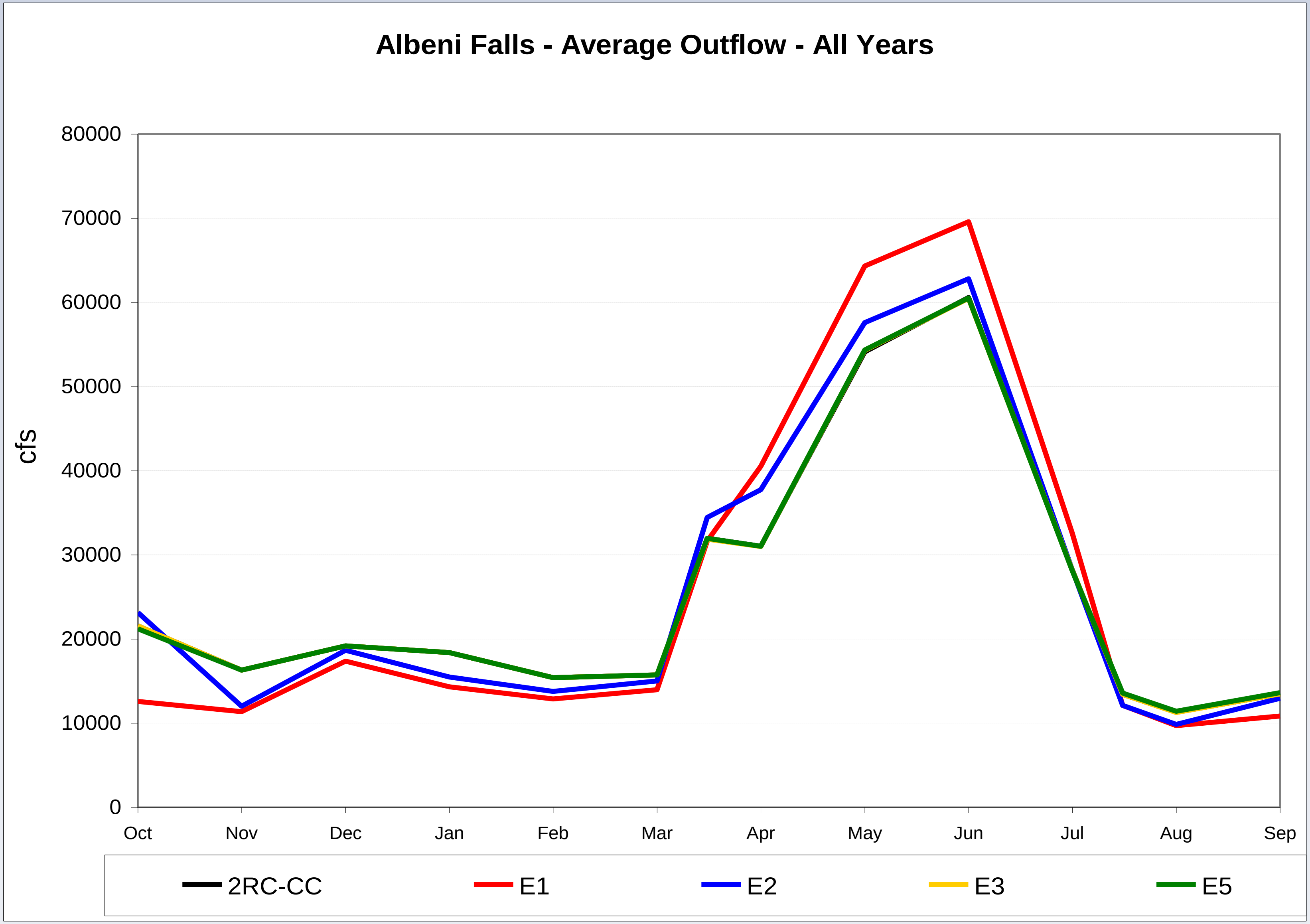


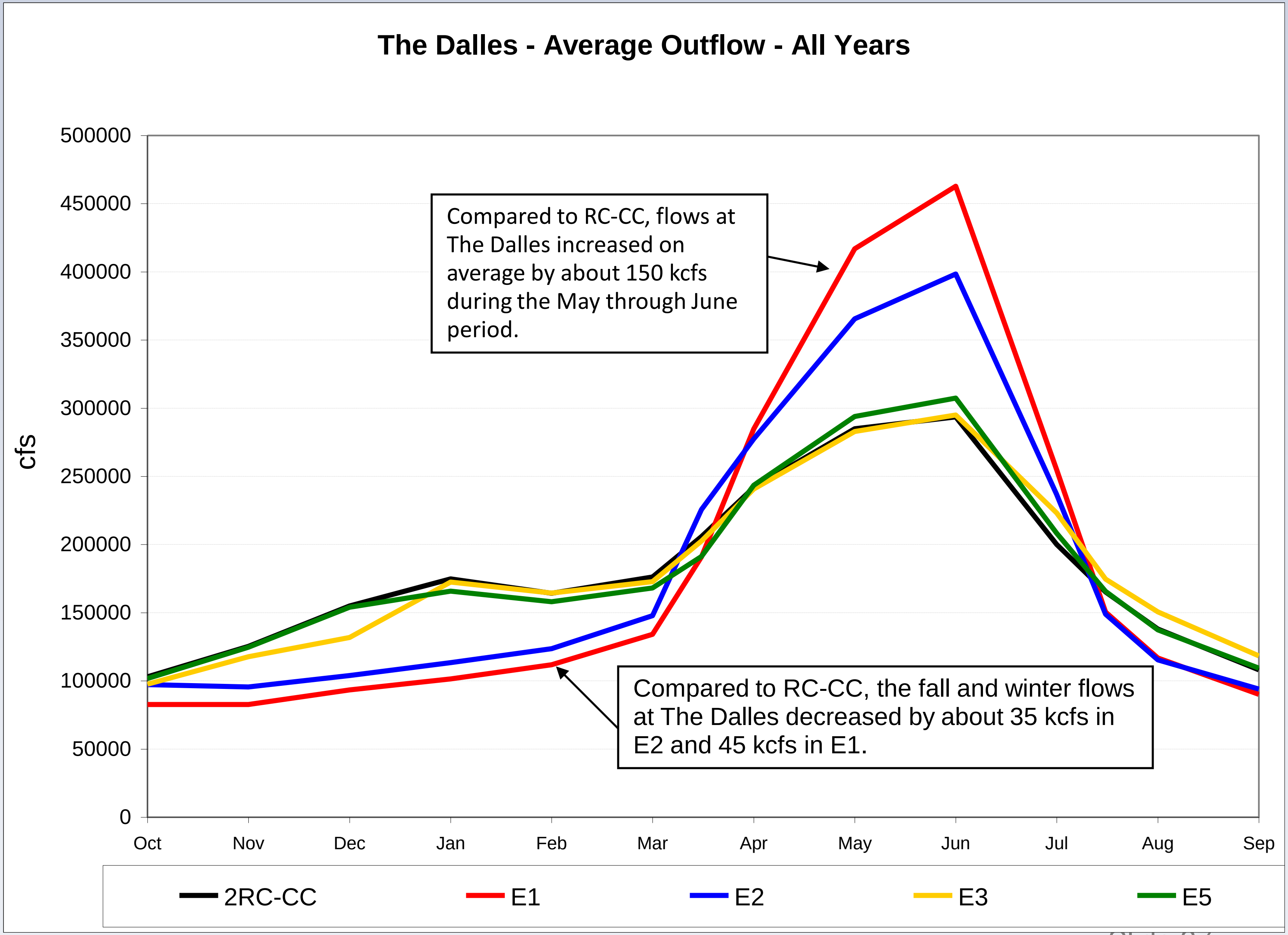

Grand Coulee - June Spill - All Years
Spill Flow (cfs)
350000.0
300000.0
250000.0
200000.0
150000.0
100000.0
50000.0
0.0
1929
1934
1939
1944
1949
1954
1959
1964
1969
1974
1979
1984
1989
1994
2RC-CC
E1
120% TDG Spill Regulating Outlets
120% TDG Spill Drum Gates

Columbia River Treaty 2014/2024 Review



Columbia River Treaty 2014/2024 Review




The Dalles - Average Outflow - All Years
500000
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
cfs
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Compared to RC-CC, flows at The Dalles increased on average by about 150 kcfs during the May through June period.
Compared to RC-CC, the fall and winter flows at The Dalles decreased by about 35 kcfs in E2 and 45 kcfs in E1.
2RC-CC
E1
E2
E3
E5

HYDROPOWER

Iteration #2
General Summary of Results

Power Revenue Impacts Compared to Reference Case

70-year Annual Averages	Canada	U.S.	**Total**
2A-TC	+$ 1 M	-$ 3 M	**-$ 2 Million**
2B-TC	+$ 2 M	-$ 16 M	**-$ 14 Million**
2A-TT	-$ 100 M	+$ 170 M	**+$ 70 Million**
E1	-$ 200 M	-$ 1,200 M	**-$ 1,400 Million**
E2	-$ 120 M	-$ 690 M	**-$ 810 Million**
E3	-$ 1 M	-$ 27 M	**-$ 28 Million**
E5	-$ 4 M	-$ 33 M	**-$ 37 Million**

- Includes U.S. energy and capacity values, but does not include Canadian capacity values
- Includes Canadian Entitlement values
- Assumes energy and capacity value of the Canadian Entitlement is the same in all scenarios except 2ATT
- Canadian Entitlement under 2A-TT is valued at +$220M U.S. and -$105M Canada

