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Rio Tinto Water Management

Hydrograph and objectives

October 2019

Agenda

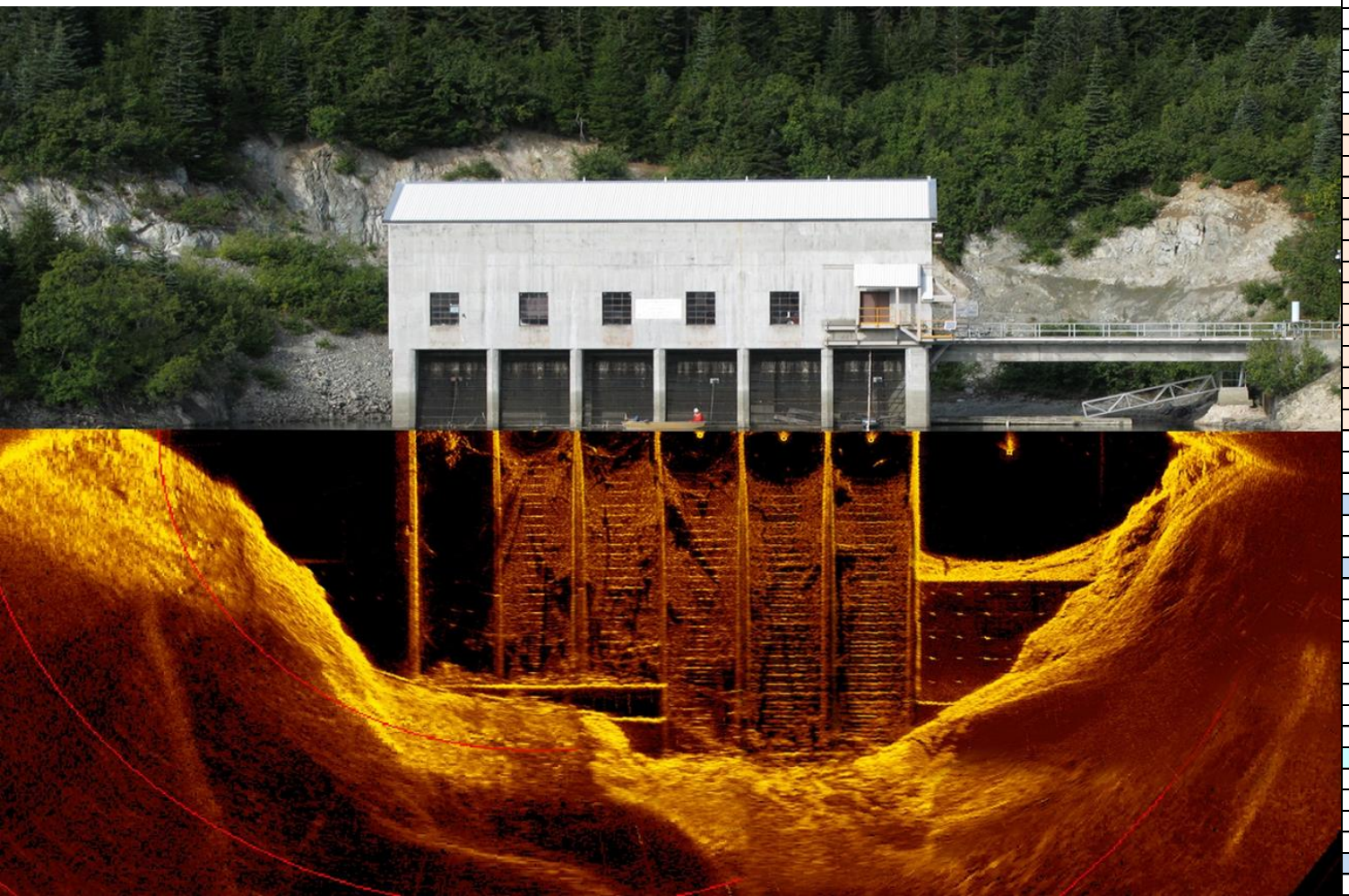
Nechako Reservoir Hydrograph

- Objectives
- Hydrograph components

Skins Lake Spillway Hydrograph

- Objectives
- Hydrograph components
- Targets and Guidelines

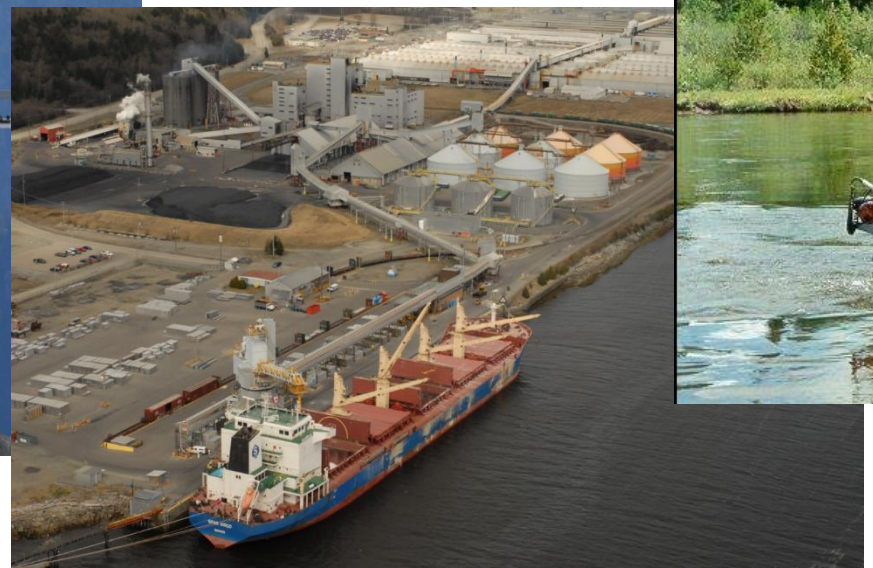
Nechako Reservoir Hydrograph

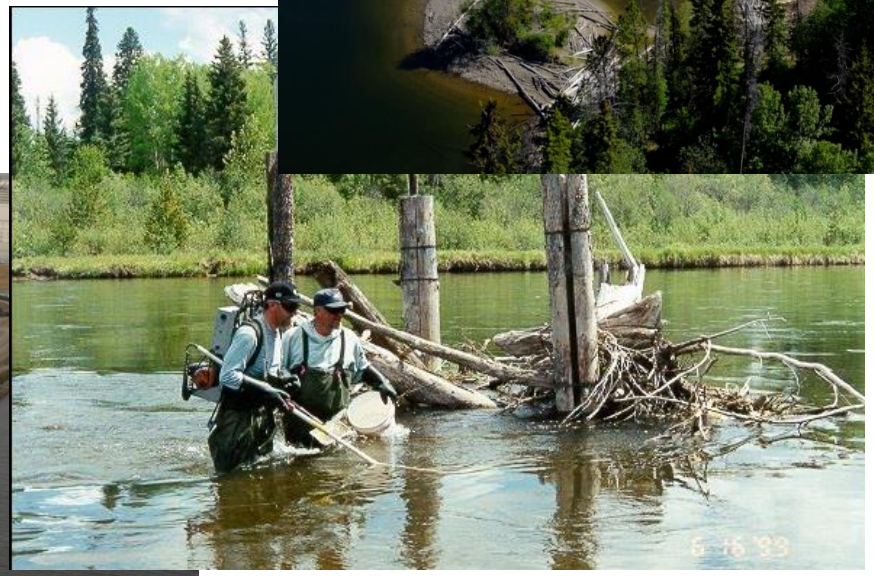


Reservoir elevation points of interest	
Feet	
2822	
2821	
2820	Top of Dams
2819	
2818	
2817	
2816	
2815	
2814	
2813	
2812	
2811	
2810	
2809	
2808	
2807	
2806	
2805	
2804	
2803	
2802	
2801	
2800	Maximum normal reservoir elevation
2799	
2798	
2797	
2796	
2795	
2794	
2793	
2792	
2791	
2790	
2789	
2788	
2787	
2786	Current minimum normal reservoir level
2785	
2784	
2783	
2782	Tahtsa narrows physical bottom
2781	
2780	
2779	Minimum reservoir elevation to achieve max STMP flows at SLS (453 m^3/s)
2778	
2777	
2776	
2775	
2774	
2773	
2772	
2771	
2770	Minimum Licenced Reservoir elevation
2769	
2768	
2767	
2766	
2765	Skins Lake Spillway invert
2764	

Nechako Reservoir hydrograph objectives

- Dam Safety, flooding
- Water allocation to Nechako River
- Smelter operation
- Electricity to BC grid





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Nechako Reservoir hydrograph

Designed for maximum operating water elevation of 2800 feet above sea level.

