



# Water Management and Reservoir Operating Plan- Bluefish

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# 1 MAP

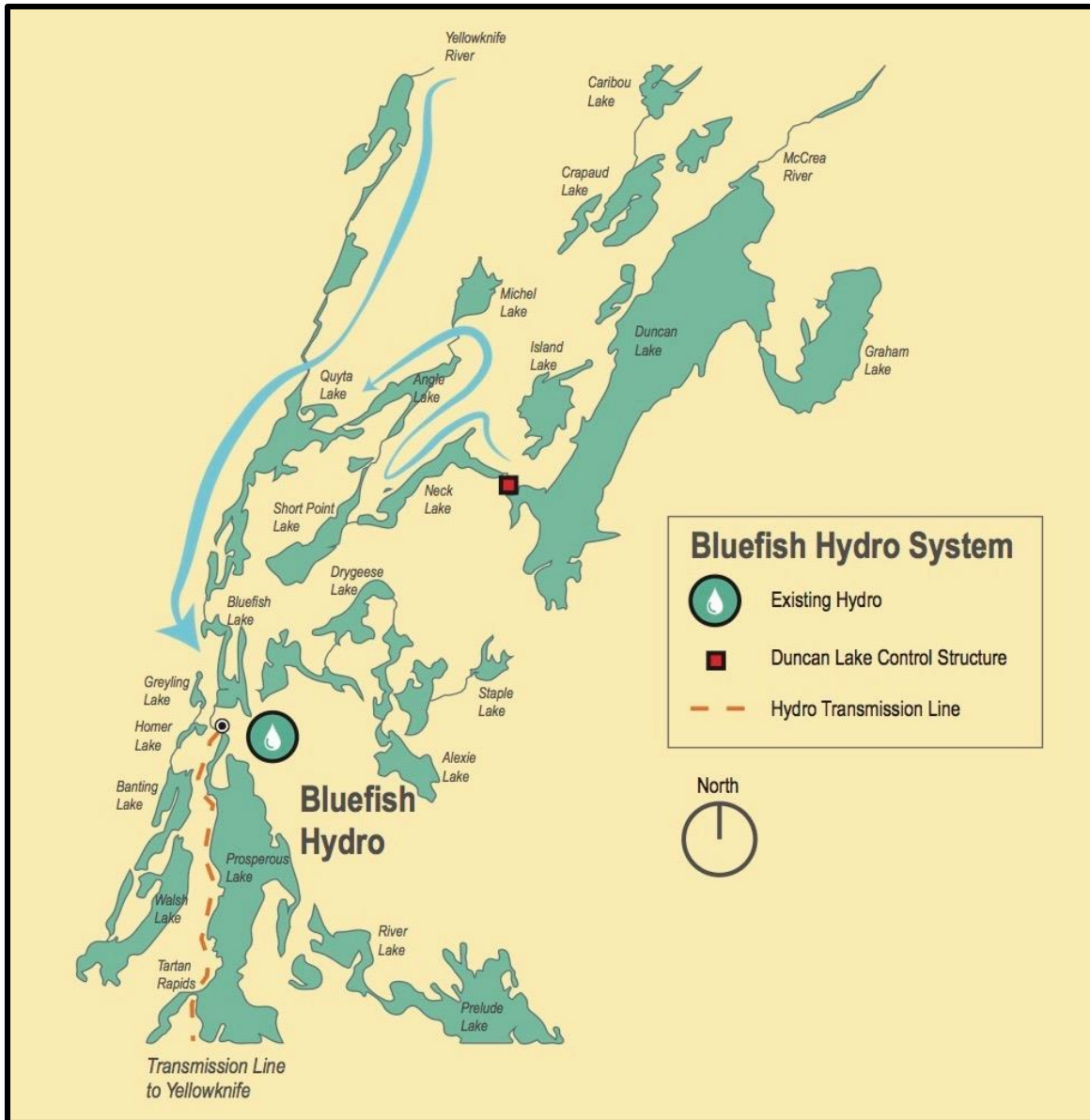


Figure 1: Map of Bluefish Hydro System Area

## 2 SUMMARY

Snow survey results of the Yellowknife basin in early April were 69% of average. The model using this data suggests peak flows of only 23.2 m<sup>3</sup>/s, very low and similar to 1962. Actual inflows and an Indin River peak of 34.8 m<sup>3</sup>/s suggest a flow pattern closer to 1993 from the hydrograph templates for natural flow of the Yellowknife River, or 2004 when the contribution of the Duncan reservoir is included. NTPC expects Bluefish operations to be above average during winter months.