Loss of Load Probability (LOLP)

Alternatives	LOLP	MW required to reach 5% LOLP*
2A-TT	27.5%	3,700 MW
2A-TC	27.9%	3,700 MW
2B-TC	28.5%	3,700 MW
RC-CC	28.3%	3,450 MW

Reference and Alternatives

- The LOLP for the reference case and alternatives are similar, about 28%
- To get the reference case and alternative LOLP down to 5% requires the addition of 3,450 to 3,700 MW of combustion turbines (CT)

E Components

- The LOLP for the E studies ranges from 30 to 95% - considerably higher than the 5% standard
- To get the E studies down to 5% requires the addition of 4,200 to 9,700 MW of combustion turbines (CT)
- To get the E1 and E2 studies down to 5% would carry an annual cost of 1 to 1.8 billion dollars

Component	LOLP	MW required to reach 5% LOLP*
E1	91.5%	9,200 MW
E2b	94.7%	9,700 MW
E3	43.7%	5,600 MW
E5	30.2%	4,200 MW
RC-CC	28.3%	3,450 MW

**Rounded to nearest 50 MW*

Note: 3700 MW is equivalent to the typical winter monthly load for Portland General Electric and Springfield

Ability to Integrate Wind

SPRING

	Apr II	May	Jun
RC-CC	**3** (451)	**4** (178)	**4** (574)
2A-TC	**4** (341)	**4** (187)	**6** (412)
2A-TT	**5** (275)	**3** (197)	**8** (347)
2B-TC	**5** (324)	**5** (246)	**13** (429)

Years unable to carry 900 MW Reserves
(Magnitude of Reserve Miss (MW))

Reference and Alternatives

- No issues in general outside of spring period.
- Ability to carry reserves in the spring similar to current conditions except for 600 level study (2B-TC) which showed slightly more misses.

