

Public Input Summary and Supporting Materials 100 Amherst Avenue – Text Amendment Rezoning Application

1. Overview

Public engagement was undertaken in accordance with, and exceeded, the District of North Vancouver's Non-Statutory Public Consultation for Development Applications Policy.

Engagement included:

- A two-week Virtual Public Information Meeting held from October 27 to November 7, 2025; and
- An in-person Public Information Meeting held on October 29, 2025, at the Holiday Inn & Suites North Vancouver.

2. Public Notification

Public notification exceeded the District of North Vancouver's requirements, as detailed in **Appendix A**, and included the following:

- Delivery of approximately 1,613 notification flyers to properties within a 375-metre radius of the site;
- Placement of two newspaper advertisements in the *North Shore News* on October 15 and October 22, 2025; and
- installation of six notification signs at key locations on and near the site.

3. Virtual Public Information Meeting

Event Date	October 27 to November 7, 2025 (two-week duration)
Website	DNV.org/public-meeting District of North Vancouver: 100 Amherst Avenue

Comments	5 comments/questions received online
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Summary of Virtual PIM Input

A total of five (5) comments were received:

- Supportive Comments (4):
These emphasized the importance of Chemtrade's operations for drinking water treatment, employment, and the local and regional economy. Some supportive comments also recommended continued oversight, including consideration of third-party operational or safety reviews to ensure alignment with best practices.
- Opposing Comment (1):
One comment expressed concern regarding land use compatibility, citing the increase in residential development in the area over time and questioning whether any residual industrial risk is appropriate in the Maplewood area.

A complete record of all Virtual PIM comments is provided in **Appendix B**.

4. In-Person Public Information Meeting

The in-person Public Information Meeting was held on October 29, 2025 at the Holiday Inn & Suites North Vancouver and was attended by 11 members of the public.

The meeting included:

- An open house format;

- A formal presentation; and
- A facilitated dialogue involving District staff and Chemtrade’s multidisciplinary project team.

Written Submissions

Two written comment sheets were submitted:

- One expressed support for the proposal and the clarity and quality of information provided.
- One requested additional study related to potential human health impacts.

Questions and comments raised during the meeting generally focused on:

- Historical safety performance and incident history;
- The nature and effectiveness of the proposed safety improvements;
- How risk is assessed and communicated; and
- The relationship between Chemtrade’s operations and surrounding industrial and residential uses.

Further details are provided in the facilitator’s report included as **Appendix C**.

5. Written Correspondence and Letters of Support

In addition to comments received through the Public Information Meetings, written correspondence was received, including letters of support from senior elected officials and community representatives.

Key themes raised in these letters included:

- The regional, national, and international importance of Chemtrade’s operations for drinking water treatment;
- The facility’s long history of safe operation and previous investments in modernization and safety;
- The role of the facility in supporting local employment, economic activity, and industrial land use; and
- Support for the proposed rezoning to enable further safety upgrades and long-term operational certainty.

Letters of support are included in **Appendix D**.

Conclusion:

Public input reflected a range of perspectives, including recognition of Chemtrade’s role in drinking water treatment, employment, and the local and regional economy, as well as comments emphasizing the importance of ongoing regulatory oversight and high operational and safety standards. Other comments raised questions regarding land use compatibility, residual risk, and the need for additional analysis related to potential human health impacts.

Attachments:

- Appendix A: Notification Materials
- Appendix B: Virtual Public Information Meeting Comments
- Appendix C: Facilitator’s Report – In-Person Public Information Meeting
- Appendix D: Letters of Support from Elected Officials

Appendix A: Notification

Newspaper Advertisement: North Shore News – October 15, 2025

A26 | WEDNESDAY, OCTOBER 15, 2025

north shore news nsnews.com

Development Proposal

PUBLIC INFO MEETING

**Wednesday, Oct. 29,
6:00–8:00pm**
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(Holiday Inn & Suites North
Vancouver)

Participate virtually
Oct. 27–Nov. 7 at
[DNV.org/public-meeting](https://dnv.org/public-meeting)

WE ARE HERE

PUBLIC INFO MEETING

PUBLIC HEARING

PROPOSAL: 100 Amherst Avenue

A site-specific text amendment to the Zoning Bylaw to permit the production of a hazardous substance (liquid chlorine), which will permit several on-site capital improvements aimed at reducing the overall risk associated with the proposed use to the surrounding community.



Contact:

Amy Jonsson, Chemtrade Logistics Inc.
ajonsson@chemtradelogistics.com 236-808-7851



UPHILL BATTLE

Grouse Grind closes for three weeks for annual maintenance

ABBY LUCIANO
aluciano@nsnews.com
Local Journalism Initiative Reporter

If you're looking to take on the Grouse Grind this month, the trek might have to wait.

The popular North Vancouver trail closed for annual trail maintenance starting Oct. 14. Metro Vancouver said in a media release that crews are working on the upper section of the trail to repair and replace steps and retaining walls to increase trail resilience.

"The Grouse Grind Trail must be closed during these upgrades because the terrain where the work is taking place is steep and hazardous and detours are not possible," the media release said.

Maintenance is needed each fall due to heavy traffic during the spring and summer months, Metro Vancouver said. Each year, the Grouse Grind attracts roughly 250,000 visitors.

The trail is expected to reopen on Nov. 8, if the weather permits. Visitors are urged to stay off the trail while it's closed, as ignoring the closure could result in serious injury and delay reopening, Metro Vancouver stated in



The Grouse Grind will be closed until at least early November for trail maintenance and repair. PAUL MCGRATH / NSN

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While the Grouse Grind will be closed, the BCMC Route and Baden Powell Trail will be open to visitors. For those wanting a route like the Grouse Grind, the BCMC Route is a good choice as it's similar in length and elevation and ends in the same location, Metro Vancouver said. The organization recommends people wear hiking shoes with good ankle support, carry lots of water and a snack, and an extra layer of clothing for warmth.



Marine piling underway, July 16, 2025

Construction Progress at Woodfibre LNG

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All marine work is supported by marine mammal observers and hydroacoustic monitoring. These safeguards pause work if underwater sound nears regulatory limits or if marine mammals enter exclusion zones.

We're proud to be building the world's first net zero LNG export facility safely, responsibly, and under the oversight of the Skwókwúmesh Úxwumixw (Squamish Nation) — follow us to see how it's taking shape right here in Squamish.

woodfibrelng.ca/news



Newspaper Advertisement: North Shore News – October 22, 2025

northshorenews nsnews.com

WEDNESDAY, OCTOBER 22, 2025 | A19



North Vancouver Football Club's U17 boys team celebrates a bronze finish at nationals on Oct. 13 in Kamloops. NICOLE SKUGGEDAL

First national medal for club

Continued from A18

loss, Robson said. However, the team was able to get back on track.

"I mentioned to them that ... when you're driving a car, the windshield is much bigger than the rear view mirror, so we didn't want to look at what happened behind us. We want to look forward to tomorrow," he said. "Then the boys were able to refocus, and came out and played really well in the bronze medal game."

The victory was huge for the team, Robson said.

"It's the first time that a team from NVFC has won a medal at a national event. We're the first boys team to even go to a national event," he said.

Robson emphasized that the team's ability to recover from such a disappointing loss was remarkable.

"It's a testament to how great these kids are, that they're becoming fantastic young men," he said.

In the tournament overall, the team

scored 12 goals and allowed just two in five games. Top scorers were Jacob Robson (four goals, one assist), Martin Mastschuch (two goals, two assists), Finn Montgomery (two goals, one assist) and Dexter White (two goals, one assist).

Robson highlighted the team's solid defensive play, which was led by centre backs Russell Ferguson and Jaiden Browning.

The coach also acknowledged the enthusiastic cheer squad, travelling with and rooting for the NVFC team. In one game, they were so rowdy that another team complained.

"The players from Ontario were actually complaining about our fan club," Robson said. "So it's a full team family win when the families are all there."

The sport is important to the players but also to the families, he said.

"I think we've made a lot of memories for a lot of people, which is the whole key thing."

REALIZE AMBITION
The Campaign for Canadian Politics

"Investing in the ambitions of Canadians is how we'll shape our future."

John Montalbano
Campaign Ambassador

RF Foundation
Robson-Fell Foundation

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Location of notification signs



- One bi-directional sign at the intersection of Amherst Avenue and Spicer Road
- One uni-directional sign at the south terminus of Riverside Drive
- Two bi-directional signs at the intersection of Old Dollarton Highway and Amherst Avenue
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Image of notification signs

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PROPOSAL:

Information is preliminary and subject to change

100 Amherst Avenue



Rezoning (site-specific Zoning Bylaw text amendment) to permit the production of liquid chlorine and permit on-site improvements to reduce community risk

WE ARE HERE

PUBLIC INFO MEETING → **PUBLIC HEARING** →



CHEMTRADE

Contact:
Amy Jonsson, Chemtrade Logistics Inc.
ajonsson@chemtradelogistics.com
236-808-7851

Notification flyer

Virtual Public Information Meeting

A two-week public input opportunity will be held through the District of North Vancouver's platform. This is an opportunity for neighbours to share their feedback and ask questions to Chemtrade regarding its rezoning application for their chlor-alkali facility located at 100 Amherst Avenue, North Vancouver.

The virtual information meeting will run from Monday, October 27 through to Friday, November 7, 2025, and be available at www.DNV.org/public-meeting

In-Person Information Meeting

Chemtrade will be hosting an in-person information meeting on Wednesday, October 29, 2025, from 6:00 p.m. to 8:00 p.m. at the Holiday Inn and Suites, North Vancouver, located at 700 Old Lillooet Rd, North Vancouver, BC.

The meeting will be an open house format with information stations and staff available for questions from 6:00 p.m. to 7:00 p.m., and a formal presentation and questions from the audience from 7:00 p.m. to 8:00 p.m.

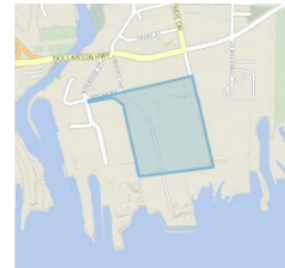
For more information, please contact:

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Chemtrade Electrochem Ltd.
ajonsson@chemtradelogistics.com
236-808-7851

Christopher Lumsden (he/they), Development Planner
District of North Vancouver
lumsdenc@dnv.org
604-990-2411 Ext. 7204

Notice for both an In-Person Information Meeting and a Virtual Public Information Meeting in Your Neighbourhood

Chemtrade is hosting both an in-person information session, as well as a virtual information meeting to present the rezoning application regarding its facility, located at 100 Amherst Avenue, North Vancouver.



This information is being distributed to the owners and occupants within 375 metres of the proposed rezoning site in accordance with District of North Vancouver policy.

Virtual Information Meeting:

October 27, 2025 – November 7, 2025

Please visit www.DNV.org/public-meeting to access the virtual two-week meeting.

In-Person Information Meeting:

Wednesday, October 29, 2025

6:00 p.m. – 8:00 p.m. (presentation to begin at 7:00 p.m.)
Holiday Inn and Suites, North Vancouver, located at 700 Old Lillooet Rd, North Vancouver, BC.

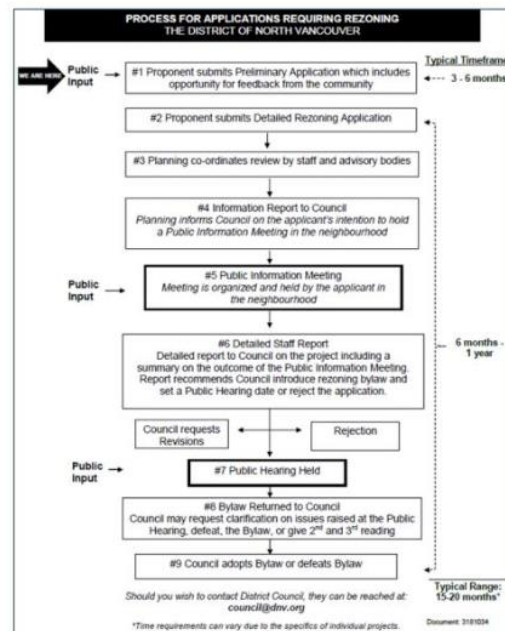
The Proposal:

Chemtrade's facility in North Vancouver produces up to 70 per cent of the liquid chlorine used to treat drinking water in BC and Alberta. This equates to 40 per cent of available liquid chlorine in Canada.

