Water Use, Hydrology Modelling, Communication

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Water Use, Hydrology Modelling, and Communication

BC Oil & Gas COMMISSION

Topics

- Water Use
- Hydrologic Modelling for North-East BC
- Strategic Water Analysis
- Questions

Role of the Oil and Gas Commission

3

Regulate All Oil and Gas Activities in BC:

- Geophysical exploration;
- Wells and wellsite facilities;
- Pipeline systems;
- Gas processing plants;
- Liquefied natural gas plants;

- **Water Use.**
  - Seismic Exploration
  - Road and well pad construction
  - Drilling
  - Transportation/pipelines
  - **Hydraulic fracturing**

Independent regulator

Single window

Exploration, Development

Pipelines, Reclamation

How Much Water is Used for Hydraulic Fracturing?

Water demands vary with geology of target formation

- 500 to 5,000 m^3 of water per stimulation stage
- Generally 10-20+ frac stages per well, 18-36 wells per pad

- Montney play – 8,000 to 30,000 m^3/well (70,000-250,000 barrels)
- Horn River Basin – 30,000 to 100,000 m^3/well (250,000-850,000 barrels)

$\therefore$ 90,000 – 1,000,000+ m^3 per well pad (9 million barrels)

Used over 2-3 months

Water Sources

Surface Water	• Freshwater • Lakes, streams, rivers • Dugouts	65%
Shallow Groundwater (0-200m)	• Unconfined or confined aquifers • Variable water quality, but often fresh	10%
Deep Groundwater (>800m)	• Disconnected from surface water • Often saline • Can require treatment	10%
Flowback Fluid Other	• Saline • Variable quality • Can require treatment	15%

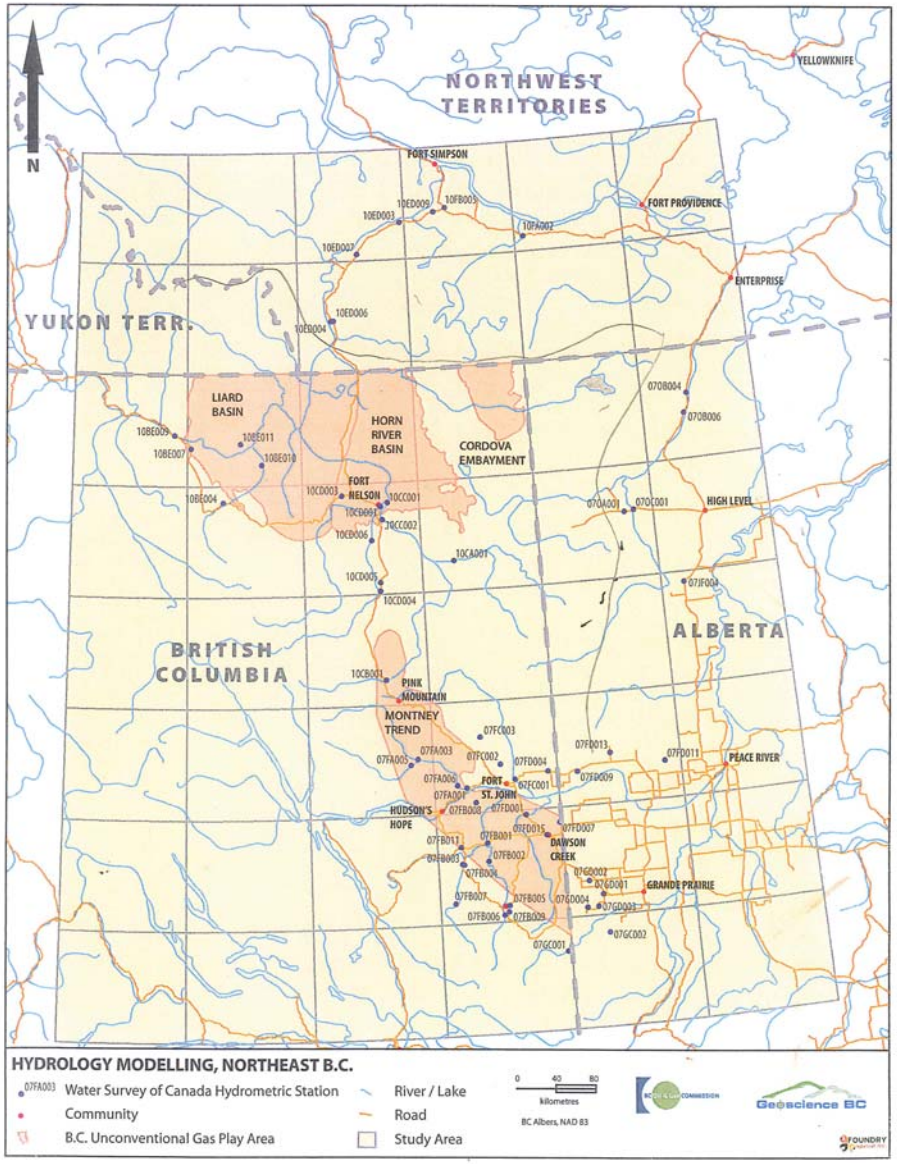
NorthEast BC Hydrology Modelling Project