E Components

- E1 and E2 Components showed significant impact to the ability to carry reserves both in the winter and spring

	WINTER				SPRING/early SUMMER			
	Nov	Dec	Jan	Feb	Apr II	May	Jun	Jul
RC-CC	**0**	**0**	**0**	**0**	**3** (451)	**4** (178)	**4** (574)	**0**
E1	**21** (395)	**14** (220)	**27** (268)	**20** (246)	**7** (563)	**49** (775)	**54** (794)	**1** (21)
E2	**17** (430)	**4** (191)	**32** (378)	**12** (317)	**13** (444)	**29** (750)	**39** (734)	**5** (557)
E3	**0**	**0**	**0**	**0**	**2** (302)	**3** (269)	**8** (420)	**0**
E5	**0**	**0**	**0**	**0**	**5** (324)	**5** (246)	**13** (429)	**0**
	Years unable to carry 1100 MW Reserves (Magnitude of Reserve Miss (MW))				**Years unable to carry 900 MW Reserves** (Magnitude of Reserve Miss (MW))			

Carbon Emission

	Increase in CO2 Metric Tons	Number of Additional Average Size Gas Power Plants*	Increase in Total Electric Power Carbon Emissions for NW	Increase in Passenger Cars Equivalents#
RC-CC				
2A-TC	40,013	0.03	0.2%	8,336
2A-TT	227,776	0.20	1.0%	47,453
2B-TC	157,751	0.14	0.7%	32,865

Reference and Alternatives

- On an average annual basis, none of the alternatives resulted in significant CO_2 emission increase nor required significant increases in added power plant generation.

E Components

- Components E1 and E2 generation losses resulted in a significant increase in carbon emission, equivalent to 5-8 gas power plants.
- Components E3 and E5 generation losses resulted in only very slight increases in carbon emission, equivalent to less than half a gas power plants.

	Increase in CO_2 Metric Tons	Number of Additional Average Size Gas Power Plants*	Increase in Total Electric Power Carbon Emissions for NW	Increase in Passenger Cars Equivalents#
RC-CC				
E1	9,197,312	7.9	41%	1,916,107
E2B	6,018,179	5.2	27%	1,253,787
E3	238,942	0.2	1%	49,780
E5	321,406	0.3	1%	66,960

**Average size of gas power plants 364 MW – for combined cycle units in the PNW*

Note: 2A-TT represents combined U.S. and Canadian system generation

Canadian Entitlement in 2025 if Treaty Continues Under Existing Methodology

- 450 aMW, with about 1,300 MW capacity
- Worth roughly $250-350 million per year (including capacity)
- Canada can specify delivery on highest value hours each month (with day-ahead scheduling)
- U.S. has to keep equivalent of 1,300 MW generation plant available for Canada and reserve 1,300 MW of transmission capacity
- This formula calculates value of DPB and CE based on with and without existence of Canadian Treaty dams

Canadian Entitlement Summary

- Based on the comparison between 2A-TC and 2A-TT, the estimated value of continued coordination benefit to the US is in the range of $50 to $60 million, which would result in a Canadian Entitlement value of $25 to $30 million (compared to $250-300 based on current methodology).
- U.S. must still estimate the value of other power benefits of Treaty coordination such as certainty of operations, the firm energy value, and the seasonal value of energy.
- The post-2024 Canadian Entitlement payment should reflect ½ of the actual U.S. benefit received from Treaty coordination.

