

IN THE MATTER OF
ENBRIDGE NORTHERN GATEWAY PROJECT JOINT REVIEW PANEL
OH-4-2011
NORTHERN GATEWAY PIPELINES INC.
ENBRIDGE NORTHERN GATEWAY PROJECT

AFFIDAVIT

Richard
I, Dr. Shane Rollans, of Kamloops, British Columbia, MAKE OATH [OR AFFIRM] AND SAY AS FOLLOWS:

1. I am an Assistant Professor in the Department of Mathematics and Statistics at the Thompson Rivers University.
2. Attached hereto as Exhibit "A" is a true copy of my curriculum vitae.
3. Attached hereto as Exhibit "B" is a report that I prepared in July 2012 entitled *Risk of a Hydrocarbon Spill During the 50 Year Operational Life of a Pipeline*. I prepared this report at the request of Kelly Marsh, a resident of Kitimat, who asked me to assist him in determining the probability of a medium or large hydrocarbon spill occurring during the first 50 years of the Northern Gateway Project, based upon the spill return period estimates submitted by Enbridge in its application.
4. Kelly Marsh, with my permission, shared my report with the Intervenor, Douglas Channel Watch, and they requested that I file this Affidavit so that my report will become part of the record before the Joint Review Panel.

SWORN [OR AFFIRMED] BEFORE ME
AT KAMLOOPS, BRITISH COLUMBIA
ON JULY 13, 2012

Sally Wong
A Commissioner for taking Affidavits for
the Province of British Columbia

Expiry Date Dec 31, 2014

SALLY WONG

A Commissioner for taking
Affidavits for British Columbia

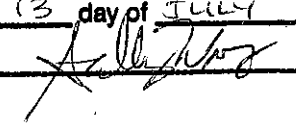
*No advice requested or given - attested
to only but not drawn by Commissioner.*

Shane Rollans
DR. SHANE ROLLANS

Richard

IK

SERVICE BC CENTRE
250 - 455 COLUMBIA STREET
KAMLOOPS, BC
V2C 6K4
(250) 828-4540

This is exhibit " A " referred to in
the affidavit of Shane Rollans
SWORN BEFORE ME at Kamloops in
the Province of British Columbia, this
13 day of JULY 20 12


Curriculum Vitae

Shane Rollans
Department of Mathematics and Statistics
Thompson Rivers University
Kamloops, BC, V2C 0C8
Residence: (250) 372-5478
Office: (250) 828-5054
srollans@tru.ca

Education

Ph.D. in Statistics, 1994, University of Waterloo
Supervisor: Dr. D.L. McLeish
Title of thesis: "*Sensitivity Analysis of Simulations and the Monte Carlo Optimization of Stochastic Systems*"

Master of Science in Statistics, 1979, University of Alberta
Supervisor: Dr. R. Routledge
Title of Master's project: "*Preliminary Analysis of Data on Resource Partitioning Between Moose and Elk in Riding Mountain National Park*".

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April 2004-2010. Chair, Department of Mathematics and Statistics, Thompson Rivers University.

January to August 1989, Consultant, Statistical Consulting Service, University of Waterloo. Dr. G. W. Bennett, Director. Acting as the on-site consultant for the Faculty of Social Work, Wilfred Laurier University, Waterloo, Ontario.

September to December 1986. Consultant, Statistical Consulting Service, University of Waterloo. Dr. K. S. Brown, Director. Providing statistical help for graduate students and faculty on an on-call basis.

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1978-1982. Consultant, Canadian Wildlife Service, Edmonton, Alberta, Working with Dr. G. Trottier on his study of resource partitioning in Riding Mountain National Park, first as part of my degree work (1978-1979), then under private contract (1980) and finally on contract through Kao Associates Consulting Ltd., Edmonton.

May to August 1975. Summer Student, Canadian Wildlife Service, Edmonton, Alberta, Field work and some elementary statistical analysis of the results. Primarily working with population studies of waterfowl in Alberta.

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Statistical Analysis for Online Social Networks, 2011, Mohamed Tawhid, Zi Jin, Alexey Antonitsin, Shane Rollans, A report submitted for the project with Prosyna, funded by the Natural Sciences and Engineering Research Council of Canada, Engage Grant.