Hydraulic Fracturing needs large volumes of surface water

"State of the knowledge" information on water supply in Northeast BC is needed:

Objective is to produce the best representation of the surface hydrology of NEBC as possible, based on existing data:

- To inform decisions
- To communicate supply and demand



Modelling Concept

Simple mass balance water budget, based on Continuity Equation:

$$Q = P - Et$$

where:

Q = Annual Runoff (mm)

P = Annual Precipitation

Et = Annual Evapotranspiration

Basic Data and Approach

Used most comprehensive spatial data available:

- **Precipitation Data** - Represents 30-year "Climate Normal" period.
- **Evapotranspiration** - Et is adjusted to vegetation and land cover type
- **Vegetation and Land Cover Data**
- **Stream Flow** Data:
  - The model is calibrated and validated against measured stream flow data.
  - About 45 gauges used, natural flow, generally >10 years of record
- **Statistical Adjustment**
  - Employed a multivariate linear regression model to remove some modelling error.

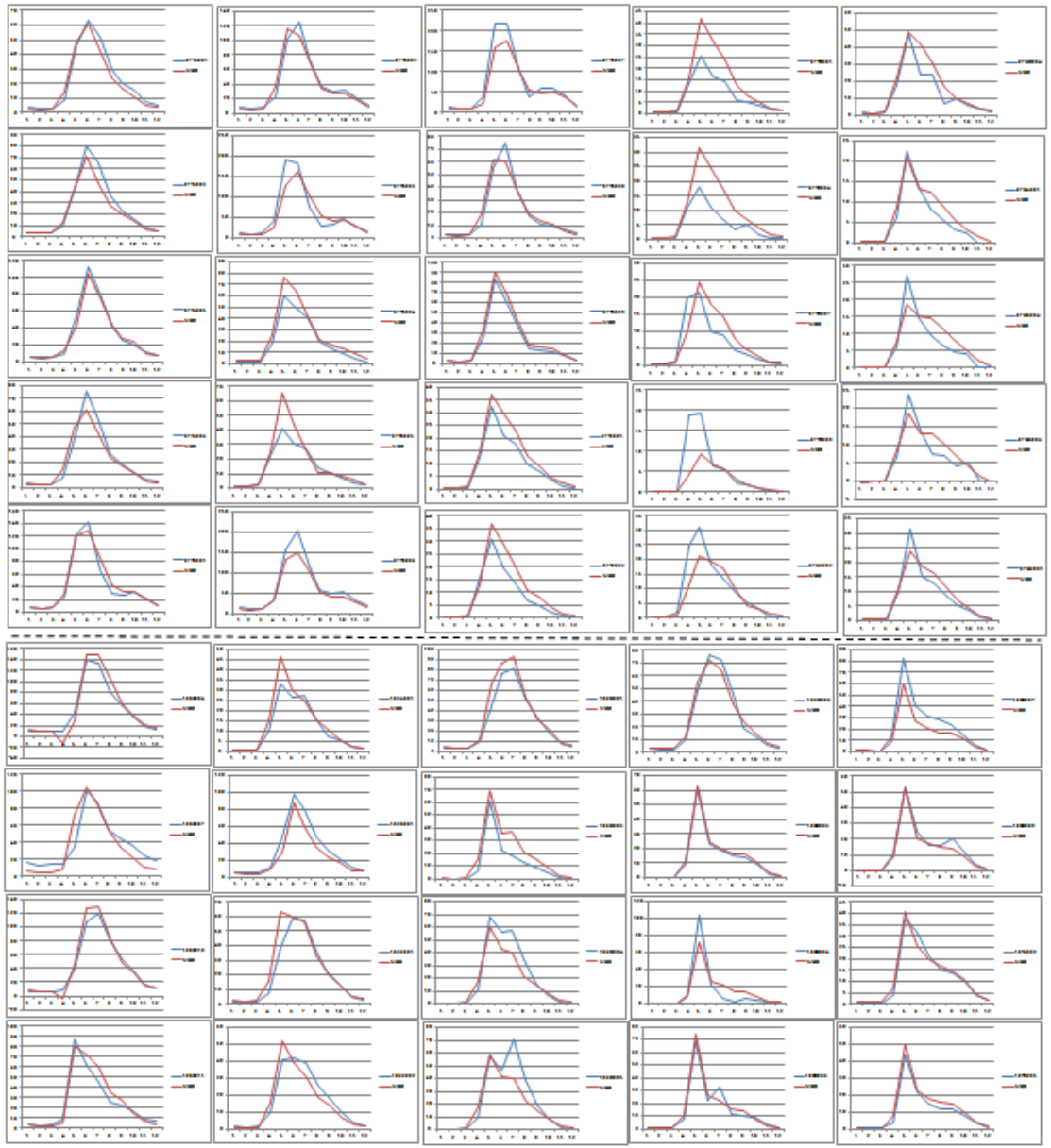
Calibration to Stream Flow Gauges

Calibrated to about 45 Water Survey of Canada streamflow gauges

Synthetic hydrographs have very good fit with measured data.

---------- observed flow

---------- modelled flow

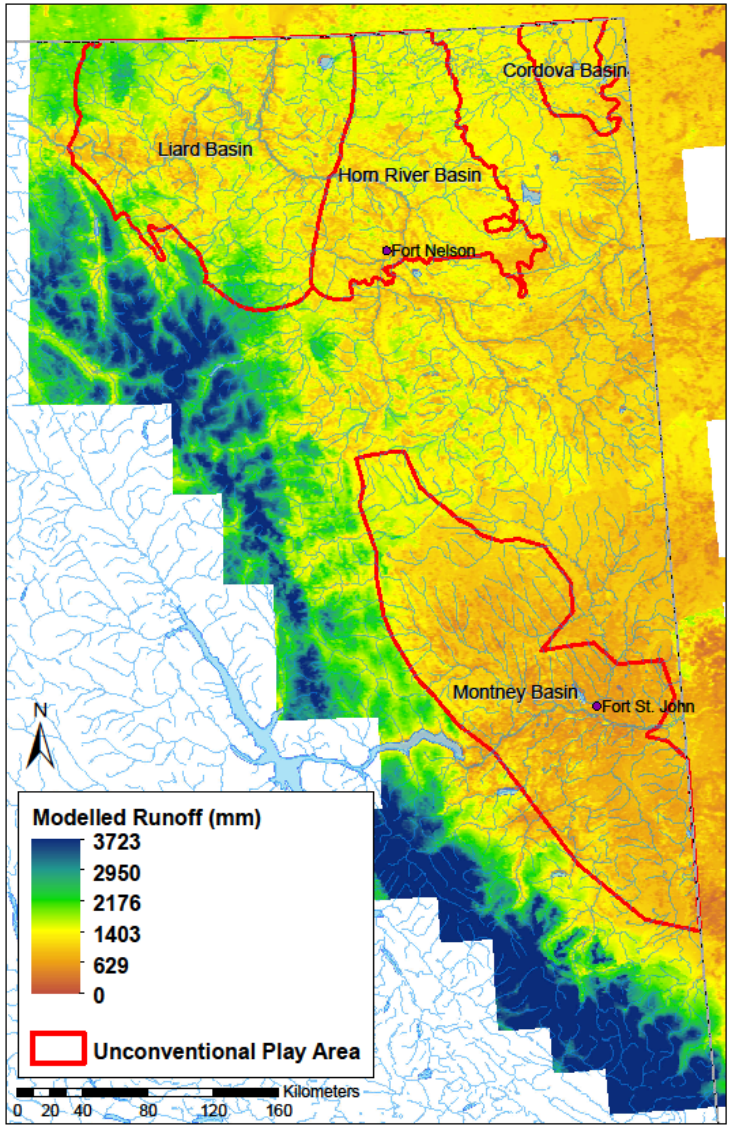


Annual Runoff

	% of basins within ± 20% error	MBE (%)	ME (%)	MAE (%)
Modelled Annual Runoff	**77.8%**	**5.5%**	**3.7%**	**16.1%**

- MBE = Mean error
- ME = Median error
- MAE = Mean absolute error

Annual Runoff (mm)