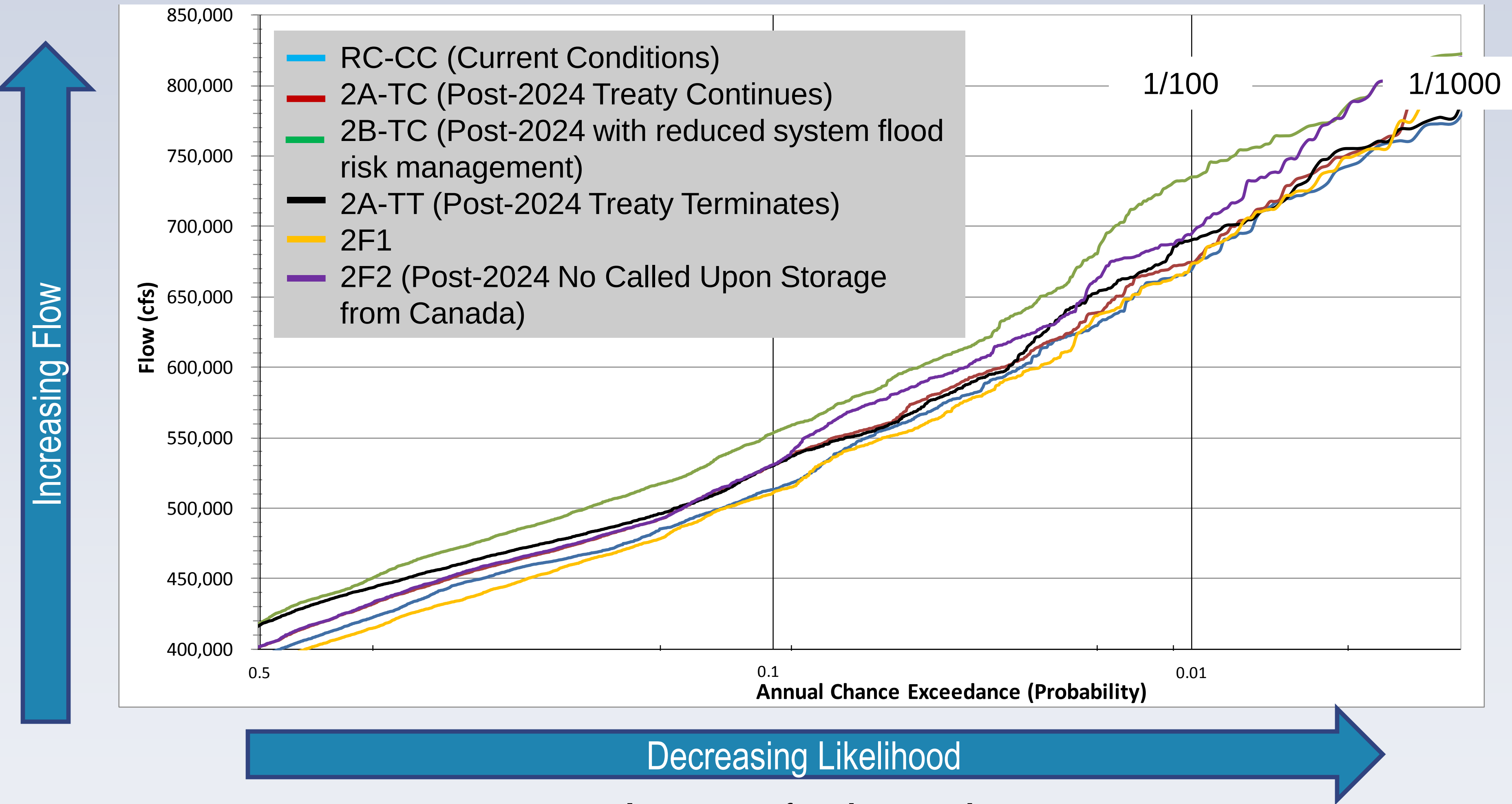
Flood Risk Management

Iteration #2
General Summary of Results

Iteration 2 Flood Risk Metrics

- **Flow Frequency Curves (Hydrologic factors)**
  - The probability that any given flow will occur in any given year
  - Compares the relative frequency of flood events between alternatives (defines 1%, 0.2%, etc. flood events)
- **Preliminary Expected Annual Damage (EAD)**
  - A metric used to compare relative economic consequences of the alternatives
  - Average monetary value of physical losses (structure and content) related to how each alternative manages an event.

The Dalles Flow Frequency



Preliminary Draft: Subject to Change

Draft, daily, regulated, spring, peak flows for CRT Review

Flow Probability @ The Dalles

		RC-CC	2A-TC	2B-TC
Iteration 2	450 kcfs*	28.9 %	31.8 %	39.1 %
	600 kcfs**	2.8 %	3.2 %	5.0 %
	800 kcfs	Possible but unlikely (0.07 %)	Twice as likely as CC (0.15 %)	Four times as likely as CC (0.27 %)

* 450 kcfs at The Dalles = Start of minor flooding
** 600 kcfs at The Dalles = Start of Major flooding

Preliminary EAD metric % change for Iteration 2 alternatives

	2A-TC	2B-TC	2A-TT	2F1	2F2
Total % increase from CC	2.3%	20.9%	4.0%	-12.4%	10.0%
Reach 1 % increase from CC	10%	93%	18%	-7.0%	45%

- Preliminary EAD (Expected Annual Damage) is a flood risk metric developed for iteration 2 to compare alternatives that incorporates flow probability and consequences.

Flood Risk Analysis Iteration 2 Conclusions

- Compared to RC-CC:
  - 1A-TC flood risk increases over CC due to how Called Upon and Effective Use was implemented; the increase in Reach 1 (Bonneville to the mouth) EAD is significant
  - 2B-TC results in a significant flood risk increase compared to CC; 97% of the increase in EAD is within Reach 1
  - 2A-TT impacts are similar (slightly higher) based on assumptions about operation of Canadian reservoirs if the Treaty is terminated; those assumptions need to be more thoroughly tested in Iteration
- We did not calculate flood risk metrics for the Ecosystem Components in Iteration 2
  - E1 and E2 are “bookend” scenarios designed to evaluate ecosystem benefits with major changes in system and local flood risk management operations
  - Either of them would lead to substantial increase in flood risk for the Columbia River basin in the U.S.