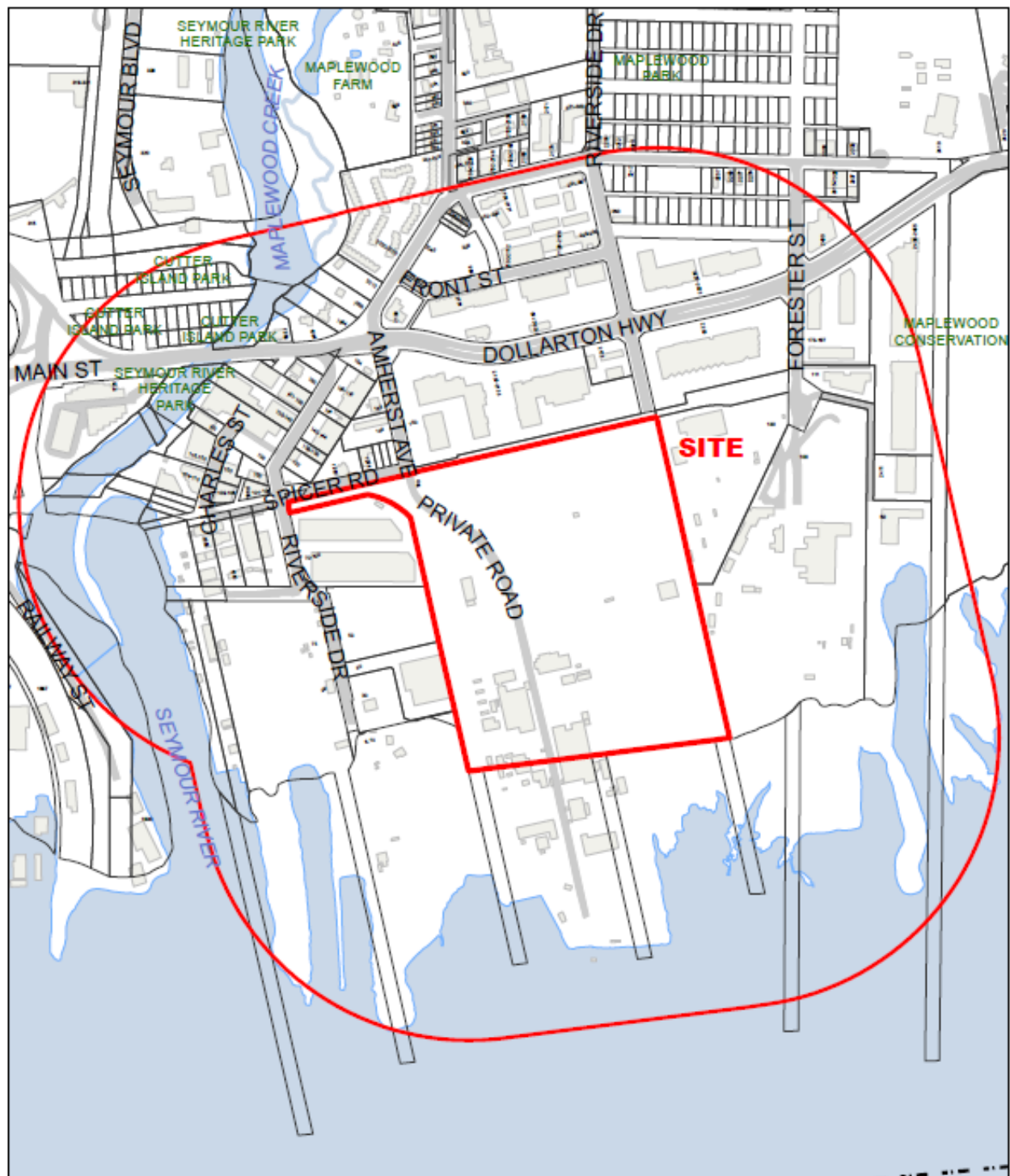
Chemtrade has proposed several major capital improvements aimed at increasing safety and reducing risk for the community. In order to move forward with these projects and to have the production of liquid chlorine listed as an allowable activity on its land, Chemtrade needs the District of Vancouver's approval to amend its prohibited uses regulations in relation to this property. All other zoning regulations related to this property will remain unchanged.



Proposed safety improvement projects, aimed at improving safety and reducing risk to the community to at or near the property line



Map of notification area (375m radius)



100 Amherst Ave-375M
375m BUFFER MAP



Appendix B: Virtual PIM Comments

Virtual PIM comments – Five comments were received via the virtual PIM

- Virtual PIM Comment #1 - 2025-10-28 08:27:18
 - o Hello: First, I am in favor of the proposal to allow Chem Trade to continue to operate in NV. We need industry in BC and companies like CT are vital to the economic success of BC. That said, during my work I had responsibilities for assessing risks at petrochemical facilities around the world and saw many facilities. I have had 2 tours of CT and suggest a condition of approval be that they CT commission a 3rd party operations review and develop a plan to meet world class standards.
- Virtual PIM Comment #2 - 2025-10-28 08:32:45
 - o Further to my previous comment, I observed during the 2 tours that CT operates a good plant, but it is not to the standards seen in the EU. Specifically, I observed many decommissioned items that had not been dismantled and removed. These can cause operational and safety issues as well as being unsightly. In addition to the decommissioned items, corrosion seemed to be an issue in several areas of the plant, and these should be reviewed. An operations review would address these and other items.
- Virtual PIM Comment #3 – 2025-10-31 10:50:07
 - o The North Van Chamber supports this application. Chemtrade’s application ensures North Van remains home to this major employer and a critical regional supplier for water treatment. Their investment will not only secure over 120 well paid local skilled jobs and the connected local supply chain of local businesses but will help sustain the local tax base that contributes to community infrastructure in North Van.
- Virtual PIM Comment #4 – 2025-11-07 11:25:13
 - o Since 1957, the Chemtrade facility in North Vancouver has been safely producing the liquid chlorine that communities in BC and beyond rely on for their supply of clean drinking water. As the MLA for North Vancouver-Seymour, I encourage the District of North Vancouver to approve this rezoning application so that Chemtrade can move forward with additional safety improvements in a timely manner, securing the future of safe drinking water in Canada and the safety of North Vancouver residents.
- Virtual PIM Comment #5 – 2025-11-07 07:03:05
 - o This region is no longer solely industrial. There are high density buildings and more residential buildings being developed. If there is even a slight risk of exposure that cannot be entirely mitigated or prevention set in place, then I strongly believe it should not be taking place. The area has changed over the years and is less and less industrial. This type of risk/exposure should not be considered in that region and should be relocating to a solely industry related region instead.

100 Amherst Avenue Development Application

Public Information Meeting Summary Report

Event Date: October 29, 2025
Time: 6pm – 8pm
Location: Holiday Inn, 700 Lillooet Road, District of North Vancouver
Attendance: 11 members of the public signed in.
Comments: 2 comments sheets and two letters: 3 in favour and 1 wanting additional study.

Meeting Purpose:

- 1) To present development application materials to neighbours
- 2) To provide an opportunity for neighbours to ask questions about the development
- 3) To provide an opportunity for neighbours to comment on the proposal.

Notification:

Invitation Brochures

Invitations were delivered to 1,613 addresses within 350m of the site, exceeding the 100m notification radius that is a standard District of North Vancouver requirement for most projects. Appendix A includes a copy of the invitation.

The addresses which were notified included the following:

Houses	1,252
Apartments	164
Businesses	197
Total	1,613

Newspaper Ad

Two newspaper ads were placed in the North Shore News: one on October 15, and the other on October 22, 2025. Copies of both of the ads are shown in Appendix A.

Signs Posted On Site

Chemtrade installed six notification signs on and near their site:

- One bi-directional sign at the intersection of Amherst Avenue and Spicer Road
- One uni-directional sign at the south terminus of Riverside Drive
- Two bi-directional signs at the intersection of Old Dollarton Highway and Amherst Avenue
- Two bi-directional signs at the intersection of Old Dollarton Highway and Riverside Drive.

A map of the sign locations and an image of the content is provided in Appendix A.

Newsletter Distribution

Chemtrade advertised the Public Information Meeting in the October 2025 edition of their newsletter, which was distributed to 175 people. The newsletter was also available on their web site. A copy of the newsletter with the ad is provided in Appendix A.

Social Media

Chemtrade advertised the Public Information via social media during the month of October, exceeding District notification requirements. A screenshot of the ad is provided in Appendix A.

Attendance:

Eleven members of the public signed in for the meeting.

A copy of the sign-in sheets is included in Appendix B.

The following municipal representatives and project team members were in attendance:

District of North Vancouver:

- Christopher Lumsden, Development Planner

Project Team members:

- Alan Robinson, Group Vice President, Commercial
- Dale Bossons, Vice President, Manufacturing, Electrochem
- Raman Batra, Senior Director, Electrochem
- Alvin Loh, Plant Manager, North Vancouver
- Toofan Ostovar, EHS Manager
- Michelle Campbell, Environmental Specialist
- Blair Hetherington, Emergency Response Systems Manager
- Fareed Ebrahim, Senior Technical Advisor, Process Safety
- Bryan Ritchey, Senior Electrochem Technical Advisor
- Drew Somerville, Project Manager, Electrochem
- Amy Jonsson, Director, Corporate Communications
- Kris Petterson, Production Manager

Facilitator:

- Steven Petersson, Petersson Planning Consulting

Meeting Format:

The meeting featured an Open House, Presentation, and Facilitated Dialogue to provide members of the public a variety of ways to participate in the process. The entire meeting ran between 6pm and 8pm.

The Open House portion of the meeting ran from 6pm to 7pm. Open House participants were able to ask questions from the many project team members to learn more about production, planned safety improvements, and the facility.

During the second hour, Alan Robinson and Dale Bossons presented project information to the participants. The presentation included information about the development application, the history of the company, the importance of their product to provide a safe water supply, and technical information to help the public understand the safety improvements that would result if the project is approved.

After the presentation, Steven Petersson facilitated a dialogue with the public and documented all questions and comments. Every participant who wished to speak had opportunity to do so.

Comment Sheet and Correspondence Summary

Participants were encouraged to submit written comments for inclusion in this report. Participants could submit their comments during a two-week comment period, which ended on November 10, 2025. Two chose to submit comment sheets: one expressed support for the proposal, and the other advocated additional study.

Two letters were received during the notification and comment period, including a letter from Premier Eby. Both letters were in support of the project.

Redacted copies of each written submission are included in Appendix C.

Discussion Summary

Below is a summary of the facilitated dialogue. Questions and answers have been numbered to help follow the flow of the conversation. Q is for Questions, C is for Comments, and A is for Answers.

Q1: Has Chlorine gas been unintentionally released from bulk storage since 2010?

A1: There have been no significant unintentional releases of chlorine gas since 2010. There have been minor releases that required precautions, but no incidents. The proposed new safety improvements will significantly decrease risk and increase safety.

C2: I don't think a 10^{-6} probability of being struck by lightning is a good comparison to represent the risk of harm on this site.

Q3: An adjacent industrial site stores hydrogen in a tank. Has Chemtrade analyzed the risk from neighbouring industrial activity?

A3: Chemtrade works with neighbours to understand the impacts of their activities. In this example, Chemtrade currently purchases hydrogen from a neighbouring site. Chemtrade has reviewed the quantitative risk curves of the proposed HTEC hydrogen project, and Chemtrade will be not be at risk from the neighbouring hydrogen storage because of the risk radius.

Q4: What is a "minor exposure" or upset? How large were past chlorine leaks?

A4: The leaks were minor because they were measured in kilograms, rather than tons, and the impact did not leave the site. Workers who received minor exposure were treated with no long-term health impacts. There has never been a fatality.

C5: Chlorine gas in the air has a much different risk of health impact than chlorine in water. Chlorine can be safely used to purify water for drinking.

Conclusion

The purpose of this Public Information Meeting was to present project information to neighbours, provide the public an opportunity to ask questions, and provide an opportunity for public comment.