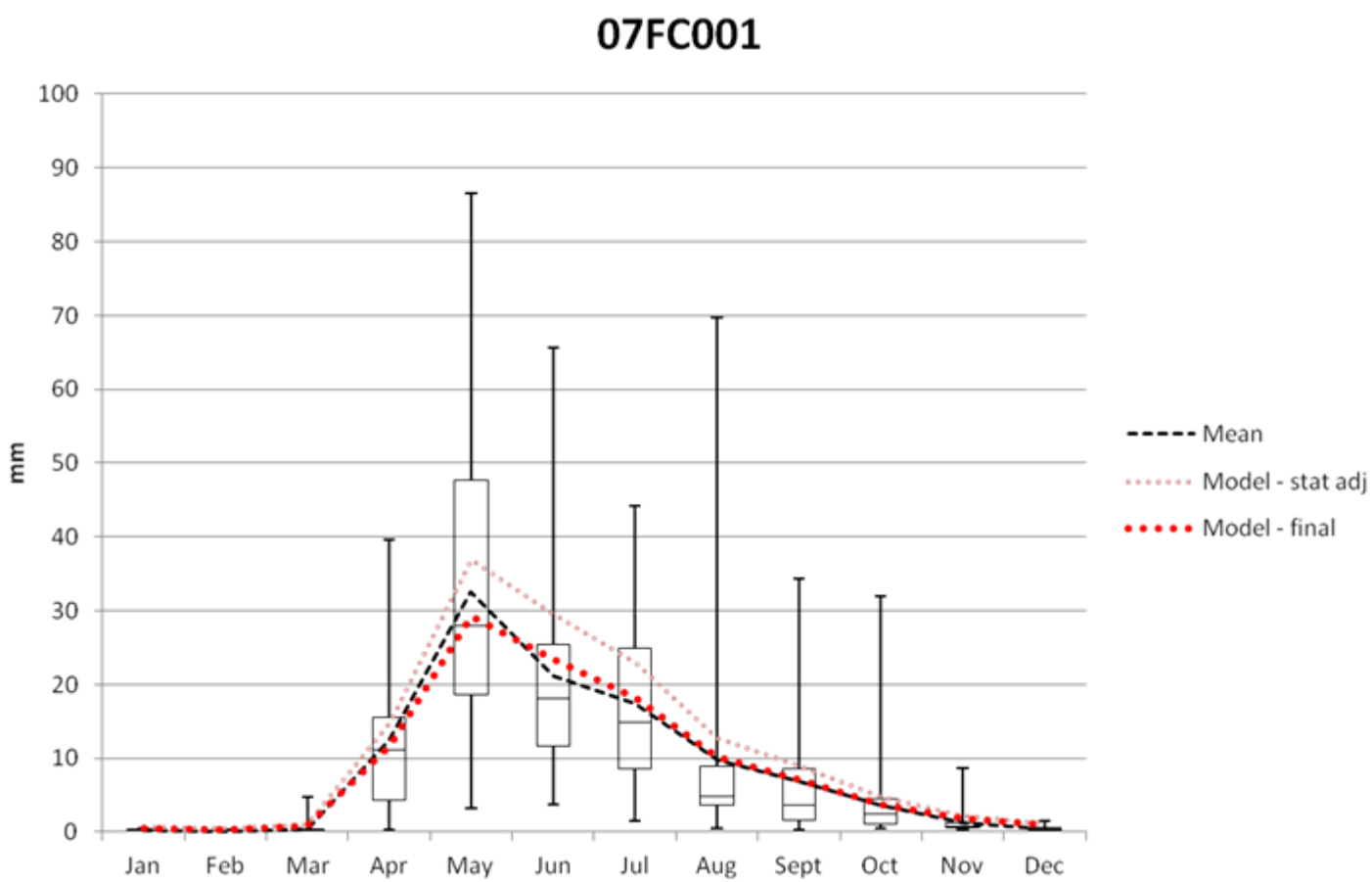


Validation – Beatton River

Beatton River

Area: 16,059 km^2
North Peace, BC
Annual Gauge
1961-present

Box plot shows monthly runoff (mm)