Flood Risk Analysis Iteration 2 Conclusions

- EAD under all alternatives is driven by infrequent/high damage events and more frequent / low damage events.
  - The difference between system-wide EAD for each alternative evaluated to date is in Reach 1. This is due primarily to adhering to local flood operations under all alternatives & mainstem development and infrastructure.
- For all Iteration 2 Alternatives, the vast majority of EAD comes from non-leveed areas;
  - The levees in our system are currently “robust”; improving existing levees is not likely to be an economically viable alternative to reducing flood risk in the future
  - Reducing EAD by constructing levees or other local flood risk management measures would have to be studied on a case-by-case basis to determine feasibility

Effects of Flood Risk Management on U.S. and Canadian Reservoirs

- "Called Upon" refers to requests to Canada to provide storage for flood risk management in the U.S. after 2024
  - Does not apply to RC-CC; post 2024 operation only
  - Most frequent under 2A-TT; driven by uncertainty of Canadian reservoir operations if the Treaty is terminated
  - Least frequent under 2B-TC due to less conservative "trigger"
- "Effective Use" refers to the making additional use of U.S. reservoir storage before calling on Canada
  - Most frequent under 2A-TT; driven by uncertainty of Canadian reservoir operations if the Treaty is terminated
  - Least frequent under 2B-TC due to less conservative "trigger"; but when needed, the volumes of storage space required are much greater than any of the other alternatives.

Anadromous Fish

Iteration #2 Results General Summary of Results

Anadromous Fish: Alternative Results

Chinook

Alternative	In-River Survival	Travel Time	SAR*
RC-CC	0.412	53.5	0.0034
2A-TC	0.412	53.6	0.0034
2A-TT	0.417	52.4	0.0035
2B-TC	0.412	53.6	0.0034

Steelhead

Alternative	In-River Survival	Travel Time	SAR
RC-CC	0.271	38.2	0.0069
2A-TC	0.270	38.3	0.0068
2A-TT	0.294	36.8	0.0075
2B-TC	0.268	38.5	0.0068

- No real change across 2A-TC, 2B-TC alternatives for Chinook
- Slight increase in Steelhead for the Treaty Terminates alternative

*Smolt to Adult Return (SAR)

Anadromous Fish: Component Results

Chinook

Alternative	In-River Survival	Travel Time	SAR
RC-CC	0.412	53.5	0.0034
E1	0.457	46.4	0.0040
E2	0.445	48.4	0.0038
E3	0.412	53.6	0.0034
E5	0.415	52.8	0.0035

Steelhead

Alternative	In-River Survival	Travel Time	SAR
RC-CC	0.271	38.2	0.0069
E1	0.410	32.8	0.0106
E2	0.360	34.8	0.0092
E3	0.268	38.4	0.0068
E5	0.281	37.4	0.0072

- Components E1 and E2 show significantly reduced travel times, increased in-
  river survival and adult returns
- Components E1 and E2 produce conditions (e.g. high TDG levels) beyond where we have observed data, requiring caution in interpretation
- Component E5 produced a slight increase in juvenile in-river survival compared

Anadromous Fish: Results Fallback/Rearing Habitat

- Adult Spring Chinook Fallback* Analysis
  - Fallback for 2A, 2B and RC alternatives similar
  - E1 and E2 showed increased chance of fallback in every year
- Fall Chinook Rearing Habitat
  - For the Hanford Reach E1 & E2b resulted in significant increase in Fall Chinook rearing habitat
  - John Day: E1 & E2b resulted in a significant decrease in habitat

*Fallback: when migrating adult fish ascend a fishway at a dam and then pass back to the tailrace through some passage route

Anadromous Fish: Results
Salmon Spawning Habitat

Two key areas for protecting spawning habit: Vernita Bar (fall Chinook salmon) & below Bonneville Dam (Chum salmon)

Based on Hydroregulation Result evaluation:

- No change for alternatives (2A-TC, 2B-TC, 2A-TT) and component E3
- E1 & E2 did not operate for Vernita Bar & Chum current protocol
- E5 dewatered Vernita Bar and Chum during low water years

Estuary

Iteration #2
General Summary of Results

Estuary Modeling Overview

- The estuary provides many important ecosystem services
- Iteration #2 alternatives and components were modeled and evaluated for three (3) estuary metrics
  - Salinity intrusion length: maximum penetration of salt during a day
  - Plume volume: volume of the regional of the continental shelf which salinity is below 28 psu
  - Salmon Habitat Opportunity: opportunity for subyearling salmon to access preferred habitats

Columbia River Treaty 2014/2024 Review

Bonneville flows: Statistical significance of differences

	River Discharge**	OCT	NOV	DEC	JAN	FEB	MAR	APR 1-15	APR 16-30	MAY	JUN	JUL	AUG 1-15	AUG 16-30	SEP
Flow differences between RC-CC and Iteration 2 alternatives															
2A-TC (450)	High														
	Medium														
	Low														
2A-TT (450)	High														
	Medium														
	Low														
2B - TC (600)	High														
	Medium														
	Low														
Flow differences between RC-CC and Iteration 2 components															
E1 - normative hydrograph	High														
	Medium														
	Low														
E2b - normative reservoir levels	High														
	Medium														
	Low														
2E3 - improve summer fish migration	High														
	Medium														
	Low														
E5 - dry year strategy	High														
	Medium														
	Low														

** Based on percentiles for BON-Q POR - High (95%), Medium (50%), Low (5%)

<u>Alternative/Component flow is</u>:

- Significantly LOWER than RC-CC (strong stat diff)
- Lower than RC-CC (weak stat diff)
- Lower than RC-CC (no stat diff)
- Not stat diff than RC-CC but changes still occur
- Significantly HIGHER than RC-CC (strong stat diff)
- Higher than RC-CC (weak stat diff)
- Higher than RC-CC (no stat diff)

Estuary: Results
Examples of Improvements and Adverse Impacts

- Complex both spatially and seasonally
- Timing and location for May & June
  - E1, E2, and 2A-TT generally improved ocean entry conditions for salmon yearlings
  - Increase habitat opportunity for subyearlings in the lower estuary but decreased it in the upper estuary
- Potential for summer hypoxia & acidification
  - 2A-TT, E1, and E2 increased the potential in August and September
  - E3 reduces the potential throughout summer relative to the RC-CC

Water Temperature and Total Dissolved Gas

Iteration #2
General Summary of Results

Water Temperature: Summary Grand Coulee

Release water temperature were influenced by alternative operations at Grand Coulee Dam (powerhouse use, reservoir elevation, etc.)