The spillway at Duncan Lake was partially closed throughout 2019, with a minimum stop log height of 210.314 m following the removal of two logs on January 8. The spillway remained at this elevation until May 13, when logs were replaced to raise it to 211.527 m. The Duncan Lake reservoir continued to build throughout the summer, and an additional stop log was placed on September 20 to bring the spillway elevation to 212.5 m. At this time, the water level in Duncan Lake was 212.509 m so a small amount of spill continued. Water levels in Duncan Lake continued to rise, increasing outflow over the top stop log during the remainder of 2019. As of December 31, the water level in Duncan Lake is 212.821 m. The spillway will be opened if necessary to provide flow to Bluefish hydro for the remaining winter months, however, natural flows at these water levels are currently sufficient to support full output from the Bluefish hydro plants.

The Bluefish fore bay level is presently in the top range of the operating level and will be operated to remain near there to have reserve capacity in the event of temporary issues arising at Snare Hydro.

### 3 ENERGY FORECAST

Forecast and actual energy production (GWh) for the months of July 2019 through June 2020 are shown in Table 1 and Figure 2.

Table 1: Bluefish Hydro Production (GWh)

	JUN-19 FORECAST	ACTUAL LOAD	DEC-19 FORECAST
JUL-19	2.60	4.07	
AUG-19	2.98	3.60	
SEP-19	4.32	4.01	
OCT-19	2.98	4.08	
NOV-19	2.02	3.77	
DEC-19	1.49	4.59	4.59
JAN-20			2.75
FEB-20			2.50
MAR-20			2.03
APR-20			1.87
MAY-20			1.61
JUN-20			2.00

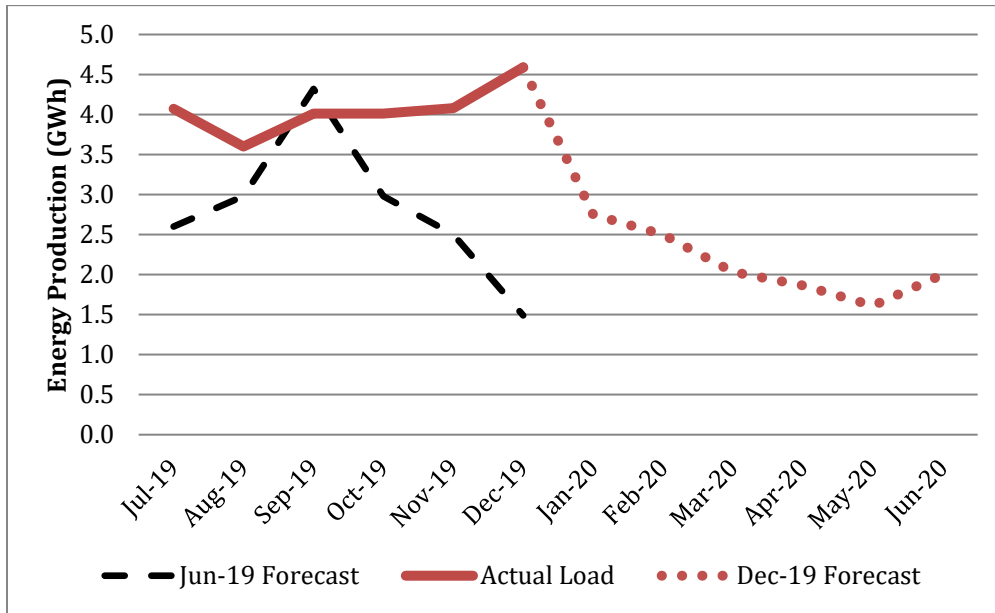


Figure 2: Bluefish Hydro Actual and Forecast Output (GWh)

## 4 REVIEW OF PREVIOUS OPERATING PLAN

Forecast and actual inflow and outflow in cubic meters per second for the months of July 2019 through June 2020 are shown in Table 2 and Figure 3.