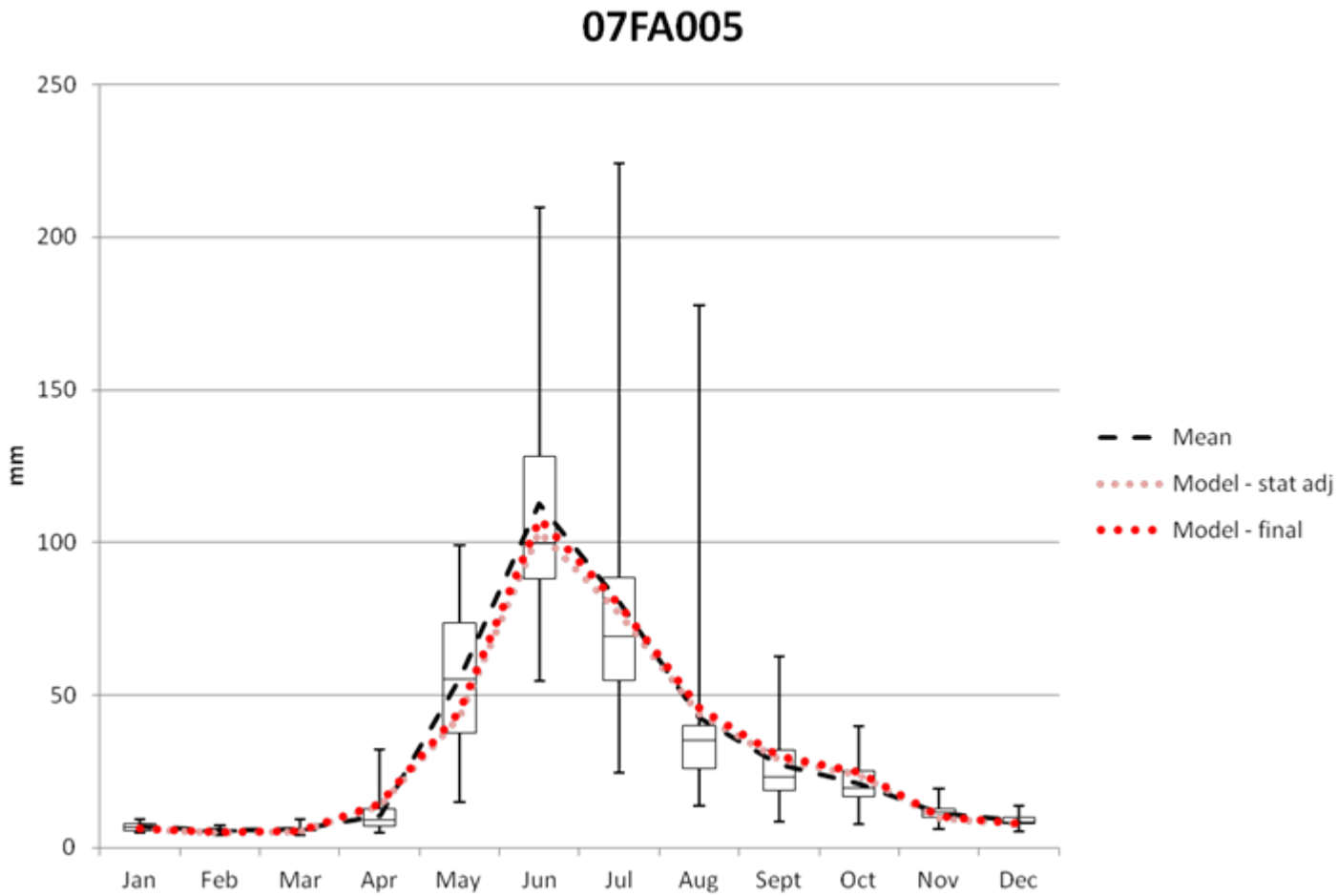


Validation – Graham River

Graham River

Area: 2,139 km^2
North Peace, BC
Annual Gauge
1981-present

Box plot shows monthly runoff (mm)



NEWAT – A Tool to Aid Decision-Making

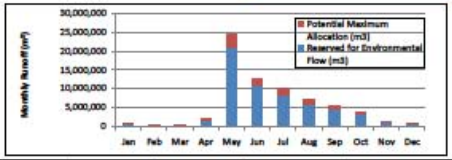
NorthEast Water Assessment Tool (NEWAT) Query

OGC LOGO

Query Location:	
UTM - EASTING	500000
UTM-NORTHING	6580000
NAME	Krista Creek

Upstream Watershed: Krista Creek

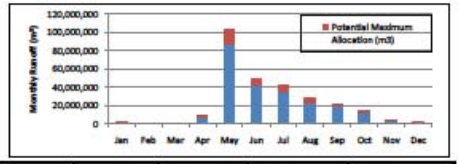
Drainage Area:	32,556	ha
Average Annual Precipitation:	471	mm
Average Elevation (m):	795	m
Basin Centre - Easting:	511858.5	m
Basin Centre - Northing:	6586119.8	m
Average Annual Runoff:	211	mm
Average Annual Runoff:	68,760,293	m3
Mean Annual Discharge:	2.18	m^3/s



Month	Average Runoff (mm)	Average Discharge (m^3/s)	Average Runoff (m^3)	Reserved for Environmental Flow (m^3)	Potential Maximum Allocation (m^3)	Existing Allocation (Licenses or Approvals) (m^3)	Remaining Potential for Allocation (m^3)	Note
Jan	1.9	0.24	630,971	536,326	94,646	17,000	77,646	winter flow limited
Feb	1.1	0.14	350,465	297,895	52,570	17,000	35,570	winter flow limited
Mar	0.9	0.11	307,252	261,164	46,088	17,000	29,088	winter flow limited
Apr	5.9	0.75	1,935,503	1,645,178	290,325	17,000	273,325	
May	75.5	9.17	24,569,077	20,883,716	3,685,362	17,000	3,668,362	
Jun	38.6	4.85	12,562,965	10,678,521	1,884,445	17,000	1,867,445	
Jul	30.9	3.76	10,067,604	8,557,463	1,510,141	17,000	1,493,141	
Aug	21.3	2.59	6,936,722	5,896,214	1,040,508	17,000	1,023,508	
Sep	17.3	2.17	5,632,632	4,787,738	844,895	17,000	827,895	
Oct	11.4	1.38	3,702,838	3,147,412	555,426	17,000	538,426	
Nov	3.7	0.47	1,207,366	1,026,261	181,105	17,000	164,105	
Dec	2.6	0.32	856,897	728,362	128,535	17,000	111,535	winter flow limited
Annual	211	2.18	68,760,293	58,446,249	10,314,044	204,000	10,110,044	