Over 1,600 invitations were sent to all owners and tenants within 375m of the site, exceeding the 100m notification radius the District typically requires. Two newspaper ads were placed in the North Shore News. Six notification signs were posted at and near the subject site. In addition to District requirements, Chemtrade also advertised the Public Information meeting in the October 2025 edition of their newsletter, which was distributed to 175 people. They also advertised the Public Information Meeting via social media during October 2025.

The public could participate in this process in five ways:

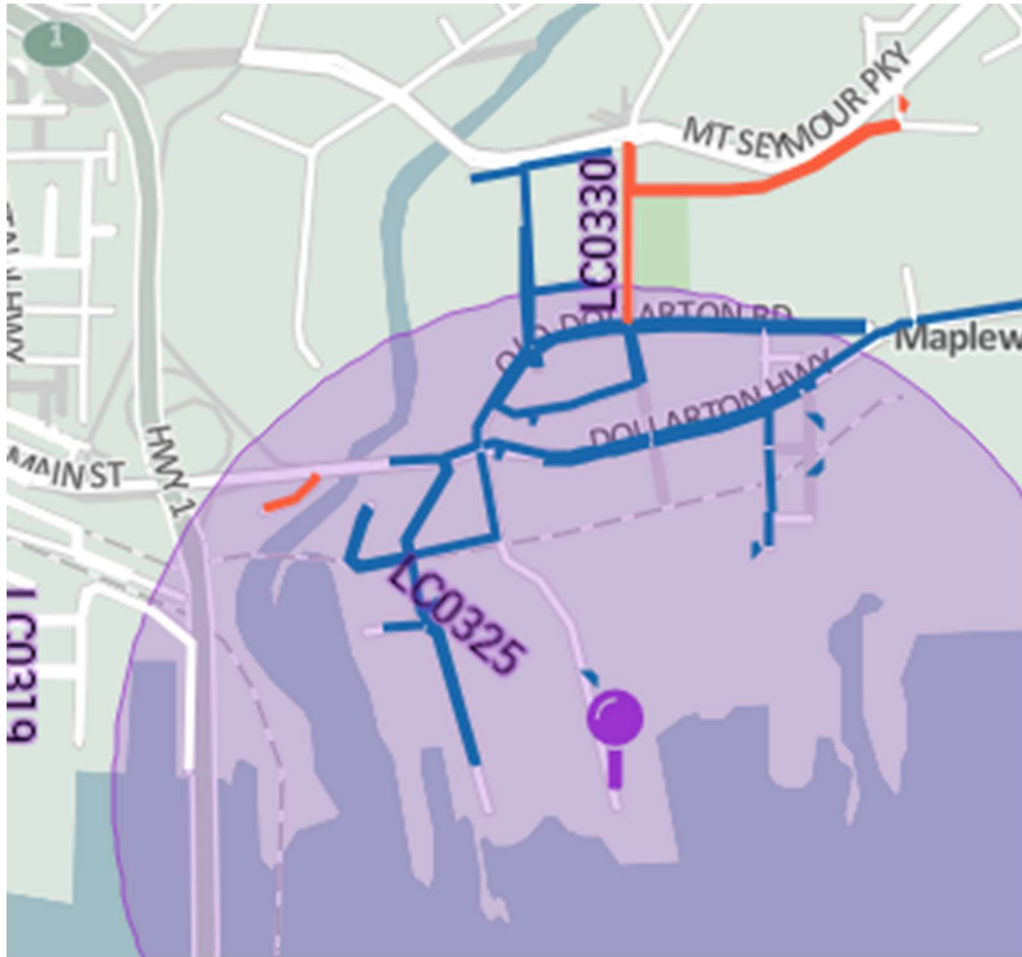
- browsing boards
- talking to the project team and municipal Development Planner
- listening to a presentation
- participating in a facilitated dialogue
- submitting written comments.

Eleven participants signed in and participated in the meeting. Two comment sheets and two letters were submitted during the notification period: three expressed support, and one advocated for additional study.

The meeting length, format, and project team presence was sufficient to provide all participants an opportunity to learn more, ask questions, and provide comments.

Appendix A: Notification

Notification Area:



Notification Letter

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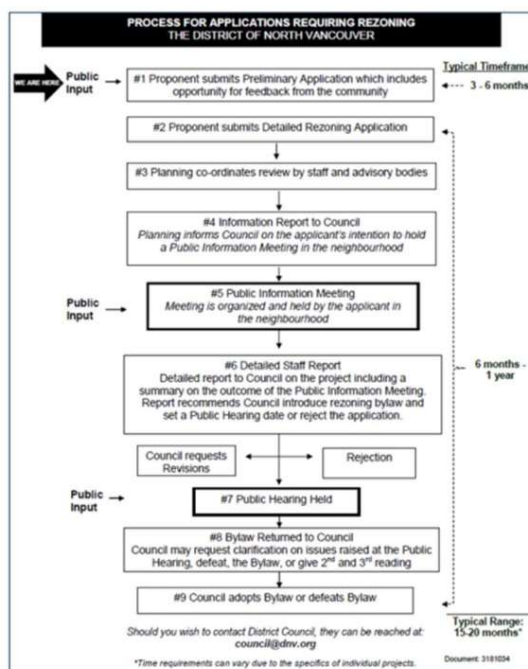
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We're proud to be building the world's first net zero LNG export facility safely, responsibly, and under the oversight of the Skwxwú7mesh Úxwumixw (Squamish Nation) — follow us to see how it's taking shape right here in Squamish.

woodfibrelng.ca/news



northshorenews nsnews.com

WEDNESDAY, OCTOBER 22, 2025 | A19



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First national medal for club

Continued from A18

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"It's a testament to how great these kids are, that they're becoming fantastic young men," he said.

In the tournament overall, the team

scored 12 goals and allowed just two in five games. Top scorers were Jacob Robson (four goals, one assist), Martin Mastschuch (two goals, two assists), Finn Montgomery (two goals, one assist) and Dexter White (two goals, one assist).

Robson highlighted the team's solid defensive play, which was led by centre backs Russell Ferguson and Jaiden Browning.

The coach also acknowledged the enthusiastic cheer squad, travelling with and rooting for the NVFC team. In one game, they were so rowdy that another team complained.

"The players from Ontario were actually complaining about our fan club," Robson said. "So it's a full team family win when the families are all there."

The sport is important to the players but also to the families, he said.

"I think we've made a lot of memories for a lot of people, which is the whole key thing."

REALIZE AMBITION
Help Realize Canadian and Canadian Potential

"Investing in the ambitions of Canadians is how we'll shape our future."

John Montalbano
 Campaign Ambassador

RHF Fondation Rideau Hall Foundation

Development Proposal

PUBLIC INFO MEETING

**Wednesday, Oct. 29,
 6:00-8:00pm**
 700 Lillooet Road North
 (Holiday Inn & Suites North Vancouver)

Participate virtually
 Oct. 27-Nov. 7 at
[DNV.org/public-meeting](https://dnv.org/public-meeting)



PROPOSAL: 100 Amherst Avenue

A site-specific text amendment to the Zoning Bylaw to permit the production of a hazardous substance (liquid chlorine), which will permit several on-site capital improvements aimed at reducing the overall risk associated with the proposed use to the surrounding community.



Contact:

Amy Jonsson, Chemtrade Logistics Inc.
ajonsson@chemtradelogistics.com 236-808-7851

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Notification Sign Locations



Notification Sign Content

Development Proposal

PUBLIC INFO MEETING:

Wednesday, Oct. 29, 6:00–8:00pm
700 Lillooet Road North (Holiday Inn
& Suites North Vancouver)

Participate virtually Oct. 27–Nov. 7
at **DNV.org/public-meeting**

PROPOSAL:

*Information is preliminary
and subject to change*

100 Amherst Avenue



**Rezoning (site-specific
Zoning Bylaw text
amendment) to permit
the production of
liquid chlorine and
permit on-site
improvements to
reduce community risk**

WE ARE HERE

PUBLIC INFO MEETING

PUBLIC HEARING



Contact:

Amy Jonsson, Chemtrade Logistics Inc.
ajonsson@chemtradelogistics.com
236-808-7851

Notification in October 2025 Chemtrade Newsletter

Chemtrade North Vancouver Community Update

October 2025 – Special Update

Issue 9

Knowing the significant role that Chemtrade liquid chlorine plays in supporting safe drinking water for millions of Canadians, and the growing uncertainty in North American trade relationships and uncertain geopolitical conditions, we are having conversations regarding how to maintain our potential future operations and secure our Canadian supply chain of this critical product.



About Chemtrade

Chemtrade's North Vancouver chlor-alkali facility is one of Canada's largest providers of liquid chlorine – accounting for 40 per cent of all liquid chlorine available in Canada. Regionally, this equates to over 70 per cent of the liquid chlorine available in BC and Alberta. **Why is this important?** A study conducted by [Statistics Canada in 2015](#) found that 96 per cent of Canadian communities relied on chlorine to treat their municipal water supply, which supplies over 30.7 million Canadians.

In this issue:

- District of North Vancouver rezoning application update
- Opportunities to engage
- Ways to stay in touch

District of North Vancouver Rezoning Application Update

On September 25, we submitted our full rezoning application, to request that the production of liquid chlorine be listed as an allowable activity on our property (100 Amherst Avenue, North Vancouver). We are taking this step so that we can apply for development permits from the District for our planned safety improvement projects, which will substantially reduce potential risk for the community – see below enhanced photo which depicts the planned railcar loading enclosure, condenser tower, and tank farm for the air scrubbing equipment.

What now?

The District of North Vancouver has a formal process for the rezoning process, which includes several opportunities for the public to engage.

As part of the process, we will be hosting two Public Information Meeting (PIM) opportunities in the coming weeks, and then following that, there will be a Public Hearing (date to be confirmed).



Page 1 of 2

Chemtrade North Vancouver Community Update

October 2025 – Special Update

Issue 9

Virtual Public Information Meeting (PIM)

A two-week public input opportunity will be held through the District of North Vancouver's platform. This is an opportunity for neighbours to share their feedback and ask questions to Chemtrade regarding its rezoning application for their chlor-alkali facility located at 100 Amherst Avenue, North Vancouver. The virtual PIM will run from Monday, October 27 through to Friday, November 7, 2025, and be available at www.DNV.org/public-meeting

In-Person Public Information Meeting (PIM)

Chemtrade will be hosting an in-person PIM on Wednesday, October 29, 2025, from 6:00 p.m. to 8:00 p.m. at the Holiday Inn and Suites, North Vancouver, located at 700 Old Lillooet Rd, North Vancouver, BC.

The meeting will be an open house format with information stations and staff available for questions from 6:00 p.m. to 7:00 p.m., and a formal presentation and questions from the audience from 7:00 p.m. to 8:00 p.m.

For more information on either meeting, please contact:

Amy Jonsson
Director, Corporate Communications
Chemtrade Electrochem Ltd.
ajonsson@chemtradelogistics.com
236-808-7851

Christopher Lumsden (he/they)
Development Planner
District of North Vancouver
lumsdenc@dnv.org
604-990-2411 Ext. 7204



Above left: QRA curves developed in 2006 which reflect today's operations



Above right: Updated final QRA curves showing projected risk following completion of proposed safety projects and reduction of on-site chlorine storage

Ways to contact us

- Visit www.AskChemtrade.ca to submit questions, find information, and send a message
- Reach out directly to Amy Jonsson at ajonsson@chemtradelogistics.com
- Visit our Facebook page (<https://www.facebook.com/chemtrade>) and send us a message.