Table 2: Bluefish Hydro Actual and Forecast Water Flow (m<sup>3</sup>/s)

	YELLOWKNIFE RIVER			DUNCAN LAKE		
	Jun-19 Forecast Inflow	Actual Inflow	Dec-19 Forecast Inflow	Jun-19 Forecast Outflow	Actual Outflow	Dec-19 Forecast Outflow
JUL-19	8.9	11.7		0.0	1.2	
AUG-19	8.0	11.5		0.0	4.4	
SEP-19	8.0	10.0		0.0	4.5	
OCT-19	8.1	10.0		0.0	1.6	
NOV-19	15.0	14.6		0.0	0.8	
DEC-19	14.5	30.4	14.5	0.0	3.1	0
JAN-20			12.2			0
FEB-20			10.5			0
MAR-20			10.0			0
APR-20			9.0			0
MAY-20			11.4			0
JUN-20			11.0			0

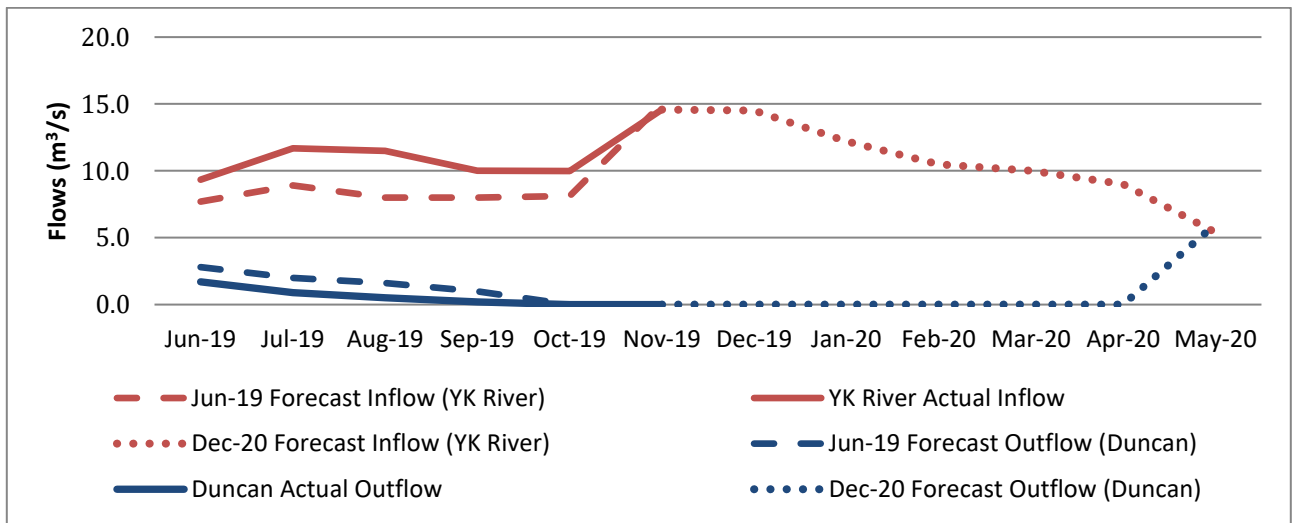


Figure 3: Bluefish Hydro Forecast and Actual Water Flow (m<sup>3</sup>/s)

Forecast and actual reservoir levels in meters of elevation above sea level for the months of July 2018 through June 2019 are shown in Table 3 and Figure 4.