Downstream Watershed: Sahdoanah River

Drainage Area:	138,998	ha
Average Annual Precipitation:	454	mm
Average Elevation (m):	776	m
Basin Centre - Easting:	511858.5	m
Basin Centre - Northing:	6586119.8	m
Average Annual Runoff:	199	mm
Average Annual Runoff:	276,661,619	m3
Mean Annual Discharge:	8.77	m^3/s



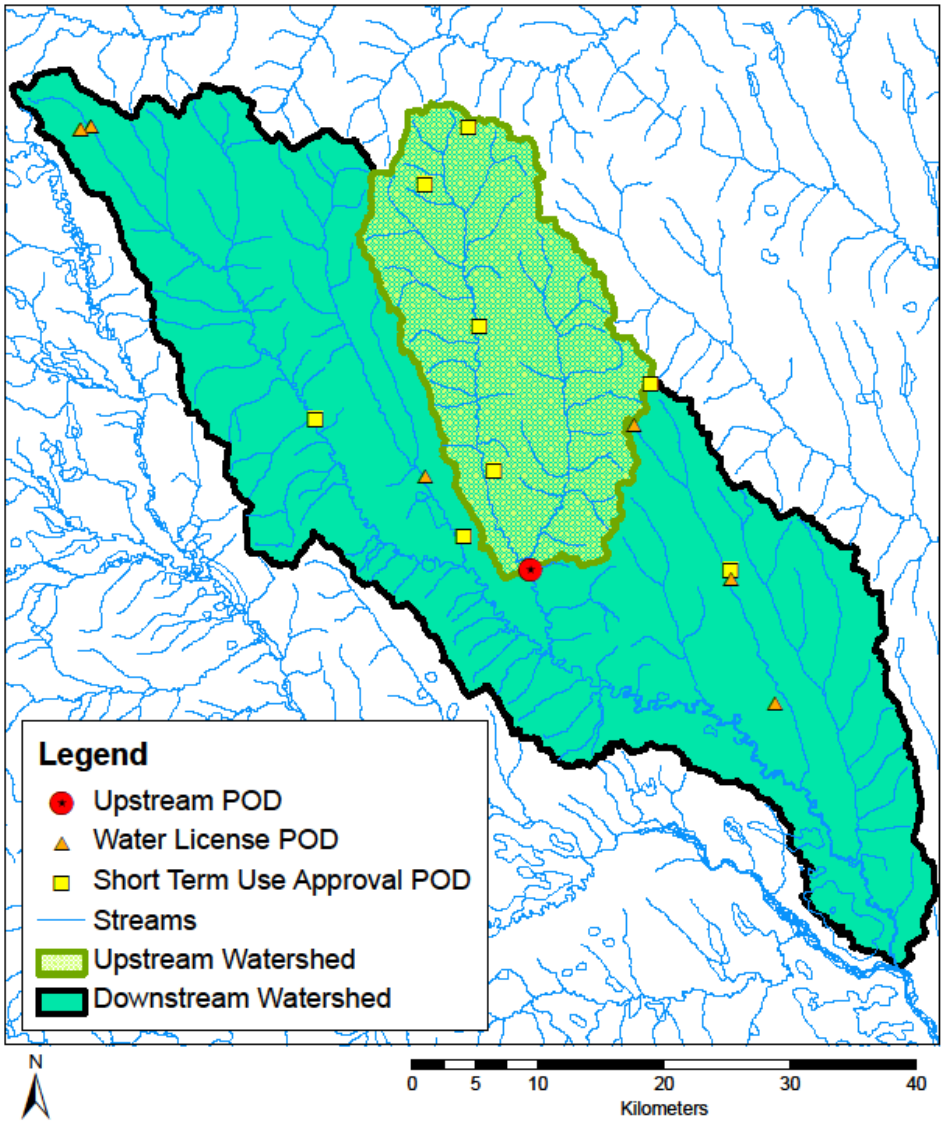
Month	Average Runoff (mm)	Average Discharge (m^3/s)	Average Runoff (m^3)	Reserved for Environmental Flow (m^3)	Potential Maximum Allocation (m^3)	Existing Allocation (Licenses or Approvals) (m^3)	Remaining Potential for Allocation (m^3)	Note
Jan	1.4	0.73	1,945,972	1,654,076	291,896	63,000	228,896	winter flow limited
Feb	0.7	0.40	986,886	838,853	148,033	63,000	85,033	winter flow limited
Mar	0.7	0.37	986,886	838,853	148,033	63,000	85,033	winter flow limited
Apr	6.0	3.24	8,395,479	7,136,157	1,259,322	63,000	1,196,322	
May	73.9	38.35	102,719,522	87,311,594	15,407,928	63,000	15,344,928	
Jun	35.5	19.04	49,344,290	41,942,647	7,401,644	63,000	7,338,644	
Jul	29.8	15.46	41,421,404	35,208,193	6,213,211	63,000	6,150,211	
Aug	19.9	10.33	27,660,602	23,511,512	4,149,090	63,000	4,086,090	
Sep	15.9	8.53	22,100,682	18,785,580	3,315,102	63,000	3,252,102	
Oct	10.1	5.24	14,038,798	11,932,978	2,105,820	63,000	2,042,820	
Nov	3.1	1.67	4,322,838	3,674,412	648,426	63,000	585,426	
Dec	2.0	1.02	2,738,261	2,327,522	410,739	63,000	347,739	winter flow limited
Annual	199	8.77	276,661,619	235,162,376	41,499,243	756,000	40,743,243	