G Ratsoy, T Dickinson, D Draney, S Rollans, V Clement, 2012, An Aboriginal Cohort Program: Processes, Results, Applications, Poster Presentation at the International Conference on the First Year Experience, Vancouver.

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2011: Deborah Carusi, Masters of Education, Thompson Rivers University,

Thesis Title: The Effect of Authentic Math Definitions in Student Achievement and Self-Efficacy

2012: Claudette Martin, Masters of Environmental Studies, Thompson Rivers University,

Thesis Title: Regional Frequency Analysis of Extreme Precipitation Events for the Southern Interior of British Columbia

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- SSC Annual Meeting, Winnipeg, June 1985
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- Graduate Student Seminar in Statistics and Biostatistics (GSSSB), University of Western Ontario, July 1988, "Estimating gradients from a single simulation of a stochastic process"
- SSC Annual Meeting, St. John's, June 1990, contributed paper, "Sensitivity analysis and the optimization of stochastic systems"
- SSC Annual Meeting, Toronto, June 1991
- Departmental Seminar, SFU, November, 1991, invited speaker, "Monte Carlo optimization of stochastic systems"
- SSC Annual Meeting, Edmonton, June 1992
- Research at Small Universities Conference, Kamloops, May 1998
- SSC Annual Meeting, Sherbrooke, June 1998
- Pacific Northwest Statistical Meeting, SFU, November 1998

- SSC Annual Meeting, Regina, June 1999
- SSC Annual Meeting, Ottawa, June 2000
- SSC Annual Meeting, Burnaby, June 2001
- SSC Annual Meeting, Hamilton, June 2002
- SSC Annual Meeting, Montreal, June 2004
- TIES Conference on Environmetrics, Kelowna, June, 2008, Chaired contributed session.
- Sharing Mathematics, Kamloops, May 2009
- SSC Annual Meeting, Vancouver, June 2009
- TRU Teaching Practices Colloquium, February 2009
- TRU Teaching Practices Colloquium, February 2010
- Sharing Mathematics, Vancouver, May 2010
- TRU Teaching Practices Colloquium, February 2011
- Sharing Mathematics, Vernon, May 2011
- Faculty Learning Community Developers' and Facilitators' Institute, June 2011
- TRU Teaching Practices Colloquium, February 2012, A Faculty Learning Community Initiates a Cohort-Based Program, Panel presentation
- SSC Annual Meeting, Guelph, June 2012

Other Talks Given

- Some Consulting Problems at UCC, Presentation to Teachers, May 2003
- A Math Magic Trick, SD 73 Math Challenge, May, 2007
- Magic Squares, SD 73 Math Challenge, May 2008
- Fibonacci Numbers, SD 73 Math Challenge, May 2009
- Picross, SD 73 Math Challenge, May 2011
- Kakuro, SD 73 Math Challenge, May 2012

Math Outreach

- 1990-date Helped at BC Secondary School Math Contest (organizing committee 2009-date)
- 2002-2004 Regular meetings with students at Beattie Elementary, Grades 3-7
- Gauss Contest, Organized contest for students from Beattie Elementary and Stuart Wood. May, 2004
- 2004-2005 Taught Math 8 to five grade 7 students from Beattie Elementary School of the Arts, met 2 to 3 times per week.
- Spring 2006, helped one grade 7 student at Beattie with grade 7 math.
- Spring 2007, Helped two grade 7 students at Beattie with grade 8 math
- Spring 2008, Math enrichment session at Aberdeen Elementary
- January 2010 to date, coordinating the TRU Math Help Centre

Professional Membership

- Statistical Society of Canada

Personal

I am a Canadian citizen, married, with two children, and in excellent health.