- Alternatives:
  - Little change between 2A-TC and 2B-TC from the reference case.
  - Slightly cooler temperatures for the Treaty terminates scenario, 2A-TT
- Components:
  - E1 and E2 generally warmer in the Nov – Mar period and the Jul-Aug period, but slightly cooler May-Jun.
  - E3 and E5 not significantly different from the reference case.

Water Temperature: Component Results

low flow, hot conditions

Snake below Ice Harbor (1941/1998)

Alternative	Mean WT (Jul-Aug) ºC	Max Daily WT ºC	Duration WT above 20 ºC days
RC-CC	21.0	22.8	67
E1	22.0	24.6	79
E2B	22.0	24.7	77
E3	21.0	22.8	66
E5	21.0	22.8	66

Columbia below Bonneville (1941/1998)

Alternative	Mean WT (Jul-Aug) ºC	Max Daily WT ºC	Duration WT above 20 ºC days
RC-CC	22.4	24.5	84
E1	22.1	24.3	83
E2B	22.1	24.3	80
E3	22.2	24.4	81
E5	22.3	24.5	81

Alternatives:

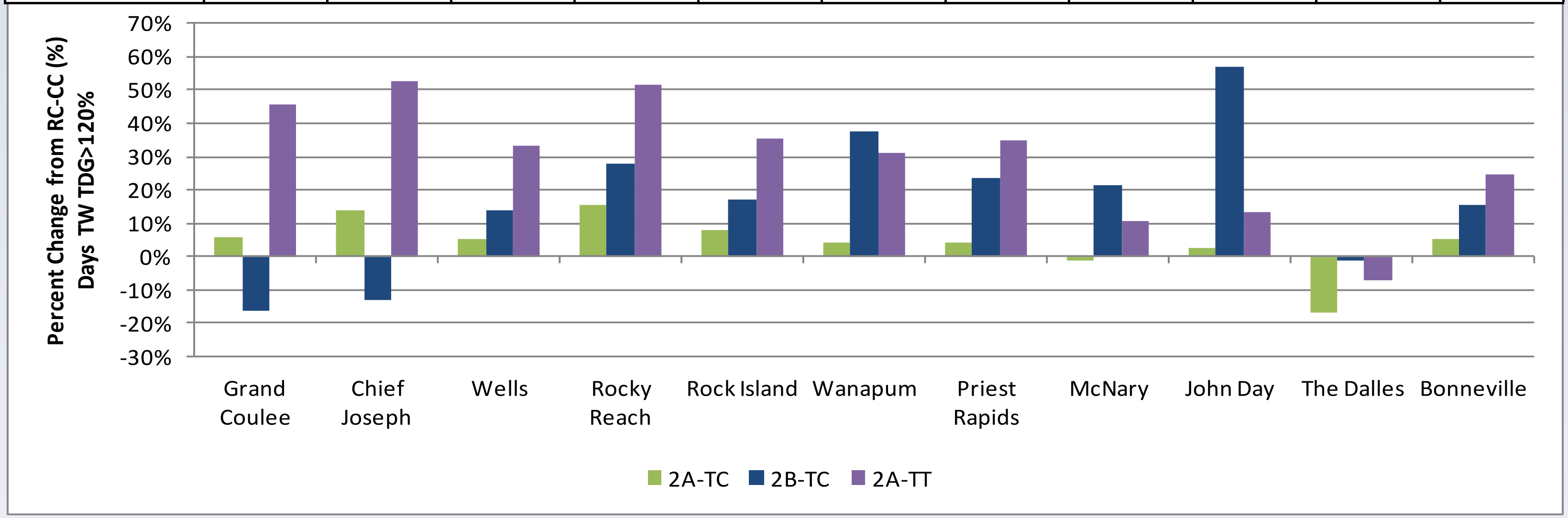
- Weather conditions were the primary driver of water temperatures
- Minimal variation in water temperature across alternatives
- Only Treaty Terminates showed a longer duration of temperatures above 20ºC from lower summer flows during warm periods at Bonneville Dam

Components

- In general, higher temperatures and longer duration in the Clearwater and Snake for E1 and E2, but not real impact in the lower river (due to no Dworshak releases for temperature control in these scenarios.