DISCLAIMER

FLNRO LOGO

GeoScience BC LOGO

North-East Water Assessment Tool



Public Reporting of Water Information

Major Basin Name	Sub-Basin Name	Section 8 Water Use Approvals - Oil and Gas Commission					River Discharge and Runoff	
		Number of Section 8 Approvals (OGC)	Total Volume Approved (m^3)	Total Volume Approved as % of Mean Annual Runoff	Total Volume Withdrawn (m^3) (2012)	Total Volume Withdrawn as % of Mean Annual Runoff	Mean Annual Discharge (m^3/s)	Mean Annual Runoff (m^3)
Fort Nelson River								
	Fontas River	2	194,801	0.027%	16,662	0.002%	23.3	734,802,107
	Kahntah River	2	209,145	0.038%	32	0.000%	17.3	544,750,613
	Kiwigana River	12	1,713,716	0.439%	9,031	0.002%	12.4	390,226,333
	Klua River	3	178,400	0.046%	4,333	0.001%	12.4	391,372,372
	Snake River	2	262,400	0.081%	0	0.000%	10.3	324,902,101
	Upper Fort Nelson River	3	337,400	0.006%	1,286	0.000%	165	5,207,004,000
	Middle Fort Nelson River	19	2,471,517	0.026%	892,390	0.009%	300	9,467,280,000
	Lower Fort Nelson River	2	310,831	0.003%	0	0.000%	340	10,729,584,000
	Fort Nelson Total	45	5,678,210	0.051%	923,734	0.008%	350	11,068,673,506

Full and transparent public reporting builds **confidence and trust**

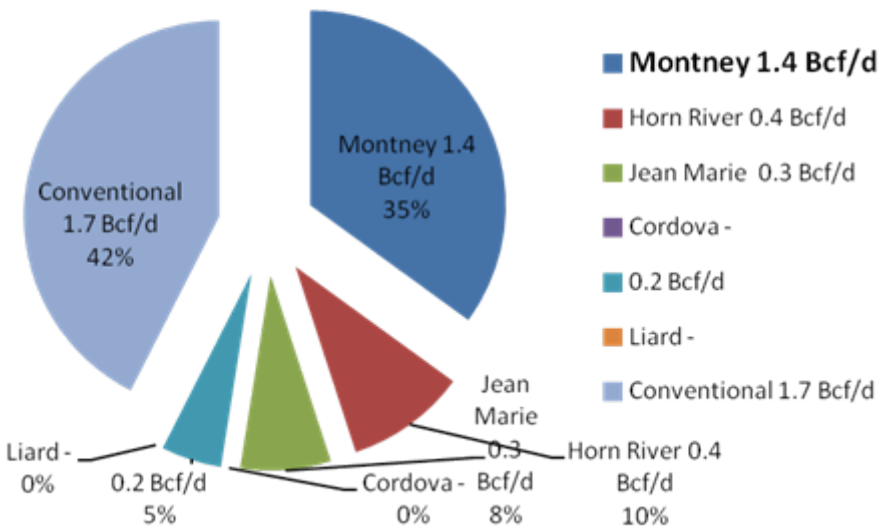
Quarterly Report on
Short-Term Water Approvals and Use
July to September 2011
BC Oil & Gas COMMISSION