- Originally had an overflow spillway at 2800 feet
- Dam Safety: a probable maximum precipitation event at full reservoir could cause dam safety issue

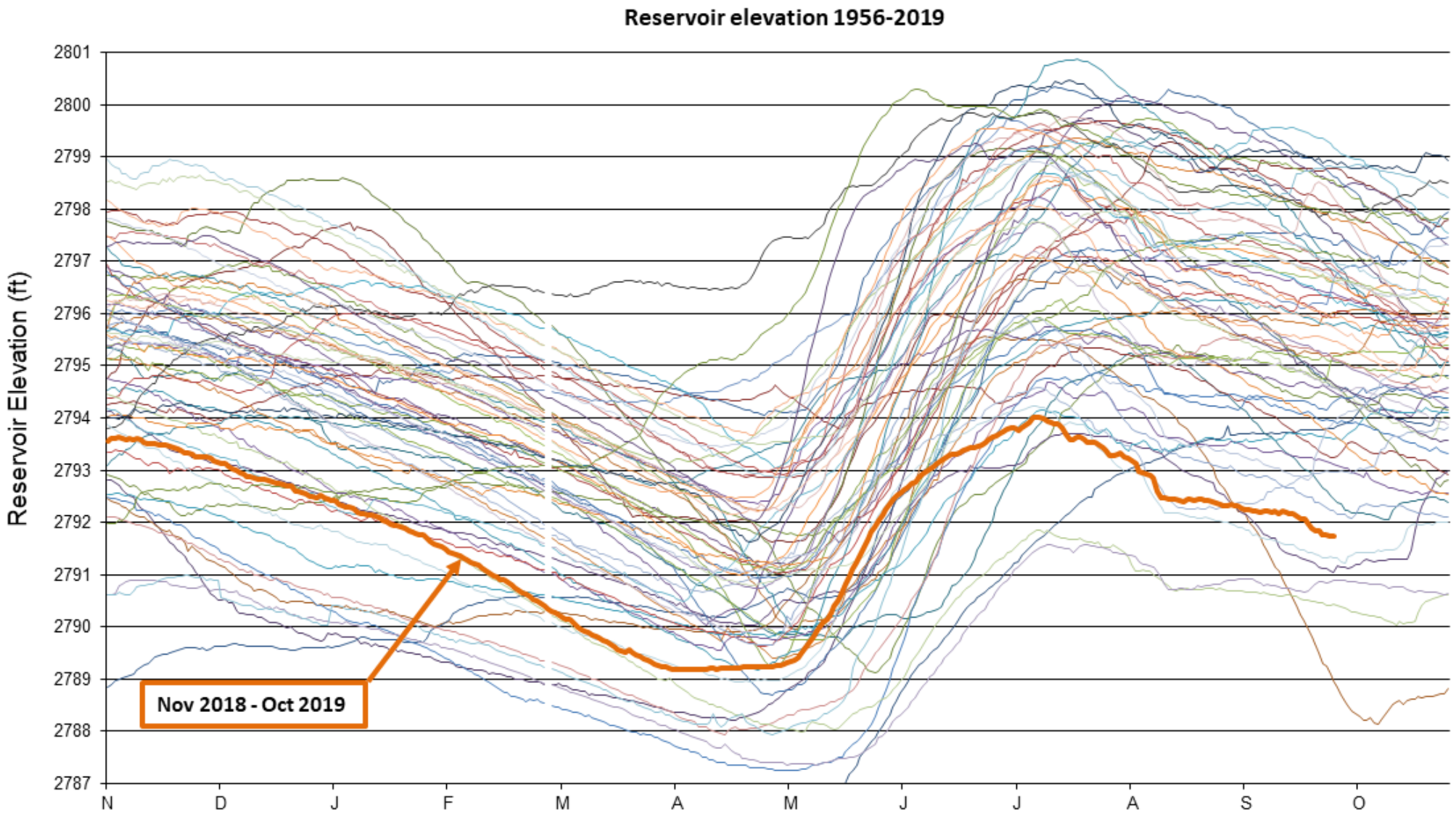
Designed for maximum water storage of 23,850 cubic-hectometres of which 7,100 is live storage.

- Live storage minimum equates to 2770 feet elevation
- Minimum water level to meet requirement for STMP flows is 2779 feet

Practical minimum water level is 2786 feet.

- Restriction at Tahtsa Narrows interferes with water delivery to the intake to Kemano