Page 2 of 2

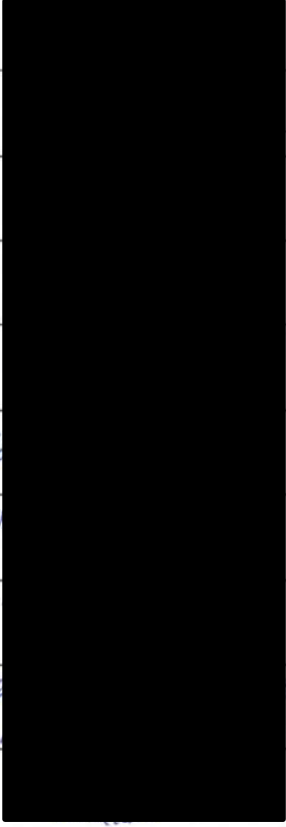
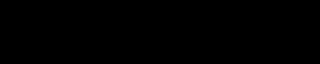
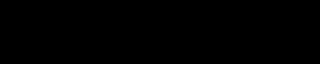
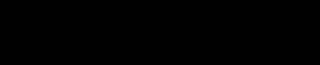
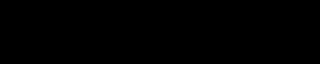
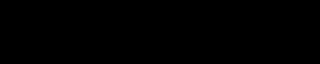
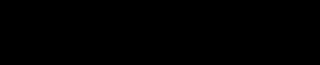
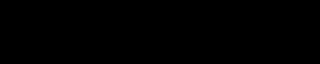
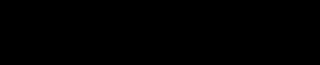
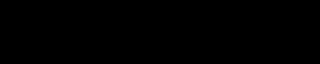
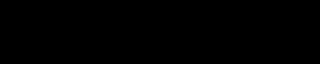
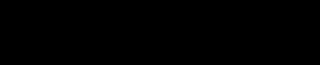
Social Media Notification



Appendix B – Sign-In Sheets:

100 Amherst Avenue (Chemtrade)
Public Information Meeting – October 29, 2025

SIGN IN SHEET

Name	Address	Email (optional)
		
		
		
		
		
		
		
		
		
		
		
		
		

The personal information collected on this form is done so pursuant to the *Community Charter* and/or the *Local Government Act* and in accordance with the *Freedom of Information and Protection of Privacy Act*. The personal information collected herein will be used only for the purpose of this public consultation process unless its release is authorized by its owner or is compelled by a Court or an agent duly authorized under another Act.

Further information may be obtained by speaking with
The District of North Vancouver's Manager of Administrative Services at 604-990-2207.

Document:

100 Amherst Avenue (Chemtrade)
Public Information Meeting – October 29, 2025

SIGN IN SHEET

Name	Address	Email (optional)
		

The personal information collected on this form is done so pursuant to the *Community Charter* and/or the *Local Government Act* and in accordance with the *Freedom of Information and Protection of Privacy Act*. The personal information collected herein will be used only for the purpose of this public consultation process unless its release is authorized by its owner or is compelled by a Court or an agent duly authorized under another Act.

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Document:

Appendix C – Public Comments: Comment Sheets & Letters:

PUBLIC INFORMATION MEETING – COMMENT SHEET
The District of North Vancouver

APPLICANT: Chemtrade

SITE ADDRESS: 100 Amherst Avenue

PROPOSAL: Rezoning (*amendment to Section 403A of the Zoning Bylaw*) to permit the continued production of a hazardous substance (liquid chlorine) at an existing facility on the subject site. The proposed rezoning would allow for the completion of several capital improvements aimed at improving overall site safety.

To help us determine neighbourhood opinions, please provide us with any input you have on this project (feel free to attach additional sheets):

A Human Health Risk Assessment
has NOT been done.
Most major projects require a HHR1
and because this facility was built
70 years ago, one has never been done.
Acute + Chronic Health impact should be assessed.
as well as community health impact

Your Name

Street Address

Please check this box if you desire your contact information to be available to the applicant: ☒

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Please return by mail or email by November 10, 2025 to:

DNV Development Planner: Christopher Lumsden

Phone: 604-990-2411 Ext. 7204

Email: lumsdenc@dnv.org

District of North Vancouver – Development Planning Department
355 West Queens Road, North Vancouver, BC V7N 4N5

Document:

PUBLIC INFORMATION MEETING – COMMENT SHEET
The District of North Vancouver

APPLICANT: Chemtrade

SITE ADDRESS: 100 Amherst Avenue

PROPOSAL: Rezoning (amendment to Section 403A of the Zoning Bylaw) to permit the continued production of a hazardous substance (liquid chlorine) at an existing facility on the subject site. The proposed rezoning would allow for the completion of several capital improvements aimed at improving overall site safety.

To help us determine neighbourhood opinions, please provide us with any input you have on this project (feel free to attach additional sheets):

The precautionary efforts of Chemtrade, going beyond the line of duty, appreciated. That means providing methan peroxide with the highly-in-demand liquid chlorine in a self-sufficient & safe manner. Thanks for well-supported presentation, and honest accurate answers to the public questions. Nina Yarnes, SCD,

Your Name

Street Address

Please check this box if you desire your contact information to be available to the applicant: ☐

The personal information collected on this form is done so pursuant to the *Community Charter* and/or the *Local Government Act* and in accordance with the *Freedom of Information and Protection of Privacy Act*. The personal information collected herein will be used only for the purpose of this public consultation process unless its release is authorized by its owner or is compelled by a Court or an agent duly authorized under another Act. Further information may be obtained by speaking with The District of North Vancouver's Manager of Administrative Services at 604-990-2207.

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DNV Development Planner: Christopher Lumsden

Phone: 604-990-2411 Ext. 7204

Email: lumsdenc@dnv.org

District of North Vancouver – Development Planning Department
355 West Queens Road, North Vancouver, BC V7N 4N5

Document:



A MESSAGE *from* PREMIER DAVID EBY

As Premier of British Columbia I extend greetings to everyone attending today's Public Information Meeting for Chemtrade's North Vancouver chlor-alkali facility.

Operating since 1957, this facility is the largest producer of liquid chlorine in Canada, supplying almost 70 per cent of liquid chlorine used in Western Canada, 40 per cent used across the country, and up to 60 per cent used in the Western United States. Liquid chlorine plays a significant role in the treatment of municipal water supplies and holds potential to support the development of clean fuels that support BC's decarbonization efforts.

In 2010, \$500 million was invested to modernize this facility's operations and improve safety, ensuring the continued availability of this critical product. Through the proposed rezoning, Chemtrade can ensure business continuity, functioning in its vital role of securing safe drinking water for millions of people across Canada and the US.

I would like to recognize everyone who came out today to lend their voices to this matter. Public engagement ensures that projects like this can move forward with community support.

A handwritten signature in blue ink, reading 'David Eby'.

Honourable David Eby, KC
Premier of British Columbia

From: [REDACTED]

Sent: Tuesday, October 28, 2025 12:56 PM

To: council@dnv.org

Cc: Jonsson, Amy [REDACTED]

Subject: CHEMTRADE ...

An important company in our community, economically and for the health and safety of residents. I fully support them.

[REDACTED], cnv Resident

Born 'n Raised in North Vancouver



LEGISLATIVE ASSEMBLY

of BRITISH COLUMBIA



September 4th, 2025

Mayor and Council
District of North Vancouver
355 West Queens Road
North Vancouver, BC V7N 4N5
Sent via email: council@dnv.ca

Dear Mayor and Council of the District of North Vancouver,

I am writing to express my support for the rezoning required for the continued operation of Chemtrade's North Vancouver chlor-alkali facility, located at 110 Amherst Avenue, North Vancouver, BC.

As the main provider of liquid chlorine for water purification in Western Canada, Chemtrade has consistently demonstrated their commitment to ensuring a clean supply of drinking water on the North Shore and beyond.

Now more than ever, it's important that British Columbians can rely on a liquid chlorine supply from within our borders. Chemtrade's North Vancouver facility produces almost 70 per cent of the liquid chlorine used in Western Canada, and 40 per cent of the chlorine used across the country. Chemtrade's continued operations in North Vancouver will guarantee the security of our own chlorine supply here in BC.

I have had the opportunity to visit the facility and to meet with the company multiple times. They keep the safety of their workers, the community, and the ecosystems surrounding the facility at the forefront of their work. It has operated safely and reliably for decades, and the improvements made possible by Chemtrade's rezoning proposal would improve safety even further, virtually eliminating risk beyond the property boundary.

Chemtrade has also made notable strides in sustainability and environmental stewardship. Their efforts to optimize production processes, reduce waste, and adopt sustainable practices align with global goals and our community's values regarding environmental responsibility. Their focus on meeting rigorous compliance standards highlights their dedication to putting communities first. I have also been greatly impressed by Chemtrade's community engagement efforts, which demonstrate values of openness, transparency, and respect.

As an employer in our community, Chemtrade is committed to diversity and equity and creating a safe work environment. Chemtrade's North Vancouver facility is a key component of our local economy, and both current and former employees speak to its well-deserved reputation as a great place to work.

**North Vancouver-Seymour Constituency
Office**
217-1233 Lynn Valley Road
North Vancouver, B.C. V7J 0A1
T 604.983.9859
Susie.Chant.MLA@leg.bc.ca

Legislative Office
Parliament Buildings
Victoria, B.C. V8V 1X4
T 250.387.3655

Chemtrade Logistics has earned its reputation as a reliable and innovative company, and their commitment to excellence is evident in every facet of their operations.

I am proud to support Chemtrade and their rezoning application, and I look forward to seeing their continued success and positive impact on the North Shore.

Sincerely,



Susie Chant, MLA
North Vancouver-Seymour

cc: Alan Robinson, Group Vice President, Commercial, Chemtrade Logistics Inc.
Amy Jonsson, Director, Corporate Communications, Chemtrade Logistics Inc.



February 26, 2025

His Worship Mike Little
Mayor of North Vancouver
355 West Queens Road
North Vancouver, BC V7N 4N5
Sent via email: mayor@dnv.org

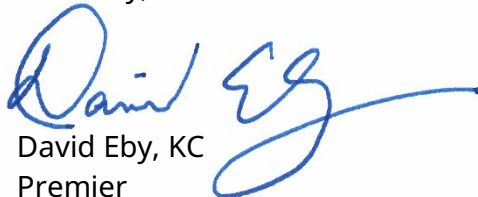
Dear Mayor Little:

I am writing today to express my support for the continued operation of Chemtrade's North Vancouver chlor-alkali facility. The facility is the largest producer of liquid chlorine in Canada and is critical for securing safe drinking water for millions of Canadians and Americans. It also produces almost 70 per cent of the liquid chlorine used in Western Canada, 40 per cent of the liquid chlorine used across the country, and up to 60 per cent of the liquid chlorine used in the Western United States. I also understand that this facility holds potential to assist in the development of clean fuels that support British Columbia's decarbonization efforts.

The facility has been in continuous, safe operation since 1957. In 2010, over \$500 million was invested in the plant to modernize its operations and improve safety, with plans to continue this type of investment should it secure the ability to continue to operate.

I respectfully ask that the rezoning application required through the District of North Vancouver be expedited and approved in a timely manner to ensure business continuity for the facility and the safety of Canadian and US drinking water.

Sincerely,

A blue ink signature of David Eby, consisting of a stylized 'D' and 'E' followed by a long horizontal stroke.

David Eby, KC
Premier

cc: Alan Robinson, Group Vice President, Commercial, Chemtrade Logistics Inc.

THIS PAGE LEFT BLANK INTENTIONALLY

From: [Corrie Kost](#)
To: [Mayor and Council - DNV](#)
Cc: [DNV Input](#)
Subject: Bylaw 8778 - Text Amendment Rezoning – 100 Amherst Avenue (Chemtrade)
Date: January 11, 2026 8:18:21 PM
Attachments: [Jan 12 2026 Comments on Bylaw 8778 - Text Amending Rezoning -100 Amherst Avenue .pdf](#)

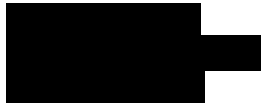
CAUTION: This email originated from outside of the DNV. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Your Worship & Members of Council,

The attached comments relate to Agenda item 8.3 of council package for Monday Jan 12 2026

If appropriate I would like to give a short summary to council at the public input period.

Yours truly,
Corrie Kost



Your Worship & Members of Council

Re: Bylaw 8778 - Text Amendment Rezoning – 100 Amherst Avenue (Chemtrade)

I will leave the detailed discussion for the likely future public hearing on the subject matter.

The following are some preliminary observations on the subject matter.