Referees

Dr. Dennis Acreman
Acting Registrar
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Risk of a Hydrocarbon Spill During the 50 Year Operational Life of a Pipeline

July 12, 2012

Dr. Shane Rollans, Assistant Professor, Department of Mathematics and Statistics, Thompson Rivers University

What are the chances of a hydrocarbon spill at some point during the life of an oil transportation system? The standard practice is to report the estimated average spill return periods (the average time between spills). It is easier to understand what the spill return periods mean when they are translated into probabilities. With the proposed Enbridge Northern Gateway Project and its projected operational lifetime of 50 years presently in the news, it is of interest to calculate the probability of at least one spill during the 50 year operational life of this pipeline. Enbridge has estimated the spill return periods for the different sections of the pipeline and reported these in its application to the National Energy Board. I will use these rates with the Poisson distribution to model the number of leaks during the 50 year period. The Poisson distribution is commonly used to model the number of occurrences of an event during a time period. When combining regions or types of leaks, I assume that the spills are independent. The assumptions of independence and the Poisson model are the same assumptions used by Enbridge, for example in Table 8-4 on page 132 of *Marine Shipping Quantitative Risk Analysis*, Enbridge Northern Gateway Project, Det Norske Veritas, Oslo Norway 2010

<https://www.neb-one.gc.ca/ll-eng/livelink.exe/fetch/2000/90464/90552/384192/620327/624798/691974/B23-34 - TERMPOL TDR - Marine Shipping Quantitative Risk Analysis A1Z6L8 .pdf?nodeid=692084&vernum=0&redirect=3>

Probabilities of a Medium Spill in a 50 Year Period.

Medium spills are defined to be no more than one million litres except for maritime travel where they are defined as no more than 20 million litres. The probabilities are for one or more medium spills in a 50 year period.

Table 1: Estimated probabilities of at least one medium spill in a 50 year period.

Region	Return Period	Spill Probability
Eastern Alberta Plains	287 ¹	16.0% ⁵
Southern Alberta Uplands	136 ¹	30.8%
Alberta Plateau	1082 ¹	4.5%
Rocky Mountains	462 ¹	10.3%
Interior Plateau	118 ¹	34.5%
Coast Mountains	454 ¹	10.4%
Kitimat Terminal	294 ²	15.6%
Marine Transport	550 ³	8.7%
Overall	33.5 ⁴	77.5%

¹ **Volume 7B: Risk Assessment and Management of Spills-Pipelines (May 2010)**, Table 3-2, Page 3-2.

http://www.northerngateway.ca/assets/pdf/application/MASTER_Vol%207B_Final_14May10.pdf

² **Volume 7C: Risk Assessment and Management of Spills-Kitimat Terminal (May 2010)**

Table 3-1 Page 3-2

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³ **Volume 8C: Risk Assessment and Management of Spills-Marine Transportation (May 2010)** Page 3-2

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⁴ The total combined risk is derived by summing the rates for the 8 regions: $1/287 + 1/136 + 1/1082 + 1/462 + 1/118 + 1/454 + 1/294 + 1/550$ which is approximately 1 per 33.53 years or 0.02982 per year or 1.49 per 50 years.

This makes the estimated probability of at least one medium spill in 50 years:

$$1 - e^{-1.49} = .775 \text{ or } 77.5\%.$$

⁵ The rate per year for a return period of 287 years is $1/287$ or about .00348 per year or .174 per 50 years. The probability of no spills in the 50 year period is then $e^{-.174}$ or about 84%. This means that the probability of at least one medium spill is 16%. The other probabilities are calculated similarly.

Probabilities of a Large Hydrocarbon Spill in a 50 Year Period

The Enbridge application includes spill return periods for large spills (defined as greater than 1,000,000 litres) in the six sections of the pipeline. The probabilities in this table are for at least one large spill during the 50 year life of the project.

Table 2: Estimated probabilities of at least one large spill in a 50 year period.

Region	Return Period	Spill Probability
Eastern Alberta Plains	669 ¹	7.2%
Southern Alberta Uplands	317 ¹	14.6%
Alberta Plateau	2525 ¹	2.0%
Rocky Mountains	1079 ¹	4.5%
Interior Plateau	275 ¹	16.6%
Coast Mountains	1058 ¹	4.6%
Overall	94.74	41.0%

There is a 41% probability of one or more large spills from the pipeline over the 50 years.

Enbridge asserts that the largest credible Kitimat Terminal spill is 250,000 litres (*Volume 7C: Risk Assessment and Management of Spills-Kitimat Terminal (May 2010) Page 3-2*) so there is no return period for a large spill at the Kitimat Terminal.

The spill return period for a spill of greater than 20 million litres for maritime transit is approximately 2800 years (*Volume 8C: Risk Assessment and Management of Spills-Marine Transportation (May 2010) Page 3-2*) giving a 1.8% probability of at least one large maritime spill during the 50 year life of the project.