NEWAT – Strategic and Tactical Analysis

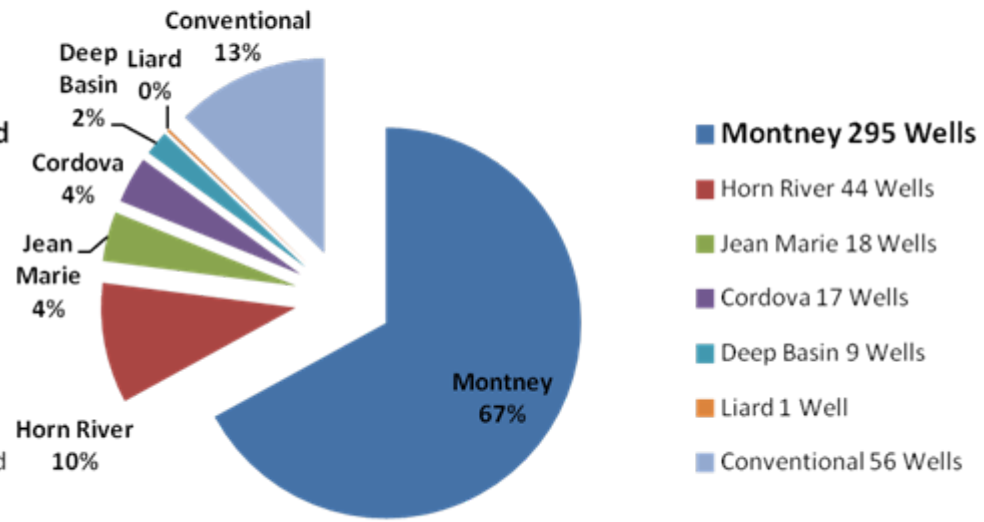
Montney Trend - Total Area: 29,850 km^2

- Multiple Industries, Interests and Municipalities
  - Forestry, Mining, Agricultural, Oil and Gas, etc…
  - First Nations, Recreational, Residential, etc…
  - Ft. St. John, Dawson Creek, Hudson's Hope, etc…

Gas Production - Dec 2011: 4.0 Bcf/day



Wells Drilled Since Q1 2011: 440 Wells



Projected Water for Hydraulic Fracturing

Basin	Area (km^2)	Area in Montney Play (km^2)	% of Basin Area in Montney Play	Average Annual Runoff		Projected Surface Water Use for Hydraulic Fracturing (m^3)	% of Total Annual Runoff for Hydraulic Fracturing
				mm	m^3		
Peace and South	**34,842**	**13,361**	**38%**	**259**	**9,019,752,282**	**2,271,877**	**0.03%**
Moberly	1,905	1,067	56%	292	556,180,003	181,150	0.03%
Pine	12,026	3,544	29%	492	5,919,868,753	601,759	0.01%
Kiskatinaw	4,059	3,318	82%	93	378,012,332	563,328	0.15%
Smoky	5,235	556	11%	73	382,755,874	97,783	0.03%
Peace Inflow	11,617	4,876	42%	153	1,782,935,321	827,857	0.05%
North of Peace	**34,220**	**16,480**	**48%**	**220**	**7,585,082,453**	**7,242,159**	**0.10%**
Beatton	12,414	6,921	56%	108	1,345,539,072	2,710,306	0.20%
Prophet	4,114	370	9%	391	1,607,645,135	175,533	0.01%
Sikanni Chief	6,405	2,102	33%	283	1,810,169,363	996,721	0.06%
Halfway	9,386	5,186	55%	277	2,602,564,747	2,458,621	0.09%
Lynx-Farrell	969	969	100%	146	141,834,369	459,192	0.32%
Cache	932	932	100%	83	77,329,767	441,786	0.57%
Total	**69,062**	**29,841**	**43%**	**240**	**16,604,834,736**	**9,514,036**	**0.06%**

Average Annual Runoff = 16.6 Billion m^3

Summary of Water Use Projections

Average Annual Runoff in Montney = 16.6 Billion m^3

- Projected Maximum Future Water Requirement for Hydraulic Fracturing in Montney Play is ≈15 million m^3 per year
- Of this, ≈65 percent is projected to be from surface sources (rivers, lakes, dugouts) ≈ 10 million m^3
- **This is 0.06 percent of average annual runoff**

- There is abundant water, but it needs careful management
- This information has been well received by public.

Final Thoughts

- Science-based information such as hydrology modelling is important.

  and

- Public communication on water use for unconventional resource development is very important.
- Helps create confidence and trust.
- Helps ensure:
  - Assured access to water for oil and gas operators.
  - Environmental flow needs for fish and wildlife are protected.
  - Present and future water needs for communities are protected.

Questions?

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