- Having read the staff report I note, that of the multitude of public notifications on this matter, the actual response by the public seems very low. (see pages 98, 105, and 106). Perhaps this is due to the repetition of the documents and the lack of clarity of risk assessments.
- With the proposed safety improvements the risks from chlorine production elements would seem to be low. However there is no detailed accounting for the risk associated with the massive storage of liquid chlorine in rail cars located on or near the production site.
- Risks to the chlorine plant resulting from the nearby Hydrogen production facilities seem not to be clearly accounted for -at least no detailed report on the subject is attached. (see page 116 Q3/A3)
- According to another public statement on page 129 a "Human Health Risk Assessment" (HHRA) – a process to determine if contaminants detected on the site are of concern to human health and the environment, has apparently never been conducted on this site since 1951. This is separate from the chlorine risk issues.
- As part of the application (figure 4 of page 141) proposes to enclose the railcar loading of chlorine in a "new enclosed Railcar Loading Building and thereby significantly reduce the overall site risk from a chlorine spill during the loading process. However there is no detailed report on this matter, nor a study to confirm this by a DNV designated independent review. It is essential to have this material well before any scheduled public hearing on this matter.
- It would be interesting to know if there are ANY other industrial sites produce a substance/chemical that could be of risk to the nearby community. In other words, is the Chlorine plant unique in terms of a public hazard in the DNV?

Yours truly,
Corrie Kost



From: Graham Gilley <[REDACTED]>
Sent: February 17, 2026 8:00 AM
To: DNV Input
Subject: Hearing for amendment to Bylaw 8778 - written submission
Attachments: Bylaw 8778 Amendment Submission G_Gilley.pdf

EXTERNAL: Do not click links or open attachments unless you trust the sender and content.

Good morning DNV Corporate Officer,

Please find attached a written submission for Council's attention regarding the Amendment to Bylaw 8778, being heard on February 24, 2026.

Graham Gilley
[REDACTED]

To: Mayor and Council
District of North Vancouver
Subject: Submission in Support of the Chemtrade Rezoning Application

Dear Mayor and Members of Council,

My name is Graham Gilley, and I am a resident and taxpayer in the District of North Vancouver. I am writing to express my support of the amendment to Bylaw 8778 for the Chemtrade facility located at 100 Amherst Avenue. As a community member with a vested interest in the long-term safety, livability, and economic health of our district, I believe this application deserves careful consideration through a balanced and evidence-based lens.

In addition to my perspective as a resident, I have had the opportunity to tour the Chemtrade site in my capacity as Chair of the Windsor Secondary PAC, alongside the school principal and fellow PAC Executive members. This visit provided valuable firsthand insight into the facility's operations, safety culture, and risk mitigation measures. We found the experience informative, professional, and reassuring.

My overall view is further informed by my 20+ years working in Enterprise Risk Management (ERM) - an approach that recognizes that risk is best managed through disciplined mitigation, strong governance, and continuous oversight.

A Risk Management Perspective

ERM principles emphasize that risk cannot simply be avoided by eliminating necessary activities. Rather, risk is responsibly reduced through structured controls, engineering safeguards, operational discipline, and emergency preparedness. Chemtrade's North Vancouver plant reflects these practices. The facility has demonstrated:

- A strong and consistent safety record
- Comprehensive process safety and operational management systems
- Redundant engineering controls and monitoring
- Rigorous employee training and certification
- Detailed emergency response planning
- Ongoing regulatory compliance and oversight

Notably, Chemtrade's operations include *limiting chemical storage volumes on-site*, a key mitigation measure that reduces potential incident severity. This is directly aligned with modern risk reduction strategies.

Essential Contributions to Public Health and Daily Life

Chemtrade produces materials that are fundamental to public safety, health, and modern living:

- Liquid Chlorine - primarily used for municipal drinking water treatment.
- Sodium Hydroxide - essential in soaps, cleaners, pulp and paper processing, and water treatment.
- Hydrochloric Acid - used in steel cleaning, oil and gas production, and manufacturing of water treatment chemicals.

These are not discretionary products. **Every resident** of the District of North Vancouver - including those who oppose this application - relies on these materials indirectly through safe drinking water, sanitation, healthcare, consumer goods, and infrastructure.

From a broader risk perspective, maintaining domestic production reduces supply chain vulnerabilities and transportation-related risks.

Economic Stability and Community Resilience

As a taxpayer, I recognize the importance of stable, skilled employment and a diversified local economy. Chemtrade provides well-paying, technically skilled jobs that support families, generate tax revenue, and contribute to community resilience. ERM frameworks recognize economic stability and employment as critical components of long-term municipal sustainability.

Balancing Perception and Managed Risk

Community concerns regarding industrial facilities are understandable. However, sound policy decisions require distinguishing between perceived risk and demonstrably managed risk.

Chemtrade's safety history, mitigation strategies, and regulatory oversight indicate an operation that actively manages its risk profile. Relocating or restricting such facilities does not eliminate societal need or risk — it often shifts risk elsewhere, potentially increasing environmental and logistical exposures.

I believe supporting this rezoning application represents a rational, balanced, and forward-looking decision. It acknowledges responsible risk management, essential public health contributions, and meaningful economic benefits to the community.

I respectfully encourage Council to approve the application.

Thank you for your time, consideration, and commitment to thoughtful governance.

Sincerely,



Graham Gilley

From: Graham Gilley [REDACTED]
Sent: February 19, 2026 9:25 AM
To: DNV Input
Subject: DUPLICATE: Hearing for amendment to Bylaw 8778 - written submission
Attachments: Bylaw 8778 Amendment Submission G_Gilley.pdf

EXTERNAL: Do not click links or open attachments unless you trust the sender and content.

Good morning - my original message may not have been delivered. Could you please confirm receipt?

Thx/gg

----- Forwarded message -----

From: **Graham Gilley** [REDACTED]
Date: Tue, Feb 17, 2026 at 8:00 AM
Subject: Hearing for amendment to Bylaw 8778 - written submission
To: <input@dnv.org>

Good morning DNV Corporate Officer,

Please find attached a written submission for Council's attention regarding the Amendment to Bylaw 8778, being heard on February 24, 2026.

Graham Gilley

[REDACTED]
[REDACTED]

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District of North Vancouver

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Community concerns regarding industrial facilities are understandable. However, sound policy decisions require distinguishing between perceived risk and demonstrably managed risk.

Chemtrade's safety history, mitigation strategies, and regulatory oversight indicate an operation that actively manages its risk profile. Relocating or restricting such facilities does not eliminate societal need or risk — it often shifts risk elsewhere, potentially increasing environmental and logistical exposures.

I believe supporting this rezoning application represents a rational, balanced, and forward-looking decision. It acknowledges responsible risk management, essential public health contributions, and meaningful economic benefits to the community.

I respectfully encourage Council to approve the application.

Thank you for your time, consideration, and commitment to thoughtful governance.

Sincerely,



Graham Gilley

From: Michael Graveson <OMG.Consulting@outlook.com>
Sent: February 20, 2026 9:23 AM
To: DNV Input
Subject: AcuTech Risk Assessment for Feb 24 Public Hearing for 100 Amherst Ave
Attachments: AcuTech Summary.pdf; AcuTech Risk Assessment Full Report.pdf

EXTERNAL: Do not click links or open attachments unless you trust the sender and content.

Please find attached reports from AcuTech for the February 24 meeting Public Hearing for 100 Amherst Avenue.

Kindly confirm receipt.

ACUTECH RISK ASSESSMENT SUMMARY



Overall Determination

Storing and transporting chlorine through the District of North Vancouver poses a high-consequence risk to the public, which is not tolerable based on risk criteria defined by MIACC.

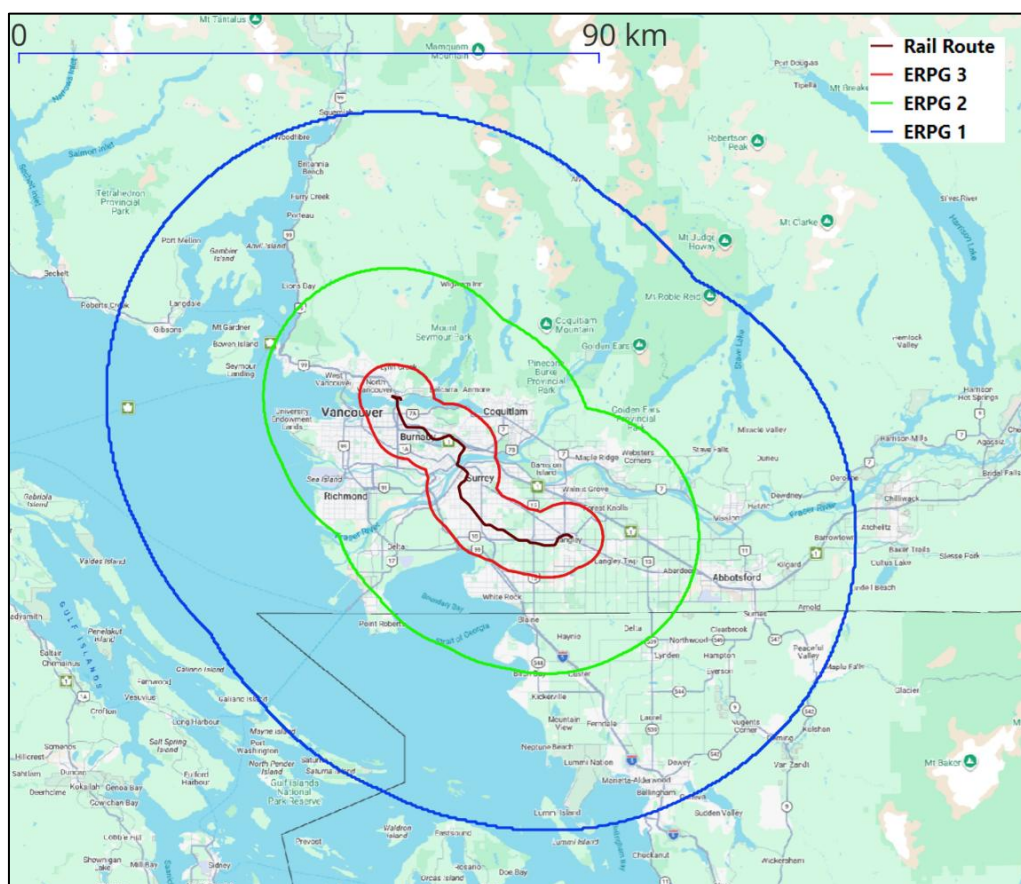
The proposed reduction in the liquid chlorine stored onsite is less than 3% of the entire onsite inventory, and does not significantly decrease the site's hazard profile. The thirty-two moving storage vessels (i.e., railcars) are more vulnerable and present significantly more risk than the single static bulk storage vessel being removed.

Converting chlorine to bleach onsite would eliminate the risks and is an established safety strategy used by the industry.

- The following summarizes an extensive Risk Assessment report written by industry experts at AcuTech. **AcuTech authored the Center for Chemical Process Safety's Guidelines for Chemical Transportation Safety, Security and Risk Management (2nd Edition).** AcuTech understand the risks associated with hazardous chemical production, storage, and transport, and have conducted thousands of risk studies across many industries.
- This study evaluates the public **consequences and risks** associated with the **storage and transportation of chlorine railcars** produced at Chemtrade's facility in North Vancouver. It also analyzes onsite conversion of chlorine to bleach as an alternative to shipping chlorine, which would eliminate the need to transport liquefied chlorine by rail for offsite conversion to bleach.
- Chlorine is classified as an **"extremely hazardous substance"** (EHS) due to its acute inhalation toxicity. Each railcar can carry up to 82 metric tonnes of liquefied chlorine, which **rapidly forms a dense, ground-level toxic cloud if released.**
- A **consequence-based** analysis is most useful for emergency response planning, as **responders must prepare for credible catastrophic scenarios** that could overwhelm emergency response, or threaten entire neighborhoods. Likelihood-based or **probability-based assessments provide an understanding of how soon an event may be expected to occur**, but do not illustrate worst-case consequences as dictated by MIACC guidance.
- **Derailments happen regularly**, and are the leading cause of hazardous-material releases.
 - Since 1995, at least **four chlorine rail accidents** have caused **13 fatalities and 300+ hospitalizations.**
 - Accident rates tend to be higher on **low-speed urban rail lines**, similar to those in Vancouver.
- While the proposed liquid chlorine loading building is designed to mitigate risks while loading onsite, the loaded railcars are shipped through the city without containment to mitigate the risks.
- Modeling of credible accident scenarios indicates that:
 - **A single large chlorine railcar release could generate a toxic vapor cloud estimated to cause up to 2,000 fatalities** and result in **evacuation of thousands of additional residents** in greater Vancouver.
 - The hazard zone includes **hundreds of sensitive locations such as schools, hospitals, childcare facilities, senior residences, and dense housing.**
- Current chlorine transport conditions present **intolerable risk levels** (as defined by MIACC) and a credible potential for catastrophic public harm that **warrant action to eliminate or reduce the risks.**
 - These risk results incorporate mitigating factors that reduce the risks of chlorine transport by rail, such as robust tank designs and rail speed limits, but **despite these factors, the risks levels are intolerable.**
- Producing **bleach** (sodium hypochlorite) onsite could **eliminate liquid chlorine** in railcars, and **eliminate the risk of catastrophic toxic hazards.**