Table 3: Bluefish Lake Reservoir - Forebay Levels (m)

	JUN-19 FORECAST	ACTUAL ELEVATION	DEC-19 FORECAST
JUL-19	185.1		
AUG-19	184.9		
SEP-19	184.7		
OCT-19	184.8		
NOV-19	185.0		
DEC-19	185.5	185.8	185.8
JAN-20			185.9
FEB-20			185.9
MAR-20			185.8
APR-20			185.7
MAY-20			185.7
JUN-20			185.7

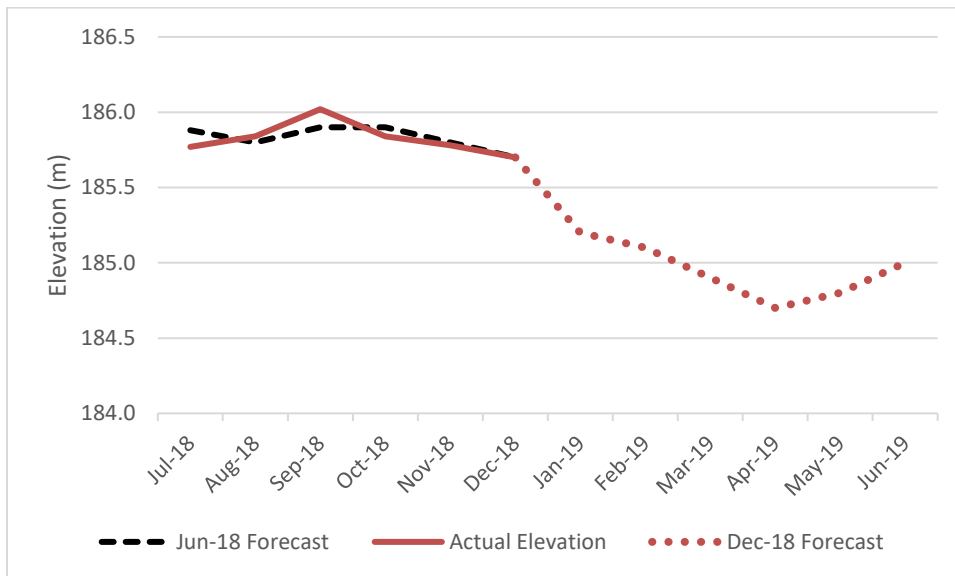


Figure 4: Bluefish Lake Reservoir - Forebay Levels (m)



## 5 INDICATORS

### 5.1 Flows and Trends

Figure 5 illustrates annual flows and trends for the Yellowknife River at Bluefish and the Cameron River at Reid Lake. 1962 provided a suitable forecast template for the first six months of 2018, with the second half of the year following more closely with 2014. The historical peak year (1992) and 30-year average trend lines are provided for reference purposes.