Nechako Reservoir Hydrograph



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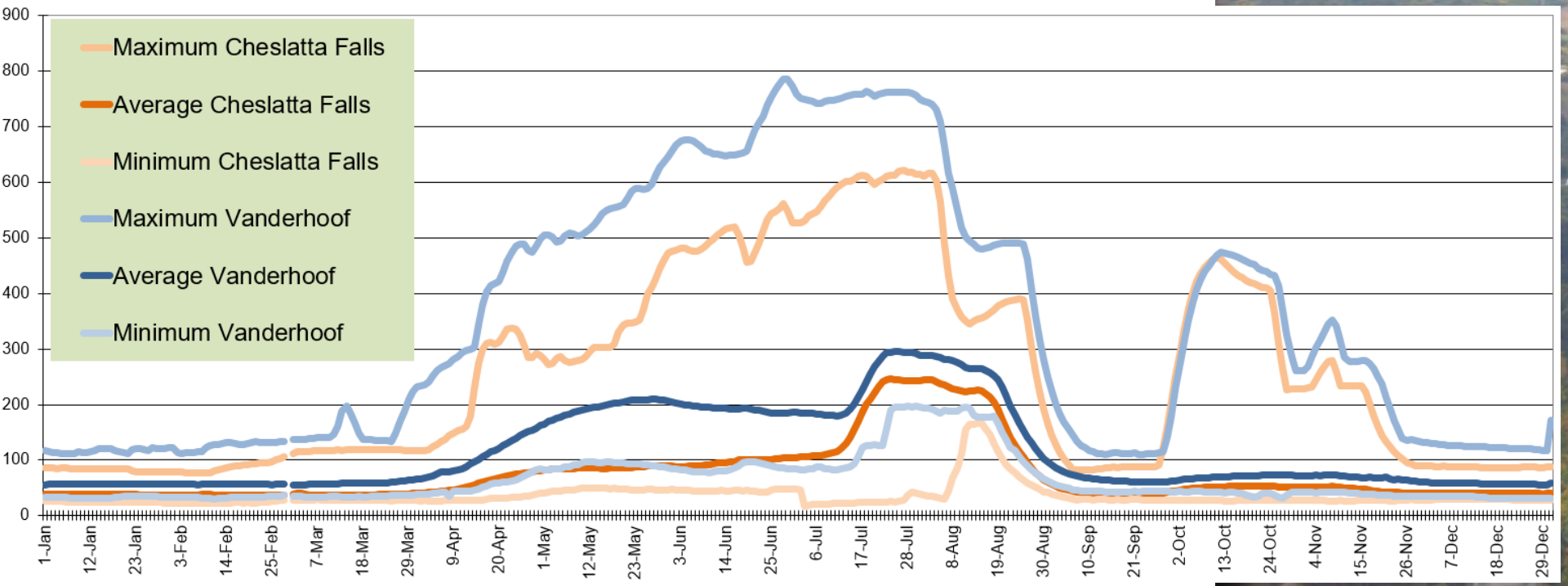
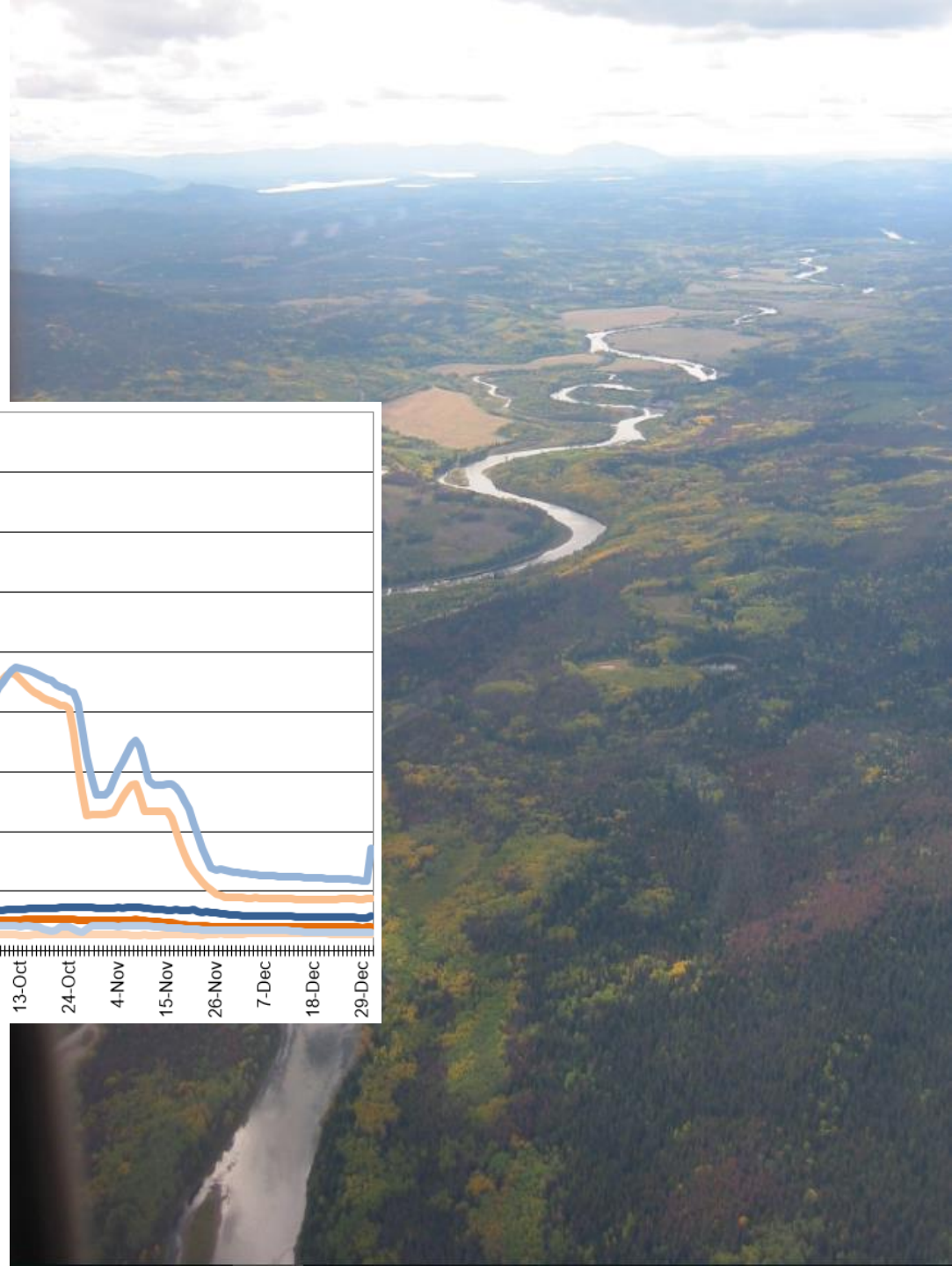
Nechako River Hydrograph





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Skins Lake Spillway

Normal maximum = 453.1 m^3/s, 2 gates, 2.5 m open

Normal minimum 14.2 m^3/s, 1 gate, 0.14 m open

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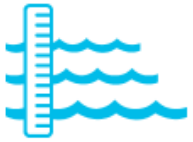
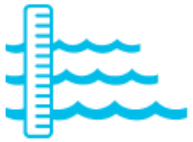
Nechako River Hydrograph Objectives

INTEREST	MITIGATION	IMPACT/BENEFIT
 Sockeye salmon	Maximum and minimum flow targets in July-Aug	• Reduces water temperature • Increase flow to near historic level • Flooding in low lying areas
 Chinook salmon	Minimum and maximum flow targets	• Enhances habitat availability
 Cheslatta watershed - flood	Maximum flow target	• Protects aboriginal burial grounds • Reduced erosion • Increase total flood risk in some scenarios
 Nechako River - flood	Maximum flow targets	• Protects agricultural/residential land from some floods • Increases flood risk in extreme floods

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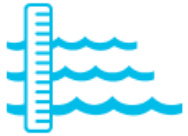
Nechako River Hydrograph Objectives

INTEREST	MITIGATION	IMPACT/BENEFIT
 Reservoir area - flood	Do not exceed maximum reservoir operating level	• Reduce erosion • Avoid flooding in reservoir, • Reduced risk of catastrophic flooding
 Dam safety	Do not exceed maximum reservoir operating level	• Reduce erosion • Avoid flooding in reservoir • Protect dams and spillway • Reduce risk of catastrophic flooding
 Aquatic fur-bearers	Delay springtime flow increase until end of April	• Mimics normal spring conditions
 Ice jam - freeze up	Maximum flow target	• Tradeoff short term ice jam risk vs long term flood risk
 Ice jam - winter-spring	Limit rate of spillway increase	• Tradeoff short term ice jam risk vs long term flood risk

1987 Settlement Agreement Flows

Initially the NFCP TC followed Schedule C in the 1987 Settlement Agreement.

- Based on the results of field studies it was determined that the timing of the natural runoff that was assumed in Schedule C was in error.
- It was agreed that maintaining fixed spillway discharge and allowing natural runoff to shape the hydrograph was a better biological approach than attempting to manipulate spillway flows to flatten the hydrograph.

SCHEDULE OF SHORT TERM WATER RELEASES FOR NECHAKO RESERVOIR

	Column I Reservoir Release (mean monthly) m^3/s cfs	Column II Approximate Nechako River Flow below Cheslatta Falls measured at hydro-metric station no. 08JA017 (mean monthly) m^3/s cfs
Jan	29.2 (1031)	31.1 (1098)
Feb	29.3 (1035)	31.1 (1098)
Mar	29.4 (1038)	31.1 (1098)
Apr	54.6 (1928)	56.6 (2000)
May	47.2 (1667)	56.6 (2000)
Jun	40.9 (1444)	56.6 (2000)
Jul	45.6 (1610) *	56.6 (2000) *
Aug	50.4 (1780) *	56.6 (2000) *
Sep	27.6 (975)	31.1 (1098)
Oct	28.6 (1010)	31.1 (1098)
Nov	28.8 (1017)	31.1 (1098)
Dec	29.1 (1028)	31.1 (1098)
Annual Mean	36.8 (1300)	41.7 (1472)

* plus additional flows as are determined to be required for cooling purposes.