ACUTECH RISK ASSESSMENT SUMMARY

Impact Zones for Single Railcar Release Events Along the Rail Line

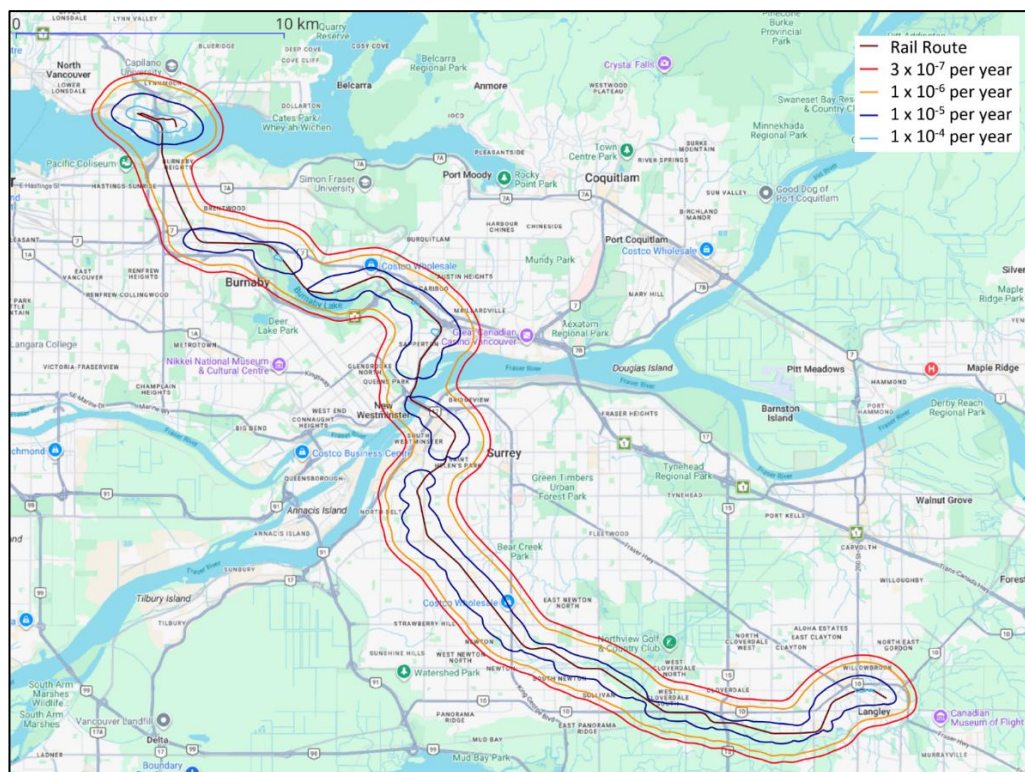


Emergency Response Planning Guidelines for Chlorine

20 ppm - ERPG-3 - life-threatening health effects

3 ppm - ERPG-2 - serious, irreversible health effects or symptoms which could impair an individual's ability to take protective action

1 ppm - ERPG-1 mild, transient health effects, a clearly defined objectionable odor



Toxic Risk Contour for Chlorine Railcars

MIACC Criteria

100 in a million (1×10^{-4}) - Tolerable limit for manufacturing, warehousing and open space

10 in a million (1×10^{-5}) - Tolerable limit for low-density residential and commercial

1 in a million (1×10^{-6}) - Tolerable limit for high-density residential and commercial

0.3 in a million (3×10^{-7}) - Tolerable limit for sensitive developments, such as childcare facilities and hospitals

FINAL REPORT

Risk Assessment of Chlorine Railcars in the District of North Vancouver, Canada

February 20, 2026



AcuTech Group, Inc.

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Authorization Sheet

Distribution Restrictions:	Issued for Public Review
Report Title:	Risk Assessment of Chlorine Railcars in Vancouver, Canada
Report Version:	FINAL Report

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1 Risk Assessment Overview

This risk assessment, conducted by AcuTech Group Inc., evaluated the public risks associated with the storage and transportation of chlorine railcars produced at Chemtrade's facility in North Vancouver. AcuTech authored the Center for Chemical Process Safety's Guidelines for Chemical Transportation Safety, Security and Risk Management (2nd Edition), and is a contributing member of the API Facility Siting Committee, which developed of API Recommended Practices 752, 753, and 756. Risks from onsite processes associated with chlorine manufacturing and railcar loading only were addressed in a QRA commissioned by Chemtrade. **This study widens the scope to assess the hazards and risks from chlorine railcars that are initially stored at the Chemtrade site, and then transported through Vancouver.** AcuTech has reviewed historical accidents and rail safety data, analyzed bleach as a chlorine alternative, and performed a chlorine transport risk assessment following industry standard risk assessment methods to evaluate the potential hazards and public risks of acute toxic vapor exposure from potential chlorine releases.

Chlorine is an "extremely hazardous substance" (EHS) as labeled by the National Research Council due to its highly acute toxic inhalation hazards. The presence of large inventories of pure liquid chlorine (82 metric tonnes per railcar), presents a significant potential hazard for any operation. While stored as a liquid, chlorine generates a hazardous greenish-yellow toxic vapor cloud that accumulates close to the ground when released. Chlorine concentrations as low as 0.5 parts per million (ppm) are sufficient to cause notable discomfort and irritation, 2-3 ppm can cause irreversible health effects, and 50 ppm is considered life-threatening [1]. Once released, chlorine is very difficult, or nearly impossible, to contain and control, as the toxic vapor cloud generates rapidly and spreads into the air resulting in potential impact to a large area.

Rail accidents involving hazardous materials have occurred; a survey of industry accidents since 1995 identified at least 4 incidents involving chlorine releases from railcar accidents, resulting in 13 deaths and over 300 hospitalizations. **Derailments are the primary cause of hazardous material releases in rail transport**, with higher accident frequencies occurring on low-speed tracks, such as those in Vancouver. While chlorine railcars are designed to be robust, there is a risk of hazardous material release upon derailment, as illustrated by previous accidents. A chlorine railcar release along the rail line through Vancouver has the potential to fatally impact up to 2,000 people, and thousands more would be required to evacuate. Within the potential impact zone are hundreds of sensitive receptors, such as schools, daycares, hospitals, senior care facilities, and dense residential areas, which could be subject to toxic inhalation hazards and required to be evacuated in the event of a large chlorine railcar spill. These severe impacts are considered to be credible catastrophic scenarios and are supported by the risk assessment.

The risk assessment was conducted by industry experts and it utilized standard industry methods for quantitative risk analysis, consequence modeling, and frequency analysis, calibrated to Canadian rail data, to develop estimates on individual and societal risk from onsite storage and transport of chlorine railcars. Individual risk (the chance of fatality per year) was assessed against risk criteria defined by the Major Industrial Accidents Council of Canada (MIACC), which specifies allowable land uses based on individual risk presented by a hazard source. The assessment identified 131 schools and daycare centers, 50 hospitals, and 15 Senior Care Facilities that are exposed to intolerable risks of lethal toxic inhalation exposures. Individual risks were found to exceed broadly acceptable risk levels to the public, indicating the need to implement risk reduction strategies.

The consequence and risk assessment show the potential for catastrophic fatal impacts to the public at risk levels that require implementation of risk reduction strategies. The most effective safeguards are elimination and substitution of hazardous materials, followed by engineering controls, administrative controls, and personal protective equipment. Though complete elimination of the hazard is not a viable option, substitution of bleach in place of chlorine would drastically reduce the operational risk and public impact.

As part of the study, AcuTech compared the public health and environmental risks of converting chlorine to bleach (sodium hypochlorite) onsite prior to rail transport, versus converting chlorine to bleach elsewhere, which requires the rail transportation of bulk liquid chlorine. Bleach does not generate toxic vapor clouds that present significant toxic risks like chlorine. A release of bleach results in only localized impacts near the liquid spill, drastically reducing the potential for catastrophic toxic releases, particularly in urban settings. While transporting bleach would necessitate a higher volume of railcars and increase operational complexities at the Chemtrade site, the conversion would effectively **eliminate the catastrophic toxic risks** associated with transporting chlorine outside of the Chemtrade site. An increased frequency of incidents with bleach, due to the increased rail traffic, would be offset by the substantial reduction in the severity of potential consequences, prioritizing public safety and limiting risk to the public. Bleach substitution is an industry recognized strategy to eliminate the risks of chlorine, and it is utilized by companies and operators globally to prioritize safety and reduce the burden of managing catastrophic risks.

The overall determination of the study showed that transporting chlorine through the District of North Vancouver poses a high-consequence risk to the public, which is not tolerable based on risk criteria defined by MIACC. Converting chlorine to bleach onsite would eliminate the risks and is an established safety strategy used by the industry.

2 Introduction

AcuTech Group, Inc (AcuTech) evaluated the public risk associated from the **storage and transportation of liquid chlorine railcars from the Chemtrade site in North Vancouver, Canada**. AcuTech was tasked with reviewing relevant historical accidents, evaluating rail safety performance data, performing release and dispersion modeling to determine hazards and assessing the potential impacts and risks associated with releases of chlorine.

This report details the **consequences and risks** associated with storing and transporting chlorine railcars, and it provides a better understanding of toxic dispersion risks, hazards, and impacts to the public. This study applies quantitative and qualitative assessment methods to evaluate the potential toxic hazards due to releases of chlorine.

AcuTech conducted this project by aligning with guidelines from Canadian regulatory requirements, reputable industry sources, such as the American Institute of Chemicals Engineers (AIChE), Center for Chemical Process Safety (CCPS), Netherlands Organization for Applied Scientific Research (TNO), and other references as deemed necessary, including:

- AIChE CCPS “Guidelines for Consequence Analysis of Chemical Releases” [2]
- TNO, “Methods for the determination of possible damage”, The Green Book [3]
- TNO, “Guidelines for Quantitative Risk Assessment”, The Purple Book [4]

These guidelines provide the methodologies for:

- Identification of Process Hazards
- Consequence and Impact Analysis
- Frequency and Risk Analysis
- Presentation of Results

AcuTech has expended its best professional efforts in performing this work. The assessment was based on publicly available information to support risk awareness and risk-based decision making. Consequently, AcuTech can accept no liability for any use of the information contained herein.

3 Description of Study Methodology

3.1 Objectives

The objectives of this railcar risk assessment study were to:

- Evaluate historical accident data and rail industry guidance to identify credible release scenarios associated with the **storage and transport of chlorine railcars** from the Chemtrade site;
- Estimate hazard distances associated with toxic vapor dispersion from credible chlorine railcar release events;
- Characterize toxic dispersion consequences, risks, and potential impact to the public;
- Provide recommendations to mitigate potential impacts.

The approach was to conduct an operation-specific analysis, using the commercially available Process Hazards Analysis Software Tool (Phast) and Software for the Assessment of Fire, Explosion and Toxic Impacts (Safeti), version 9.11. Phast was used to complete the hazard/ consequence modeling and Safeti used to develop the risk results presented in this report. Phast and Safeti were selected for this analysis because they are well established, have been validated and are widely used quantitative risk assessment tools in the oil, gas and chemical industries.

3.2 Project Steps

This project was completed following five (5) main project steps:

1. Data Collection
2. Literature Review and Release Scenario Development
3. Consequence modeling
4. Frequency Analysis
5. Risk Integration and Results

3.2.1 Step 1 – Data Collection

This analysis was performed considering site-specific conditions. Therefore, these results are specific to the storage locations and transportation routes of the chlorine railcars, hazards of the railcars, and presence of nearby populated areas.