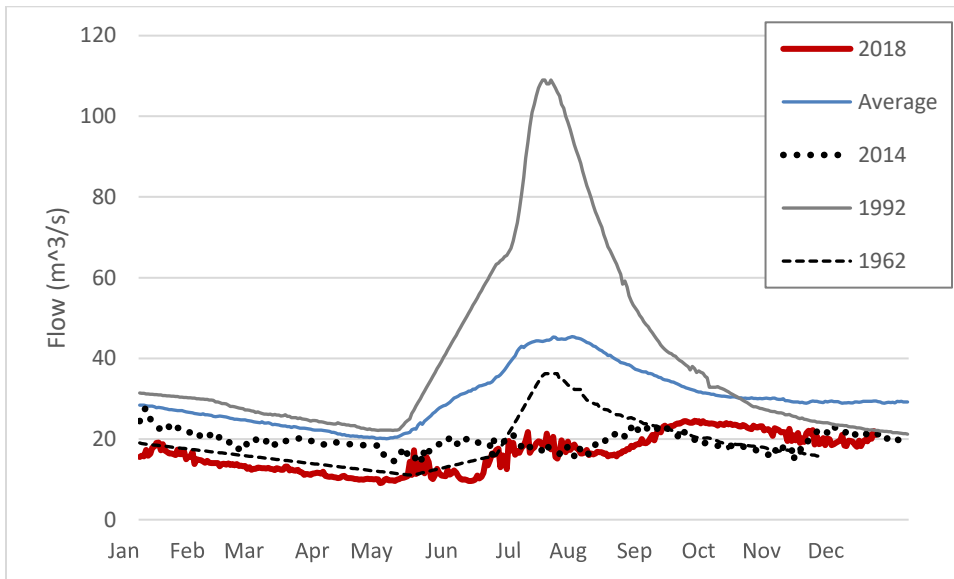


Figure 5: Annual Flow Trends - Yellowknife River at Bluefish

## 5.2 Precipitation

Table 4 shows the 2019 and historical normal monthly precipitation at Yellowknife. Total precipitation throughout 2019 was on par with normal historical values.

Table 4: Yellowknife Precipitation<sup>1</sup>

MONTH	NORMAL PRECIPITATION (MM)	2019 PRECIPITATION (MM)
JAN	14.3	17.9
FEB	14.1	2.2
MAR	13.9	1.4
APR	11.3	22
MAY	18.4	16.2
JUN	28.9	49.4
JUL	40.8	33.6
AUG	39.3	51.7
SEP	36.3	41.5
OCT	30.3	19.7
NOV	24.8	20.5
DEC	16.2	10.2
<b>TOTAL</b>	<b>288.6</b>	<b>286.3</b>

## 5.3 Snow Survey

Results of the April 03, 2018 Snow Survey are summarized in Table 5.

Table 5: Snow Survey Results (Snow Water Equivalent mm)

	2019 SWE (MM)	AVERAGE SWE (MM)	YEARS OF RECORD	PERCENT OF AVERAGE
ALAN LAKE	59.5	87.3	31	68%
BLUEFISH HYDRO (ADDED 2019)	60.5	80.8	24	75%
DENIS LAKE	80.5	108.6	32	74%
JOLLY LAKE	102.0	138.4	7	74%
LITTLE LATHAM LAKE	65.0	97.6	32	67%
NARDIN LAKE	75.5	107.3	32	72%
SHARPLES LAKE EAST	74.0	107.3	32	69%
TIBBITT LAKE	38.5	84.2	37	62%
<b>AVERAGE</b>	<b>69.4</b>	<b>101.2</b>		<b>69%</b>

<sup>1</sup> Precipitation data from Environment Canada <https://weather.gc.ca/> retrieved 2019-12-19

## 5.4 Expected Inflows

The Runoff Forecasting Model results for 2018 using the snow water equivalent in the Yellowknife River basin suggested a low water year similar to 1962.

### 5.4.1 May Yellowknife River Forecast

Snow Survey Basin *SWE*

69.4

**SWE > 80**       $Q_{max} = 0.0137*SWE^2 - 0.789*SWE + 2.2$       **13.0**

SWE < 80       $Q_{max} = 0.336*SWE$       23.2

Forecast Peak Flow =

23.3 m<sup>3</sup>/s

mean date Julian 195 (July 14)

Template Year

1962

Peak Flow =

38.0 m<sup>3</sup>/s

The McCrea River peak inflow, based on the 2019 Indin River Peak of 34.8 m<sup>3</sup>/s, is estimated to be 12.9 m<sup>3</sup>/s.

### JUNE McCREA RIVER FORECAST

$$Q_{max} = 0.469*Q_{indin} - 3.4$$

Indin Peak      34.8 m<sup>3</sup>/s

McCrea

12.9 m<sup>3</sup>/s

24.0

lag past Indin = July 22

Note: McCrea River Inflows can also be crudely estimated as 1.07 Cameron River Flows

Cameron River (07SB010)

2.85 m<sup>3</sup>/s

18-06-27

McCrea River estimation

3.05 m<sup>3</sup>/s

## 5.5 Forecast Water Flows and Levels

### 5.5.1 Reservoirs

The following table summarizes the expected flows for the Yellowknife River, McCrea River and Duncan Lake outflow and Duncan Lake reservoir level for the next six months.