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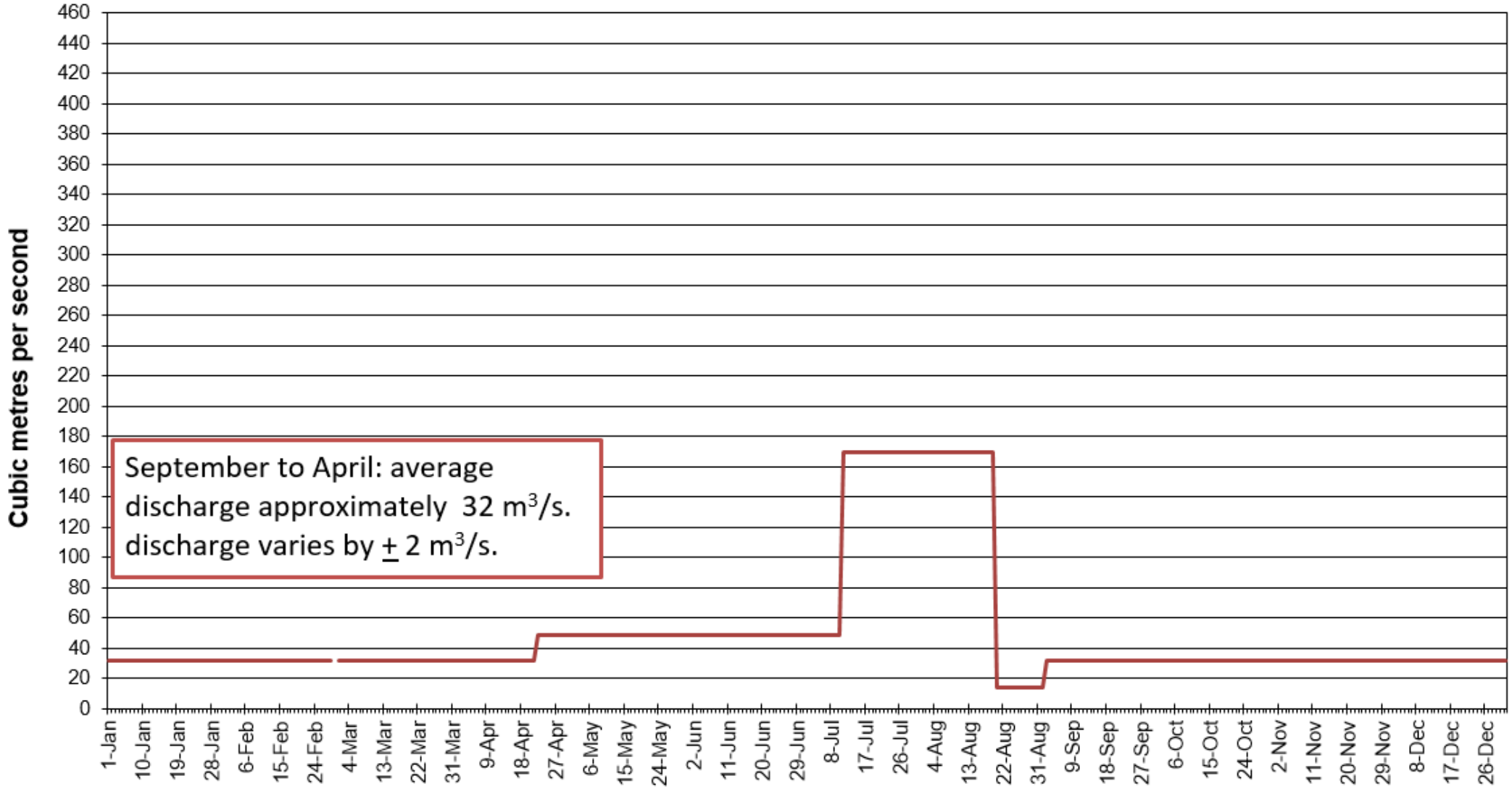
Spillway Hydrograph
Winter Flow



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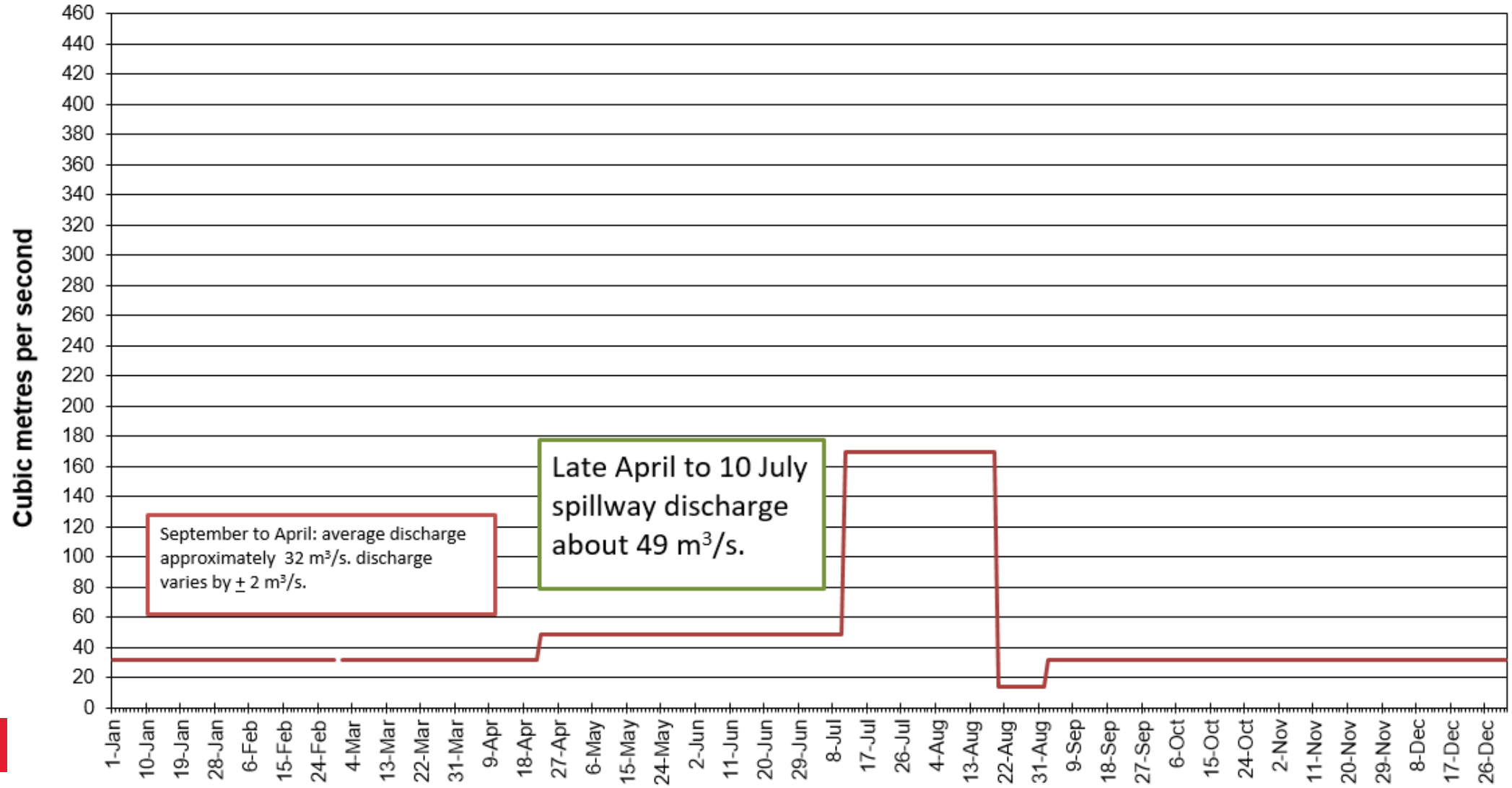
Spillway Hydrograph
Spring Flow