Probabilities of a Medium or Large Hydrocarbon Spill in a 50 Year Period

Table 3: Estimated probabilities of at least one spill (medium or large) in a 50 year period.

Region	Return Period	Spill Probability
Eastern Alberta Plains	201	22.0%
Southern Alberta Uplands	95	40.9%
Alberta Plateau	757	6.4%
Rocky Mountains	323	14.3%
Interior Plateau	83	45.4%
Coast Mountains	318	14.6%
Overall	28.4	82.8%

There is an 82.8% chance of at least one medium or large leak in the pipeline during the 50 year life of the project.

The overall return period for maritime transit is about 460 years giving about a 10% chance of at least one medium or large maritime spill during the life of the project.

Combining the results for medium or large spills from the Kitimat Terminal, the pipeline and maritime transit, the spill return period is about 24.5 years and the probability of at least one medium or large spill over the 50 years is about 87%. There is a 60% chance of at least two, a 33% chance of at least three and a 15% chance of at least four such spills during that time period.

The probabilities given here are contingent on the numbers and assumptions used by Enbridge being correct. It should also be noted that the environmental impact of a spill is heavily dependent upon the location of the spill.

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- SSC Annual Meeting, Burnaby, June 2001
- SSC Annual Meeting, Hamilton, June 2002
- SSC Annual Meeting, Montreal, June 2004
- TIES Conference on Environmetrics, Kelowna, June, 2008, Chaired contributed session.
- Sharing Mathematics, Kamloops, May 2009
- SSC Annual Meeting, Vancouver, June 2009
- TRU Teaching Practices Colloquium, February 2009
- TRU Teaching Practices Colloquium, February 2010
- Sharing Mathematics, Vancouver, May 2010
- TRU Teaching Practices Colloquium, February 2011
- Sharing Mathematics, Vernon, May 2011
- Faculty Learning Community Developers' and Facilitators' Institute, June 2011
- TRU Teaching Practices Colloquium, February 2012, A Faculty Learning Community Initiates a Cohort-Based Program, Panel presentation
- SSC Annual Meeting, Guelph, June 2012

Other Talks Given

- Some Consulting Problems at UCC, Presentation to Teachers, May 2003
- A Math Magic Trick, SD 73 Math Challenge, May, 2007
- Magic Squares, SD 73 Math Challenge, May 2008
- Fibonacci Numbers, SD 73 Math Challenge, May 2009
- Picross, SD 73 Math Challenge, May 2011
- Kakuro, SD 73 Math Challenge, May 2012

Math Outreach

- 1990-date Helped at BC Secondary School Math Contest (organizing committee 2009-date)
- 2002-2004 Regular meetings with students at Beattie Elementary, Grades 3-7
- Gauss Contest, Organized contest for students from Beattie Elementary and Stuart Wood. May, 2004
- 2004-2005 Taught Math 8 to five grade 7 students from Beattie Elementary School of the Arts, met 2 to 3 times per week.
- Spring 2006, helped one grade 7 student at Beattie with grade 7 math.
- Spring 2007, Helped two grade 7 students at Beattie with grade 8 math
- Spring 2008, Math enrichment session at Aberdeen Elementary
- January 2010 to date, coordinating the TRU Math Help Centre

Professional Membership

- Statistical Society of Canada

Personal

I am a Canadian citizen, married, with two children, and in excellent health.

Referees

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Secretary to the Joint Review Panel
Enbridge Northern Gateway Project
444 Seventh Ave S.W.
Calgary, Alberta
T2P 0X8
August 2, 2012

Re: Northern Gateway Pipelines Inc. File OF-Fac-Oil-2010-01 01

Notice of Motion #7

Name of person bringing forward the motion:
Douglas Channel Watch

Douglas Channel would like to submit late evidence.

“Risk of a Hydrocarbon Spill during the 50 years of Operational Life of the Pipeline”
by Dr. Shane Rollans.

Alternate analysis of the probability of a spill using the information from Northern Gateway data has been developed. Dr. Shane has agreed to be a witness and the evidence has an affidavit.

Sincerely yours

Cheryl Brown