TDG: Alternative Results
Columbia River

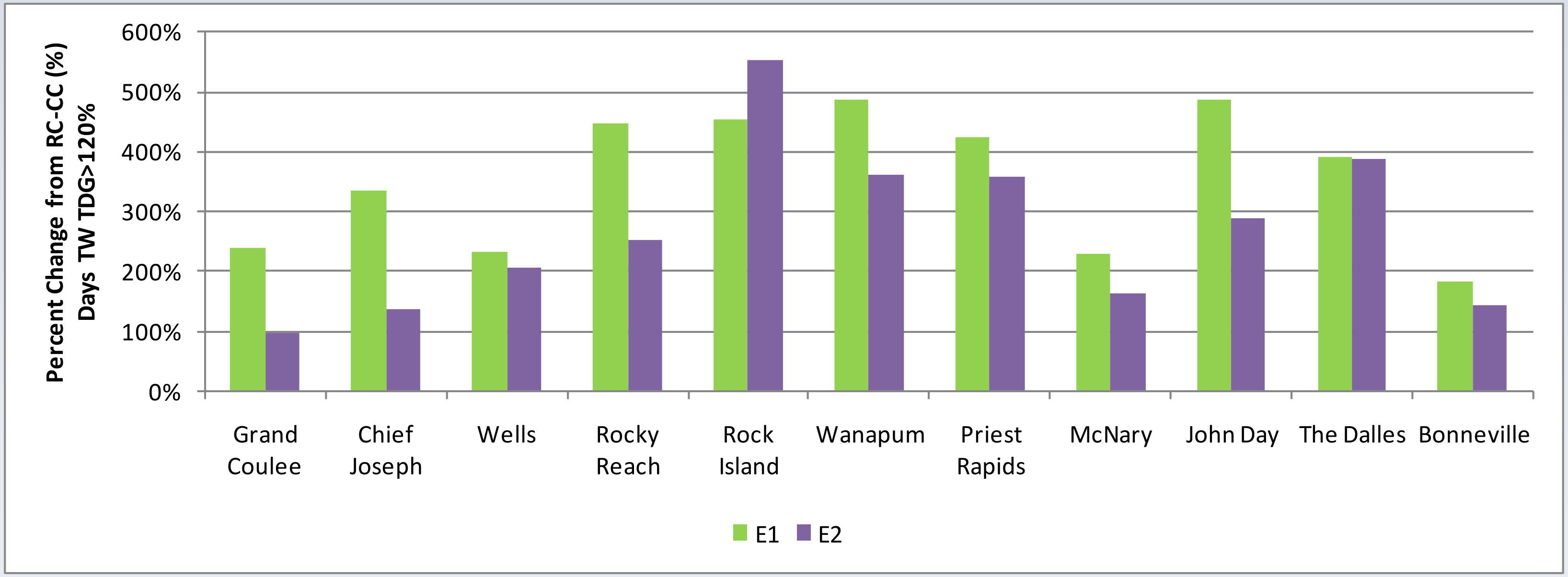
Provisional Summary of Iteration 2 Alternatives for Total Dissolved Gas Loading											
Alternative	Percent Change from RC-CC of the Number of Days Tailwater TDG Loading were Greater than 120% (April-August, 70 years)										
	GCL	CHJ	WEL	RRH	RIS	WAN	PRD	Mcn	JDA	TDA	BON
RR-CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2A-TC	5.6%	13.6%	5.5%	15.3%	7.7%	4.4%	3.9%	-1.3%	2.6%	-16.9%	5.3%
2B-TC	-16.5%	-13.1%	13.9%	28.0%	17.1%	37.8%	23.4%	21.4%	56.8%	-1.4%	15.6%
2A-TT	45.9%	52.6%	33.4%	51.3%	35.3%	31.2%	34.7%	10.4%	13.2%	-7.0%	24.4%



Slight increases in dissolved gas throughout the Columbia River were determined for Alternatives 2A-TT and 2B-TC compared to current condition

TDG: Component Results
Columbia River

Provisional Summary of Iteration 2 Components for Total Dissolved Gas Loading											
	Summary of Percent Change from RC-CC of the Number of Days Tailwater TDG Loading were greater than 120% (April-August, 70 years)										
Components	GCL	CHJ	WEL	RRH	RIS	WAN	PRD	Mcn	JDA	TDA	BON
RR-CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
E1	239.5%	334.1%	232.8%	447.7%	453.3%	485.3%	424.0%	228.1%	486.4%	389.8%	182.1%
E2	95.5%	135.3%	207.4%	253.7%	553.7%	361.6%	359.2%	163.7%	287.2%	387.8%	142.9%



E1 and E2 Components resulted in prominent increases in TDG loading throughout the entire study area compared to RC-CC

Impact Assessments: Navigation

Iteration #2
General Summary of Results

Iteration 2 Navigation Metrics

- **Inchelium Ferry Operations**
  - The average number of days per year the ferry is unusable du to low elevations at Lake Roosevelt
- **High Flow Impacts**
  - Flow levels at which navigation through the inland waterway becomes more difficult and less safe; thresholds at which tow boat operators reduce the number of barges towed through navigation locks
  - Lower Columbia River: 450 kcfs at Bonneville Dam
  - Lower Snake River: 100 kcfs at Ice Harbor Dam
- **Low Flow Impacts**
  - Flow levels below 120 kcfs at Bonneville Dam
  - Low flows impact channel depth and port facility access on the lower Columbia River; deep draft navigation adversely affected due to draft restrictions on ships.

Navigation: Results

- For high flow and low flow thresholds compared to RC-CC:
  - Very little difference in the alternatives and components for navigation on the lower Snake River.
  - E-1 and E-2 Components result in substantial increase in the average number of days that lower Columbia River high flow thresholds are exceeded.
  - Alternative 2A-TT and the E1 / E2 components all lead to substantial increase in the average number of days that lower Columbia River flows fall below the low flow threshold.
- Inchelium Ferry operations
  - Adversely affected by Alternatives 2A-TT and E1 compared to RC-CC
  - Alternatives 2B-TC and Components E2-B and E-5 would have fewer outage days than the RC-CC Alternative.
- Analysis of alternatives' effects on sedimentation in the lower Columbia River deep draft is on-going.
- A technical workshop with navigation stakeholders will be held to refine the interpretation of navigation impacts for the alternatives.