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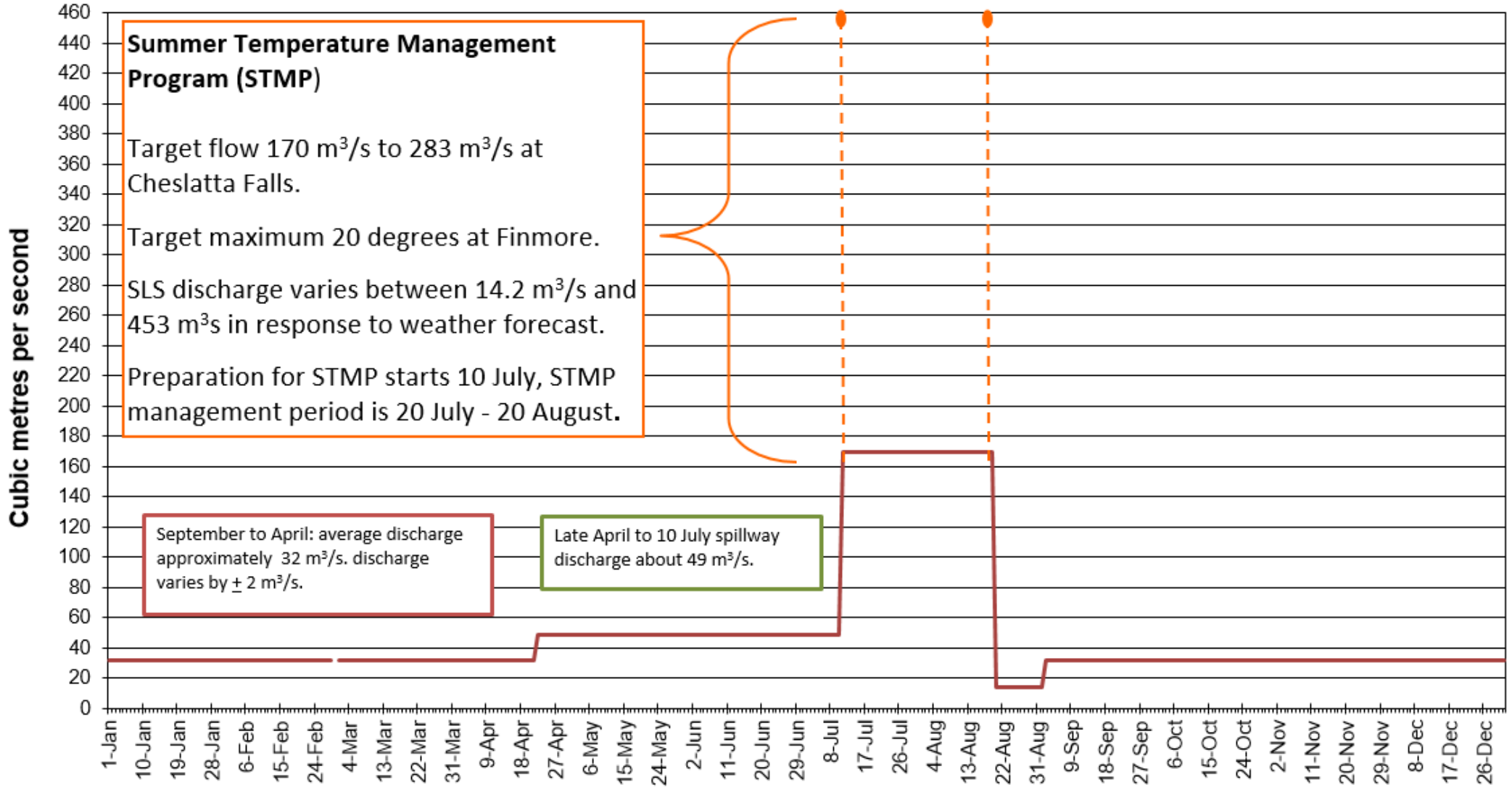
Spillway Hydrograph
Summer Temperature Management Program



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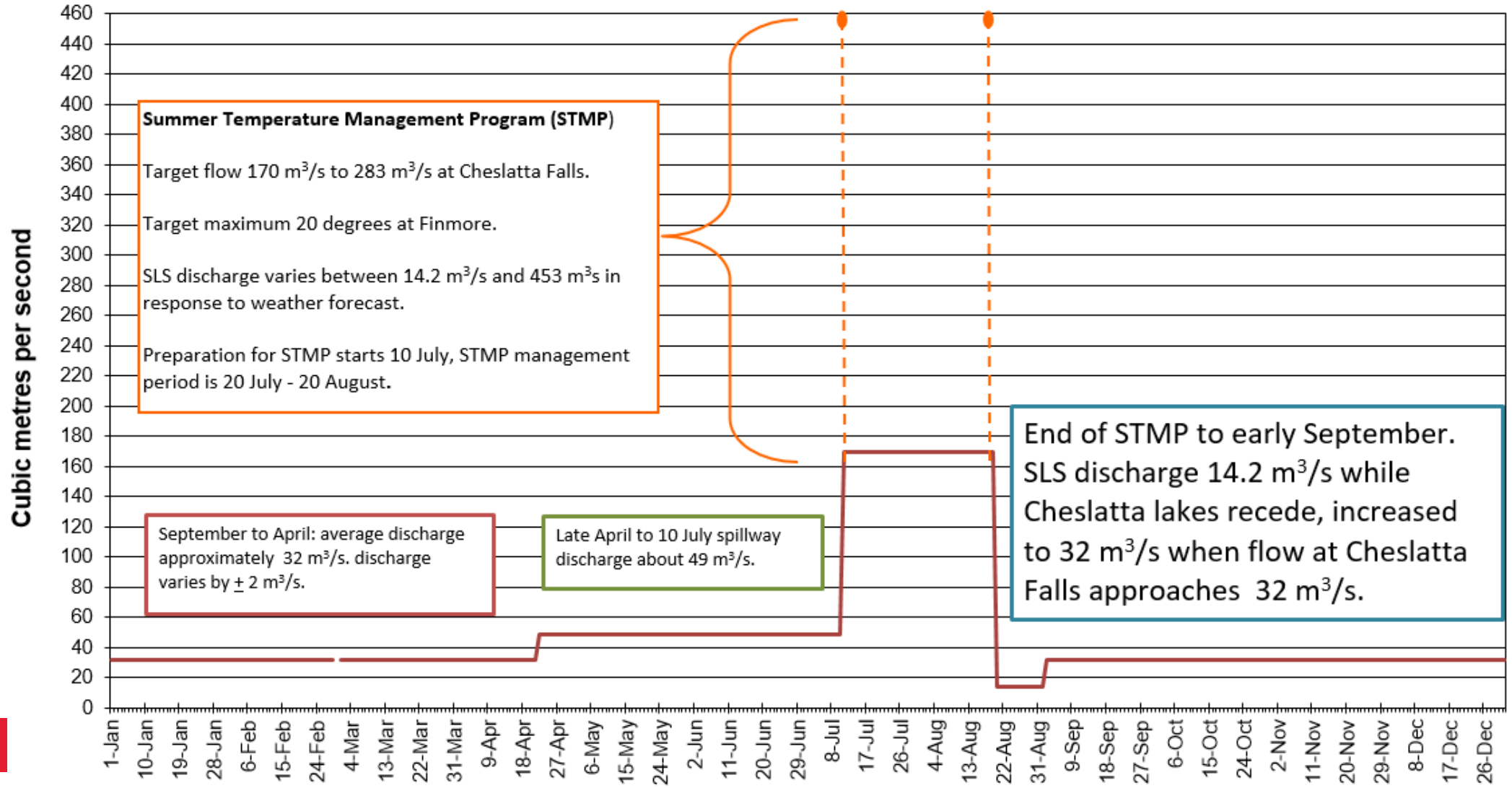
Spillway Hydrograph
Fall Flow