The data that was collected provides the basis for the study. This information includes the following:

- Characterization of scenarios including chlorine inventory and storage/transport conditions
- Locations of facility and railways utilized
- Number of railcars stored onsite
- Number and frequency of railcars transported via railway
- Population density and distribution

- Local weather data

3.2.2 Step 2 – Literature Review and Release Scenario Development

To develop a basis for the railcar release scenarios, a literature review was performed which included:

- Canadian railway transportation regulatory review focused on safety and risk management
- Review of industry incidents related to rail transport, railcars, and chlorine release events
- Historical incident data analysis using Canadian Transportation Safety Board (TSB) datasets and US Federal Railroad Administration (FRA)
- Current rail transport risk assessment methods

The findings from the literature review formed the basis for the credible release scenarios considered in this study.

3.2.3 Step 3 – Consequence Analysis

Consequence is the measure of the expected outcomes for a given accidental release. In this study, consequence is defined as the hazard distance to hazardous end points for toxic dispersion. For the scenario developed in Step 2, the consequences were modeled using Phast, a consequence modeling package developed by Det Norske Veritas.

In general, hazardous endpoints were determined using various parameters, including:

- Inventory
- Material storage conditions
- Prevailing Atmospheric Conditions and Surrounding Terrain
- Chemical toxicity

To inform the potential consequences associated with releases from chlorine railcars during railway transportation, consequence and impact results were developed in a graphical and tabular formats. Dispersion profiles were obtained for a range of flow rates, pressure, and weather conditions. Additionally, maximum distance to toxic concentration levels were obtained.

3.2.4 Step 4 – Frequency Analysis

Release frequencies and conditional probabilities were derived using a combination of statistics derived from the FRA and TSB historical incident databases and from TNO Purple Book [4].

The risk factors that affect release frequencies for railcars include:

- Train speed / Track class
- Road features, such as crossings and switches
- Tank car design (pressure vs atmospheric vessels)

3.2.5 Step 6 – Risk Results

Once the population data, consequence modeling results, likelihood calculations and weather data were collected, the information was combined to generate risk results, using Safeti, risk analysis software developed

by Det Norske Veritas. For this study, the risk is defined as the individual risk, F-N Curve, geographical risk contours, and risk-based effects contours. The following results were developed and compared to the risk acceptance criteria:

- **Individual Risk:** Defined as the risk to a single person exposed to a hazard; in other words, an individual in the potential effect zone. The scale of the incident, in terms of the number of people impacted, does not affect individual risk. This report presents individual risk results as individual risk contours, which show the geographic distribution of individual risk, and individual risk values which define the level of risk at defined locations.
- **Consequence Contours:** Overlay of the maximum potential impact, expressed in terms of toxic concentration levels and lethality probability, on a map of facility and railway route. The contours enable a visual illustration of the vulnerable areas within various damage level zones.

4 Plant Site and Railway Description

Although there are many possible rail routes for chlorine railcars to transit from Chemtrade’s North Vancouver production facility, as illustrated in Figure 4-1, this study evaluated a representative transit route through Vancouver, Surrey, and Langley. Most chlorine railcars from Chemtrade’s facility must cross through populated urban areas to reach Langley and continue south to the United States.

Figure 4-2 shows the representative railway route considered in this study, which starts at the Chemtrade facility in North Vancouver, and ends in Langley. The 30-mile direct route from the Chemtrade site to Langley was analyzed in this study and passes through the locales of Burnaby, New Westminster, Surrey, Newton, and Cloverdale. The route crosses the Burrard Inlet from North Vancouver into Burnaby and crosses the Fraser River at New Westminster. Railcars could be routed using other tracks, but this route is selected for illustration of risks.

Figure 4-1: Railway Routes from North Vancouver to Langley

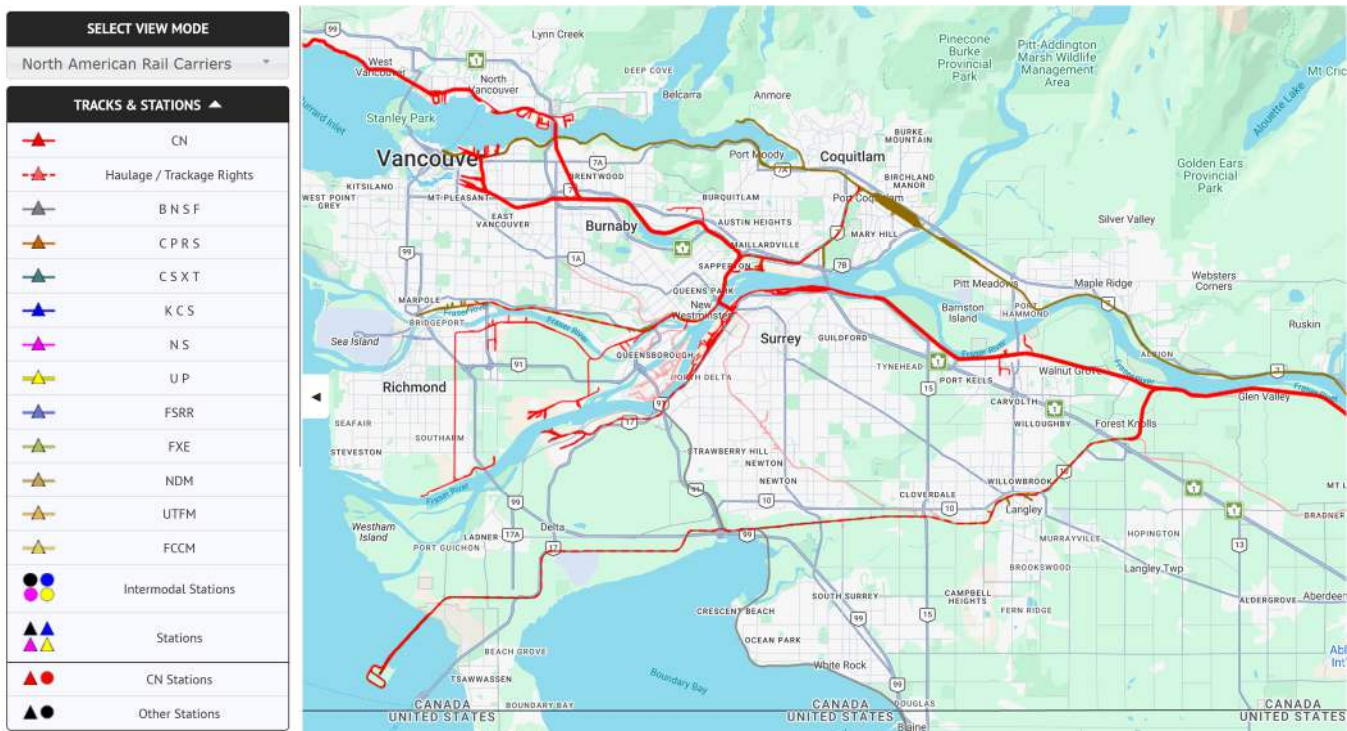
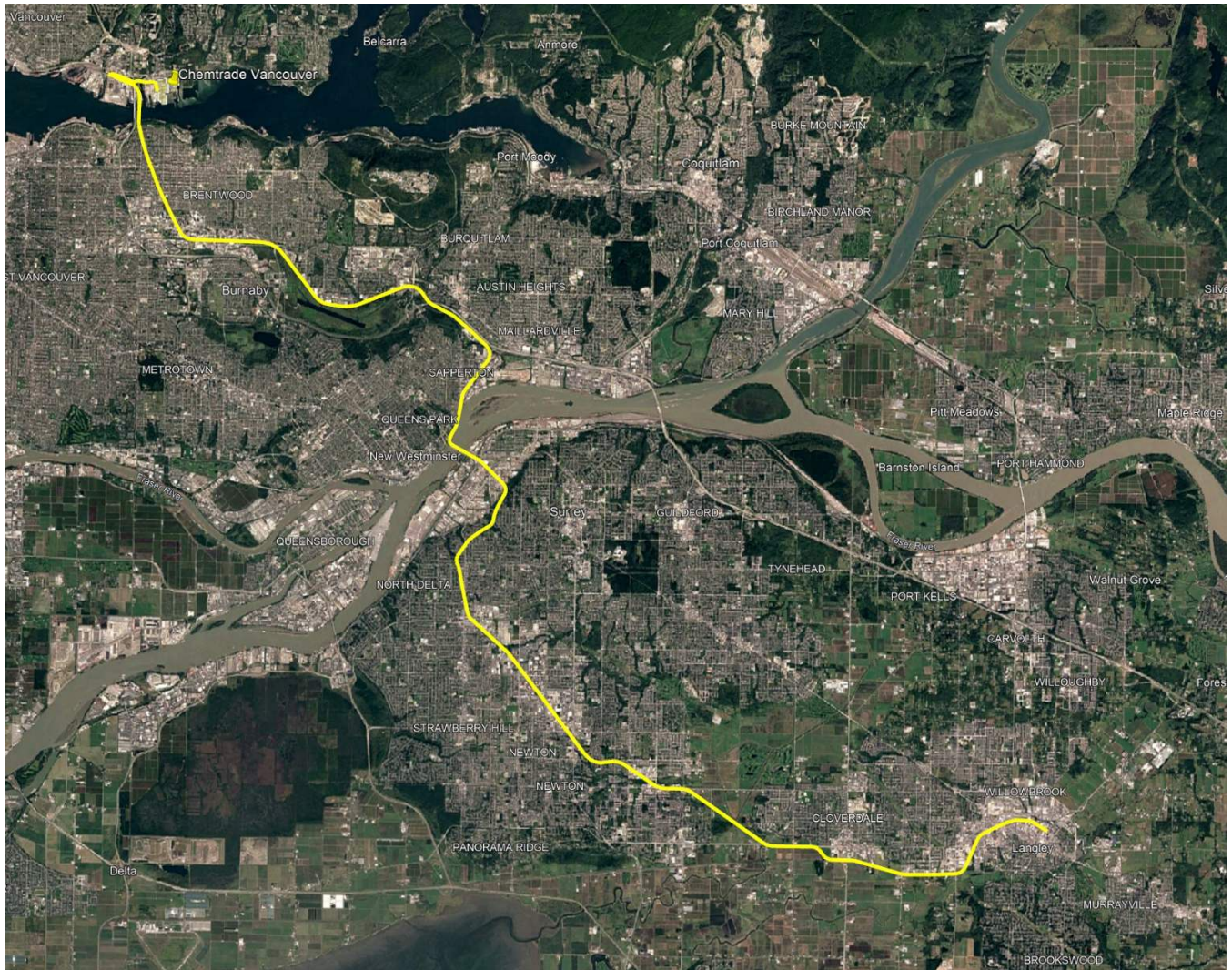


Figure 4-2: Representative Railway Route



Features of the railway route are described in

Table 4-1. All crossings, switches, tunnels, and bridges were enumerated using Google Earth, with crossings denoted as automated or not automated and bridges as major (crossing large rivers or inlets, multi-lane) or minor (crossing small creeks or road overpasses). Elevation changes were observed along the route, primarily as a steep climb into Surrey with a maximum of 5.7% grade and a descent into Langley with a maximum of -3% grade. Additionally, sections of curved track were observed along the route, with small turn radii that could present a risk of train stringlining at high locomotive power.

Table 4-1: Railway Features

Feature Type	Quantity Along Route	Comments
Crossing	49	138 total vehicle traffic lanes through all crossings
Automated	25	103 through travel lanes
Not Automated	24	35 through travel lanes; many one-lane dirt roads/construction entrances
Switch	63	Majority located near railyards in Brunette Creek and Langley
Curved Track	8	
Elevation changes	5	Largest uphill gradient 5.7%; largest downhill gradient -3%
Tunnel Entrance/Exit	2	Tunnel underneath Brentwood
Bridge	7	
Major	2	Spanning Burrard Inlet & Fraser River
Minor	5	

4.1 Site Layouts

An aerial view of the Chemtrade site is shown in Figure 4-3.

Figure 4-3: Chemtrade Site Aerial View



4.2 Applicable Canadian Railway Regulation

Sections 13, 14, & 15 of the Railway Safety Management System Regulations, 2015 address identification of rail transport safety concerns and includes guidelines for risk assessment. This railway study was conducted in alignment with these regulations. Appendix D contains the text from Sections 13, 14, & 15 of the regulation.

4.3 Nearby HTEC Hydrogen Facility

Hydrogen Technologies and Energy Corp. (HTEC) has announced plans to develop a hydrogen liquefaction facility with an associated hydrogen refueling network. As shown in Figure 4-4, the proposed liquefaction facility is located immediately adjacent to the eastern boundary of the existing Chemtrade site.