Navigation: Results Alternatives

Lake Roosevelt Gifford Inchelium Ferry

Lake Roosevelt Ferry Average Outage Days/Month				
Month	RC-CC	2A-TC	2A-TT	2B-TC
January	0.0	0.0	0.0	0.0
February	0.0	0.0	0.0	0.0
March	0.0	0.0	0.0	0.0
April	3.7	3.7	5.2	0.5
May	4.8	5.3	6.4	0.9
June	0.3	0.5	0.7	0.2
Totals	8.9	9.5	12.3	1.6

Based on drafts below elevation of 1228 ft

Navigation: Results Components

Lake Roosevelt Gifford Inchelium Ferry

Lake Roosevelt Ferry Average Outage Days/Month					
Month	RC-CC	E1	E2B	E3	E5
January	0.0	0.9	0.0	0.0	0.0
February	0.0	0.8	0.0	0.0	0.0
March	0.0	0.9	0.0	0.1	0.0
April	3.7	1.0	0.0	4.6	0.6
May	4.8	2.3	0.0	5.8	0.9
June	0.3	4.1	0.0	0.6	0.2
Totals	8.9	10.0	0.0	11.1	1.7

Based on drafts below elevation of 1228 ft

Impact Assessments: Recreation

Iteration #2
General Summary of Results

Iteration 2 Recreation Metrics

- **Reservoir Recreation**
  - Boat Ramp Access: Number of days boat ramps are accessible based on lake elevations
  - Lake Roosevelt, Lake Koocanusa, Hungry Horse Reservoir, Flathead Lake, Lake Pend Orielle, Brownlee Reservoir, Dworshak Lake
- **River Recreation**
  - Number of days per year that flows are within an "optimum" range for recreation
  - Example: 8,000 – 25,000 cfs on the Kootenai River below Libby Dam
  - Flathead River below Hungry Horse Dam, Flathead River below Kerr Dam, Pend Oreille River below Albeni Falls, Clearwater River below Dworshak and Snake River below Hells Canyon

Recreation: Summary
Average Usable Boat Ramp Days

Alternative	Libby (U.S.)*	Hungry Horse*	Grand Coulee**	Brownlee**	Dworshak*
RC-CC	1,562	1,361	4,617	1,335	896
2A-TC	1,562	1,358	4,615	1,335	895
2A-TT	1,556	1,355	4,644	1,333	895
2B-TC	1,558	1,355	4,911	1,448	903
E1	748	269	4,467	1,335	490
E2	1,748	1,437	5,856	1,708	1,023
E3	1,553	1,358	4,614	1,335	895
E5	1,558	1,355	4,914	1,448	903

*May – September
**April - November

Recreation: Lake Results

Storage reservoirs:

- Alternatives:
  - Little change in boat ramp usability compared to current conditions except 2B-TC
  - Alternative 2B-TC relaxed flood control SRDs result in slight to moderate increase in usability
- Components:
  - E1, releases for normative river operations lead to substantial decrease in boat ramp usability for all reservoirs
  - E2, stable reservoir levels result in substantial reductions in boat ramp access

Natural lakes with dams (Flathead Lake, Lake Pend Oreille, and Coeur d'Alene):

- Alternatives: little change from the current conditions and alternatives
- Components:
  - Negative impacts from E1
  - Estimated 15.8% reduction in usable days at Lake Pend Orielle

Recreation: Results
Average "Optimal" River Use Days

Alternative	Kootenai below Libby Dam	Flathead below Hungry Horse Dam	Flathead below Kerr Dam	Hells Canyon below Hells Canyon Dam	Clearwater below Dworshak Dam
RC-CC	130	90	108	93	88
2A-TC	130	90	108	93	87
2A-TT	130	90	108	94	87
2B-TC	129	89	108	92	87
E1	70	56	104	95	37
E2B	91	60	108	73	67
E3	130	92	111	93	87
E5	129	91	111	92	87

River Recreation: Results

- In open river reaches below Libby, Hungry Horse, Kerr, Albeni Falls, Dworshak and Hells Canyon dams there is not much departure from the current condition or difference between the Alternatives.
- The E1 and E2 component result to slight to substantial reductions in the number of optimal flow ranges for downstream recreation.

Impact Assessments: Water Supply

Iteration #2 General Summary of Results

Summary of Average Annual Pumping Requirements (MWh)

Alternative	Columbia Basin Project	Lake Umatilla
RC-CC	975,262	50,358
2A-TC	975,812 **(0%)**	50,358 **(0%)**
2A-TT	975,244 **(0%)**	50,358 **(0%)**
2B-TC	963,729 **(-1%)**	50,358 **(0%)**

- John Day: No effects from pumping or pumping cost to WA and OR as the storage operation did not vary between alternatives.
- Grand Coulee: little difference between the current condition and alternatives for pumping energy requirements for water supply deliveries to the Columbia Basin Project.
- Grand Coulee: E1 did not include delivery of water supply to the Columbia Basin Project in its assumptions.

Next Steps for Today

- Questions and Comments:
  - Questions about the Iteration 2 results?
  - Suggestions for Iteration 3?
- One-on-one discussions at information stations