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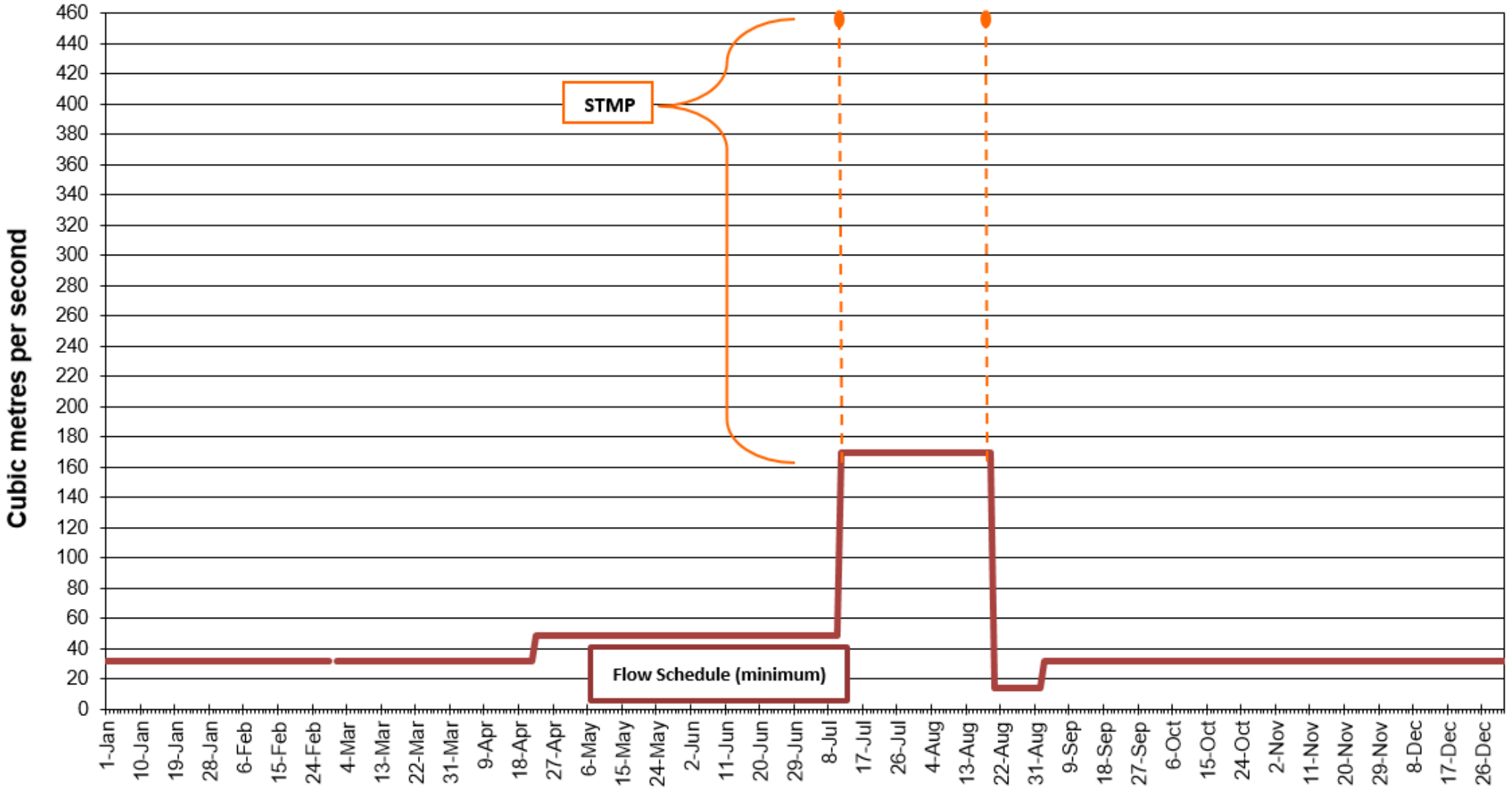
NFCP related flow guidelines



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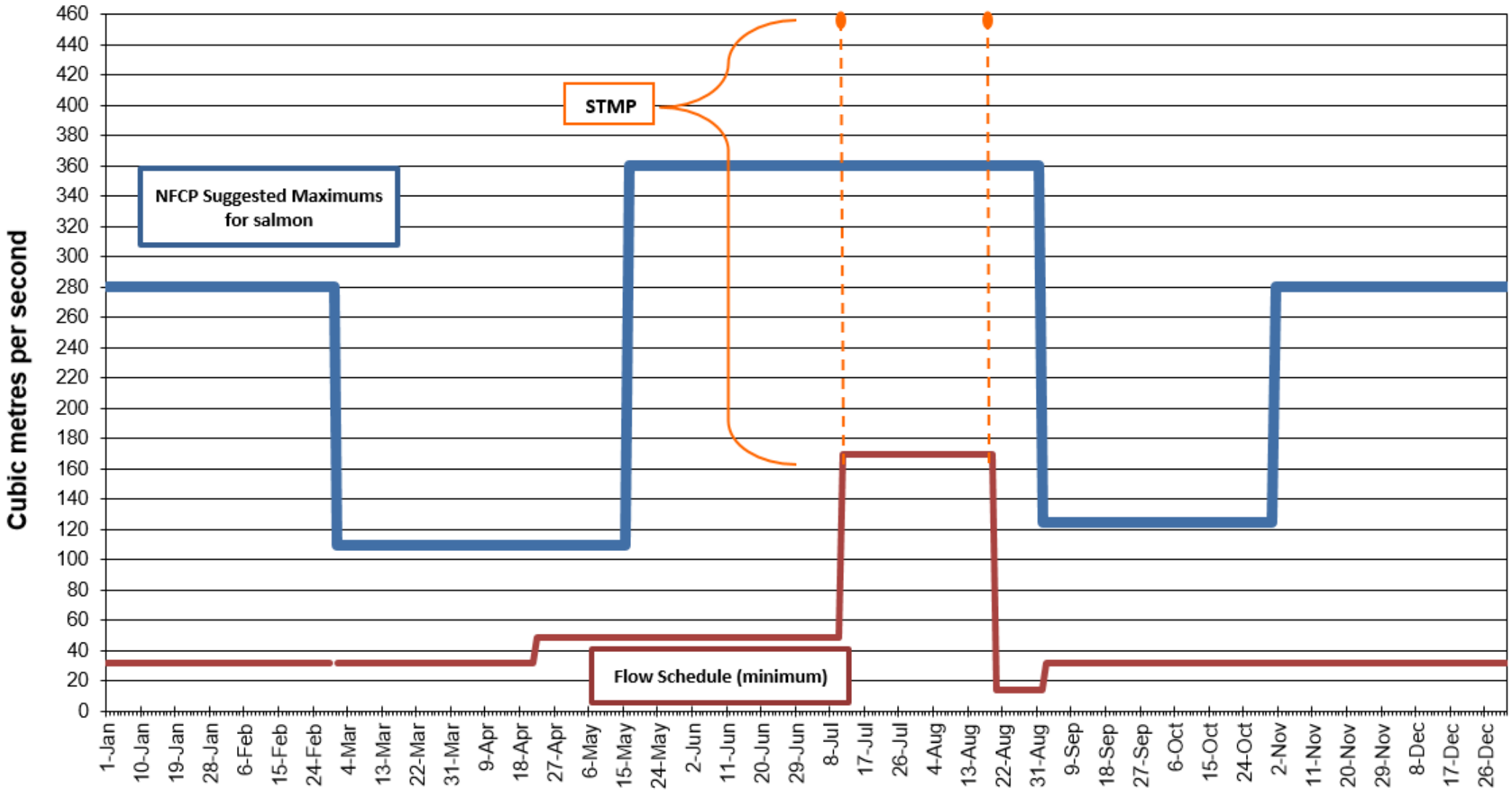
NFCP Flow related guidelines