Table 6: Forecast Flows and Levels

MONTH	MCCREA RIVER (M <sup>3</sup> /S)	DUNCAN OUTFLOW (M <sup>3</sup> /S)	RESERVOIR WATER LEVEL (M)	YELLOWKNIFE RIVER (M <sup>3</sup> /S)
JULY	8.5	0.0	211.59	21.9
AUG	7.0	0.0	211.85	32.6
SEPT	6.0	0.0	212.08	45.0
OCT	9.5	0.0	212.44	43.0
NOV	7.0	1.3	212.65	40.0
DEC	6.0	14.9	212.31	39.0

### 5.5.2 Water Use Efficiencies

The following table summarizes the expected GWh to m<sup>3</sup>/s flow from the Yellowknife River and the Duncan Lake reservoir.

Table 7: Generation & Forecast Efficiencies

MONTH	YELLOWKNIFE RIVER (M <sup>3</sup> /S)	DUNCAN OUTFLOW (M <sup>3</sup> /S)	PLANT FLOW (M <sup>3</sup> /S)	SPILL (M <sup>3</sup> /S)	ENERGY (GWH)
JULY	21.9	0.0	21.9	0.0	3.72
AUG	32.6	0.0	32.6	0.0	4.46
SEPT	45.0	0.0	45.0	0.0	4.32
OCT	43.0	0.0	43.0	0.0	4.46
NOV	38.7	1.3	40.0	0.0	4.32
DEC	24.1	14.9	39.0	0.0	4.46

Notes:

- Plant Flow Capacity = 26.5 m<sup>3</sup>/s
- Gross Head = 33.0 m
- Hydraulic Efficiency = 98%
- Turbine Efficiency = 86%
- Generator Efficiency = 97%
- Overall Efficiency = 82%

## 6 ACTUALS EXAMPLE

A comparison of actual to forecast outflows at Bluefish in 2019 and other recent years is shown in Figure 6. The high amount of rain during the summer months caused a significant increase in outflow compared to forecast over the second half of 2018.

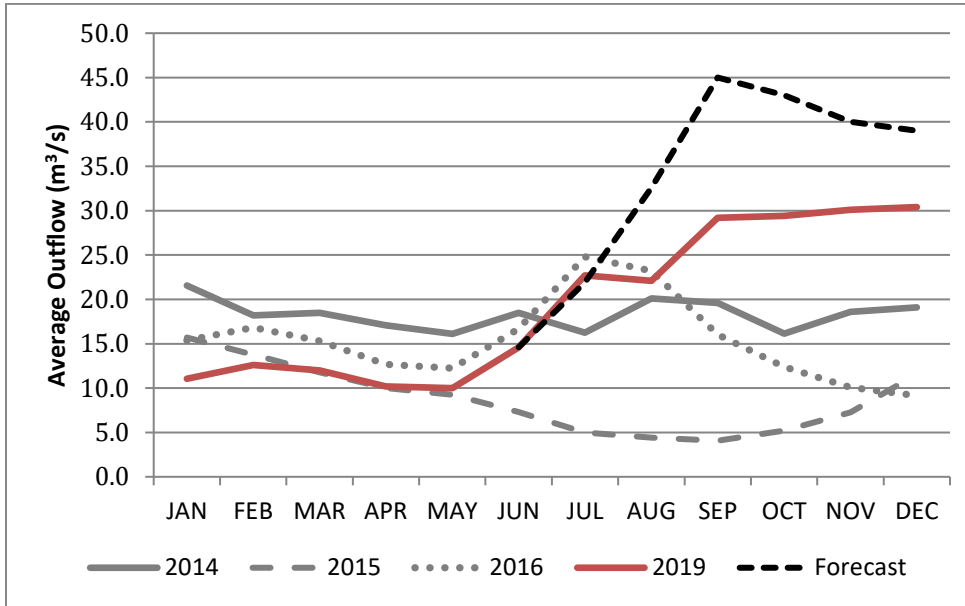


Figure 6: Actual and Forecast Flows

## 7 COMMENTARY ON OPERATIONS AND COMPLIANCE

The Bluefish Hydro facilities were operated within compliance of the water license throughout the previous six months.

## 8 COMMENTARY ON REPORTS AND INSPECTIONS