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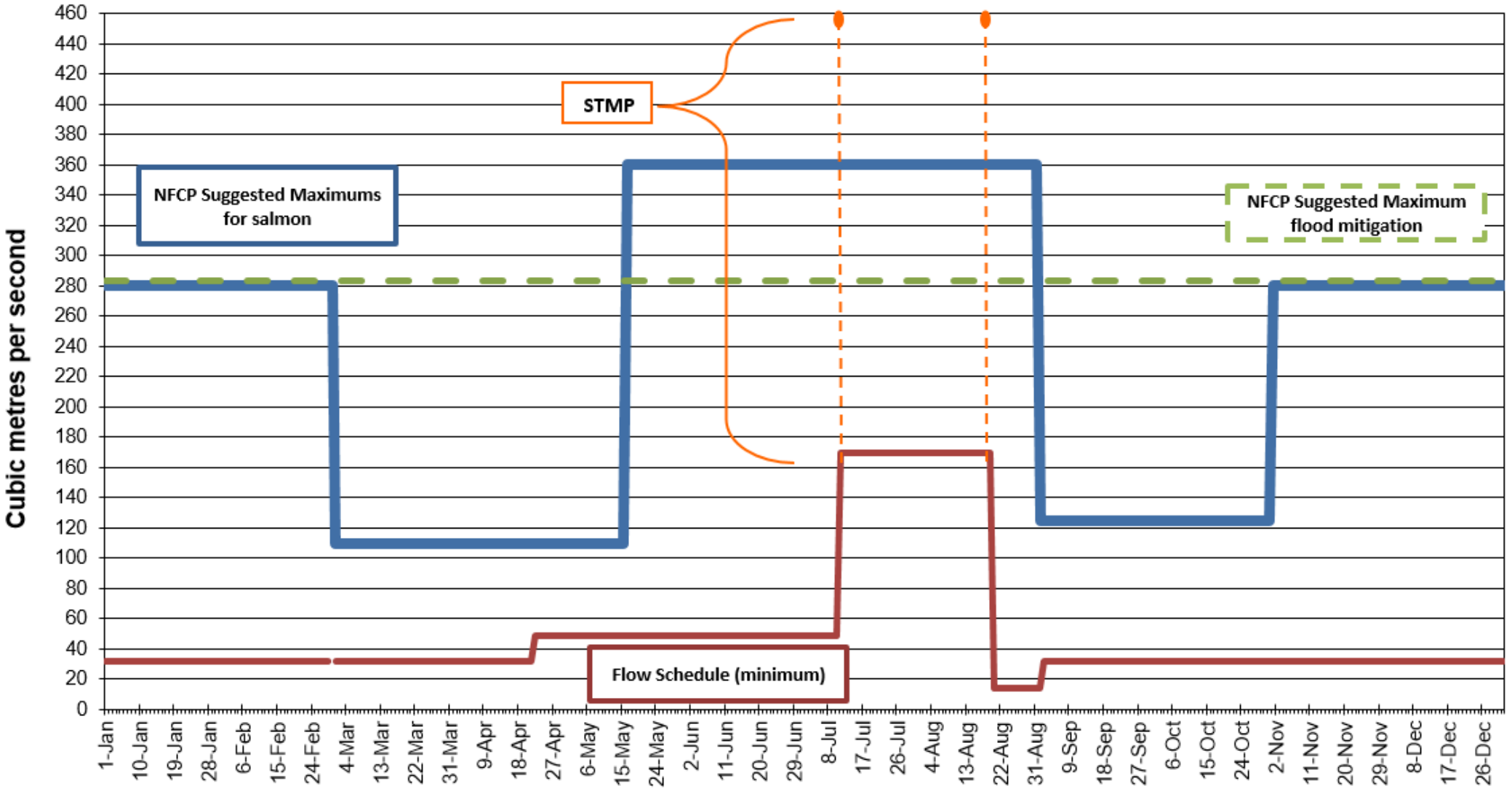
NFCP Flow related guidelines



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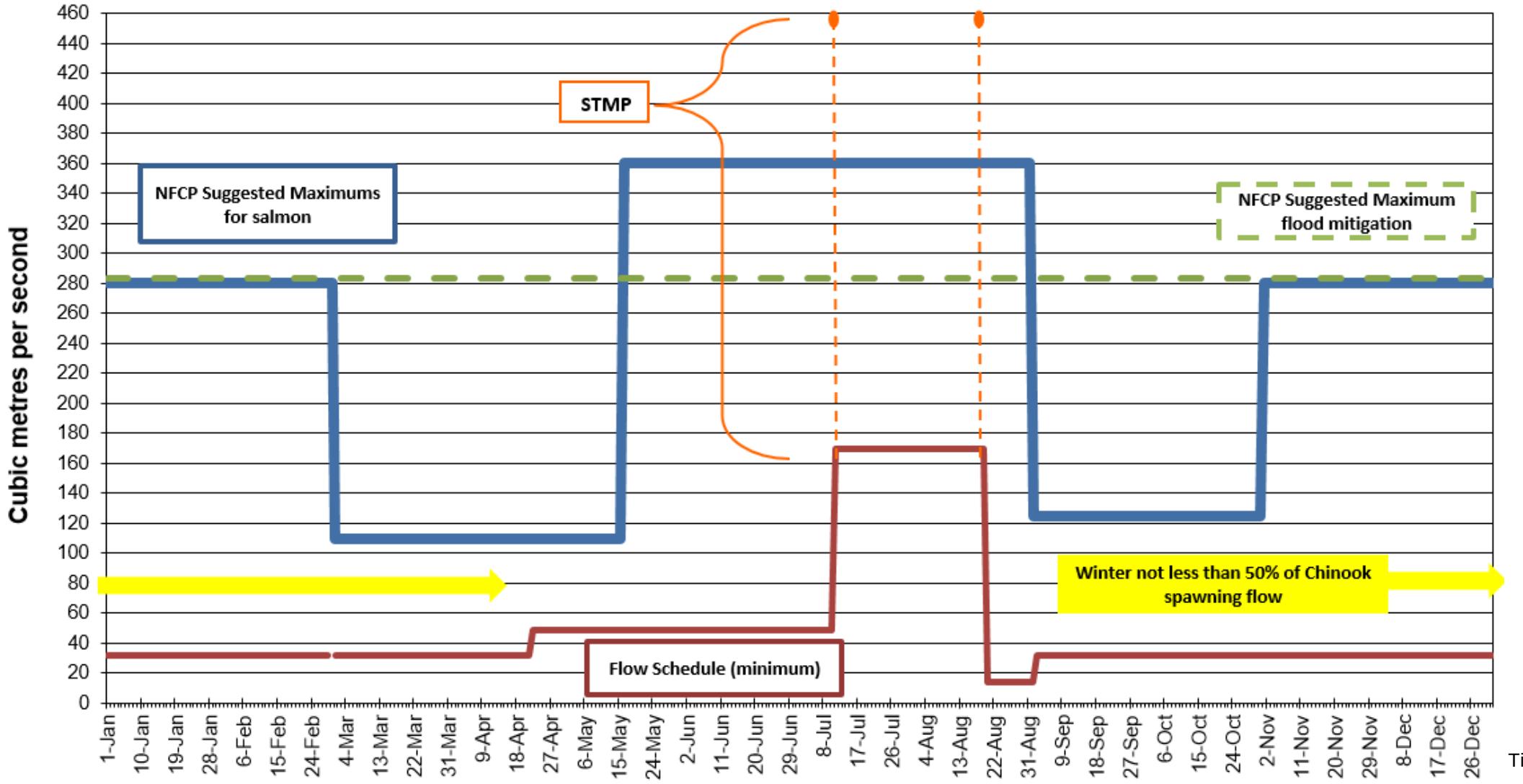
Flow related guidelines



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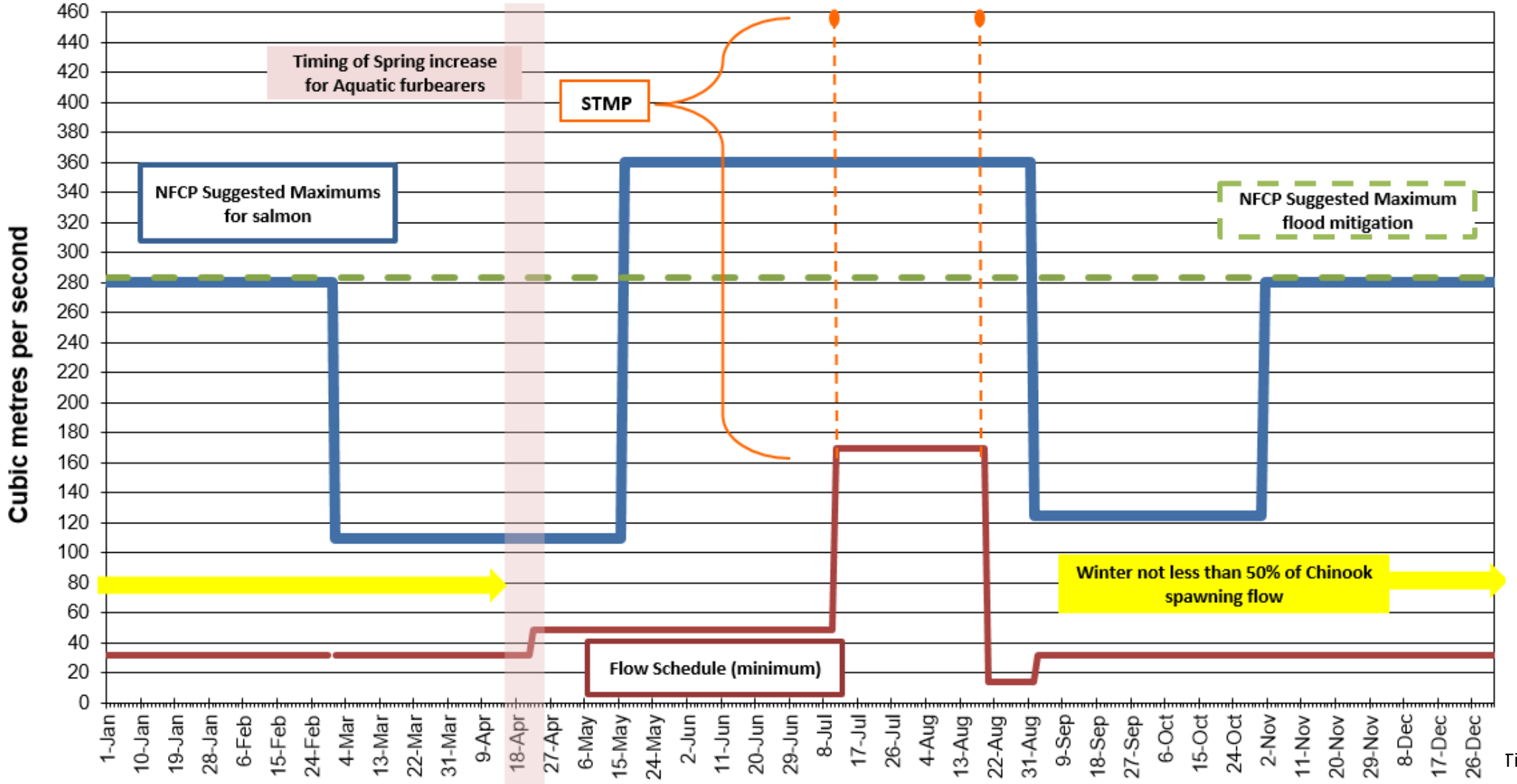
NFCP Flow related guidelines



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NECHAKO RESERVOIR
NFCP SUGGESTED MAXIMUM MONTHLY RELEASES

MONTH	Discharge m^3/s	RATIONALE	CONDITIONS/LIMITATIONS
September October	125 m^3/s	Defines maximum spawnable area	• Flows in excess of that value may result in reduction of prime habitats due to increases in depths and velocities. • Chinook spawning may occur in habitats of lesser quality.
November December January February	Up to 280 m^3/s	Winter flow levels above base flows will not negatively affect incubating/rearing chinook.	• Initiation to precede river ice formation. • Not to be less than 50% of September/October flow to avoid risk of exposing eggs to desiccation or freezing. • Not to exceed March and April maxima to avoid negative stage change and stranding of newly emergent fry. • Assess flow reduction risks as they relate to collapse of ice cover and scouring of substrate.
March April mid May	110 m^3/s	Limit at which margin velocities would start to displace emergent fry.	• Flow increases from base flows flood shoreline and gravel bar vegetation used by fry from early March until mid May. • Emergent fry habitat availability increases up to this discharge. • Once water levels reach bank full velocities increase to values that exceed swimming ability of newly emergent fry.
mid May June July August	• Upstream of Nautley River 360 m^3/s • Downstream of Nautley River 540 m^3/s	• Juvenile Chinook begin selecting habit associated with deeper and faster flows. • Fish actively migrating out of the river	• Limitation on flow amount based flooding along the Nechako River. • Maximum of 283 m^3/s later adopted based on International Pacific Salmon Fisheries Commission.

Flow related guidelines
Ramping Rates

Ramping is the rate of increase or decrease in discharge:

- There is no ramping procedure applied during the Summer Temperature Management Program
  - Discharge is changed from 14.2 m^3/s to 453.1 m^3/s within 1 hour.
- There is no ramping procedure applied during flood mitigation.
- Outside of the STMP and Flood mitigation (reservoir management, no immediate flood risk):
  - Change to spillway discharge at about 60 m^3/s per step.

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Flow Targets, non-NFCP
Flood mitigation

All Year:
Maximum of 330 m^3/s at Cheslatta Falls.
- Ancestral burial grounds along Cheslatta Lake begin flooding

Maximum 550 m^3/s in the Nechako River at Vanderhoof
- Considered bank full flows – flooding of low lying areas begins at about 500 m^3/s

During freeze-up
Maximum of 100 m^3/s in the Nechako River at Vanderhoof
- Ice jam formation above this level has caused flooding of homes

After freeze-up
Not more than 15 m^3/s increase in discharge per step.
- Based on ice stability assessment. avoid causing ice break up and ice jam formation
- Balance risk of ice jam vs flood risk in spring
- Exceeds the NFCP suggestion of 10% maximum increase after freeze up

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Questions?