The proposed facility will involve the production, processing, storage, and transfer of hydrogen under high-pressure and, in some cases, cryogenic conditions. As a result, the **proposed plant introduces potential fire and explosion hazards that may impact adjacent Chemtrade operations, including the staging and handling of chlorine railcars.**

Based on industry experience, hydrogen is highly flammable and can produce significant fire and explosion hazards under certain conditions. While hydrogen is capable of generating damaging overpressure in confined or congested environments, its low density and high buoyancy generally limit the extent of vapor cloud explosion hazards in open areas due to rapid dispersion. **Given the short separation distance of ~15 m between the proposed facility boundary and the railcar staging area, there remains a credible potential for jet fire and blast effects to impact this location.**

Figure 4-4: Proposed HTEC Hydrogen Liquefaction Plant East of Chemtrade Site



5 Summary of Significant Railway Incidents

Significant railway accidents have occurred in recent history, many involving hazardous materials and impacts to public. A selection of high-impact incidents are summarized in Table 5-1 and described in further detail below.

Table 5-1: Causes & Consequences of Significant Incidents

Location & Year	Incident Type	Immediate Cause	Root Cause	Consequence	Lessons Learned
Alberton, MT, 1996	Train derailment-Chlorine	Fracture of rails causing train derailment	Internal cracking undetectable by equipment in use	64.8 tons Cl released; 1 death; 200 hospitalizations	Analyses should consider routine derailment causes for toxic materials.
Macdona, TX, 2004	Train collision & derailment-Chlorine	Train collision at high speed causing derailment	Operator shift work fatigue leading to human error	9,400 gallons Cl released; 3 deaths; 30 hospitalizations	Awareness of fatigue as accident cause; insufficiency of emergency response
Graniteville, SC, 2005	Train collision & derailment-Chlorine	Train collision at moderate speed causing derailment	Operator fatigue and haste leading to human error	60 tons Cl released; 8 deaths; 75 hospitalizations	Need to lock & monitor main-track switches; low speed in absence of switch lights
Squamish, BC, 2005	Train derailment-other hazmat	Wheel slip at low speed causing derailment	Steep & winding travel route with excessive train loading, high horsepower causing sideways force	40,000 liters sodium hydroxide released in river	Tonnage limits and operational controls required on difficult track terrain
Lac-Mégantic, QC, 2013	Train derailment-other hazmat	Brake failure leading to high-speed train derailment	Poor repairs leading to fire; fire mitigation & procedural conflict then causing loss of braking power	47 deaths; 2000 evacuations	Mandatory minimum hand brakes required; improvements to route planning of hazardous materials
Aqaba, Jordan, 2022	Chlorine tank release	Mishandling of chlorine tank causing rupture	Poor safety culture & communication leading to the use of insufficient lifting equipment	25 tons Cl released; 9 deaths; 250 hospitalizations	Safety culture is integral to incident-free operations; employees should be aware of procedures and hazard risks
East Palestine	Train derailment – hazmat released	Axel failure leading to high-speed train derailment	Overheated L1 bearing on a hopper car	Environmental impact and long-term toxic exposure to community	Improve railroad design, railcar inspection, and emergency responder preparedness

Alberton, Montana, USA (1996) [5]: A freight train derailed near a small town in Montana, causing a 24-inch tear in a chlorine tanker car that released 64.8 tons. It was found that the rail section had fractured under the moving train. Inspectors had checked this area with ultrasonic rail defect detection equipment just one month prior, but were unable to find any internal defects due to extensive surface defects on the rail. The release was difficult for cleanup crews to control, and continued to leak for two weeks. **This resulted in 1 death, over 200 hospitalizations, and the evacuation of 1,000 people.**

Lessons Learned: Even routine mechanical issues causing derailment can have catastrophic effects when HAZMATs are present. This incident led to better planning of hazmat route planning.

Macdona, Texas, USA (2004) [6]: **Human error**, likely stemming from crew fatigue, led to a collision between a train on the main line track and another train which was leaving the main track towards a parallel siding. The train on the main line track was carrying chlorine, and was traveling significantly faster than the signal indicators required, resulting in a collision at 44 mph. The train on the main line derailed, including a car loaded with liquefied chlorine, which was punctured and released an estimated 9,400 gallons. The incident resulted in **3 deaths and 30 hospitalizations, including the hospitalization of several emergency responders who were not prepared to address the hazardous materials release.**

Lessons Learned: Railroad employers and employees should be aware of fatigue as a failure cause, preventing employee schedules that lead to excessive fatigue. **Insufficient first responder preparedness** also indicates that there should be better training and emergency response planning for rail-specific incidents. Railroads were recommended to implement operational measures to reduce risk, such as positioning hazmat tanker cars at the rear of trains and reducing speed. Crew members on hazmat freight trains were also recommended to travel with emergency breathing apparatus, and trained on its use.

Graniteville, South Carolina, USA (2005) [7]: **Human error** led to an improperly lined switch on an industrial track, causing a train from the main line to collide with a parked train on the industry line. Both trains derailed, including three tank cars from the main line train carrying **chlorine**, the aftermath of which is shown in Figure 5-1. One of those chlorine cars released 120,000 lbs of liquefied chlorine to the surrounding neighborhood and industrial area, resulting in **8 deaths, 75 hospitalizations, and the evacuation of 5,400 people.**

Lessons Learned: After this incident, the FRA mandated positive locking of track switches and improved operational procedures around switches. As in the Macdona incident, railroads were recommended to implement operational measures to reduce risk and provide emergency breathing apparatus to the crews of hazmat trains. It was also recommended to reduce speed in the absence of clear switch position indicator lights to allow for safe stopping distance.

Figure 5-1: Aftermath of Graniteville, SC Incident



Squamish, British Columbia, Canada (2005) [8]: An excessively loaded train was carrying sodium hydroxide through steep and winding slopes near the Cheakamus River. The slope necessitated slowing the train and bringing on additional locomotive horsepower. However, this caused lateral forces to develop between the wheels and rail as draft forces simultaneously stretched the train, like a string being pulled taut. The wheels climbed over the rail just as the train was crossing a bridge over the river, derailing nine cars. Four similar derailments occurred in this subdivision in the five years leading up to the accident, and three similar derailments occurred in the year following the accident, none of which involved hazardous materials. This derailment resulted in the release of 40,000 liters of sodium hydroxide, **causing significant environmental damage to the river ecosystem.**

Lessons Learned: Tonnage and power should be limited on difficult rail terrain, and organizational controls were put in place to ensure that trains traversing this territory are sufficiently equipped.

Lac-Mégantic, Quebec, Canada (2013) [9]: A train carrying crude petroleum was parked on a descending grade above the town of Lac-Mégantic. It had been experiencing mechanical difficulties throughout the trip due to an improper repair several months prior, and a fire started overnight. The fire was brought under control, but the electrical breakers were moved to the off position in keeping with railway policy. Without power, the compressors could not supply air to the air brakes, which were unable to continue holding the train. The engineer had applied several hand brakes in addition to the air brakes, but these were insufficient to hold the train in place without the air brakes operating. The train rolled downhill into the town, **derailing and breaching 59 of the cars. This caused a fire and explosions which led to 47 deaths and 2000 evacuations.**

Lessons Learned: A minimum number of hand brakes, in addition to automatic brakes, must be applied when leaving a train unattended. Furthermore, locomotives transporting hazardous materials should never be left unattended. Routes for trains carrying hazardous materials should be better planned and controlled.

Aqaba, Jordan (2022) [10]: A 25-ton container of chlorine was being loaded onto a ship in the Port of Aqaba when the winching cable snapped and the container fell, resulting in a puncture and catastrophic rupture of the container. The root cause was the use of improper lifting equipment, as the lifting slings were designed only for a maximum load of 8.6 tons. Further investigation found that the port staff lacked training and practical experience handling hazardous materials; some were unaware of the weight and contents of the container, believing it to be empty. No supervisors or safety officers were present, and the site's maintenance practices were known to be deficient. An estimated 50,000 lb spill rapidly dispersed around the ship and dock, shown in Figure 5-2, resulting in **13 deaths and 250 injuries**.

Lessons Learned: Safety culture should be present at all levels of the organization, with proper implementation of employee training, permitting, and management of change processes.

Figure 5-2: Aftermath of Aqaba Incident



East Palestine, Ohio, USA (2023): Based on the NTSB investigation RIR-24-05, the derailment of Norfolk Southern Railway (NS) train 32N occurred due to an overheated L1 bearing on a hopper car, causing the axle to separate. This led to a post-derailment fire initiated by a Class 3 flammable liquid released from a punctured tank car. The severity of the hazardous materials release was worsened by the continued use of tank cars and operator's failure to communicate expert opinions and accurate information to the incident commander. NS and its contractors incorrectly believed that the tank cars were at risk of catastrophic failure from a polymerization reaction, creating unnecessary urgency for a vent and burn procedure on five vinyl chloride monomer (VCM) tank

cars. The delayed transmittal of train consist information to emergency responders and Ohio's insufficient training for volunteer firefighters also contributed to the hazards. While no immediate injuries were reported during the derailment or emergency response, the community may suffer the long-term health and environmental impacts of the chemical releases and the "vent and burn" operation, illustrated in Figure 5-3.

Three tank cars carrying flammable or combustible hazardous materials sustained mechanical breaches, and five VCM tank cars released flammable gases due to fire exposure or deliberate breaching during a "vent and burn" procedure, as summarized below:

- TILX402025 (DOT-105, VCM): Entire load released via vent and burn.
- OCPX80235 (DOT-105, VCM): Entire load released via pressure relief device (PRD) release, vent and burn.
- OCPX80179 (DOT-105, VCM): Entire load released via PRD release, vent and burn.
- GATX95098 (DOT-105, VCM): Entire load released via PRD release, vent and burn.
- SHPX211226 (DOT-111, Ethylene glycol monobutyl ether): Entire load released via tank head crack and fully open bottom outlet valve.
- DOWX73168 (DOT-111, 2-ethylhexyl acrylate): Partial load released via tank head cracks and tank head puncture.
- UTLX205907 (DOT-111, Butyl acrylates): Entire load released via tank head punctures and burned away manway gasket.
- OCPX80370 (DOT-105, VCM): Entire load released via PRD release, vent and burn.

The 2023 derailment in East Palestine highlighted significant gaps in rail safety, emergency response, and hazardous materials management. Key lessons include the need to improve railroad design, such as wayside bearing defect detection systems and optimized detector spacing, and clearer operational response protocols to address emergency preparedness deficiencies. Misleading hazardous materials information and flawed communication and decision-making processes resulted in an unnecessary vent-and-burn procedure for vinyl chloride monomer (VCM), underscoring the need for clear federal guidance on such high-consequence actions.

Figure 5-3: Vent and Burn during East Palestine, Ohio Incident



6 Historical Incident Review Summary

Across all datasets reviewed, **derailments were consistently identified as the dominant rail accident type associated with hazardous materials transport.** Analysis of both Canadian (TSB) and U.S. (FRA) data shows that railcar-normalized accident frequencies are generally higher at lower operating speeds, with Track Class 1 contributing most to accident occurrence within the ≤ 40 km/h grouping. In contrast, accidents occurring on higher-speed mainline track are less frequent on a railcar-km basis but exhibit a higher conditional probability of hazardous material release, reflecting increased derailment severity and multi-car involvement. These relationships are consistent with findings reported in the literature and highlight the importance of distinguishing between accident frequency and accident consequence when defining credible release scenarios.

In addition, both the TSB and FRA datasets indicate that tank car design strongly influences release outcomes, with pressurized tank cars exhibiting substantially lower conditional probabilities of release than non-pressurized (atmospheric) designs across all speed groupings. While the TNO Purple Book provides a useful benchmark for generic railway risk assessment, its speed-dependent accident frequency trends differ from those observed in the North American datasets, particularly with respect to lower-speed operations. Given the completeness, transparency, and direct relevance of the Canadian TSB data to current operating practices, regulatory controls, and pressurized chlorine transport, the TSB dataset is considered the most representative primary source for this assessment. FRA data are used to support and corroborate observed trends, while Purple Book values are applied selectively for benchmarking and conditional release behavior.

Appendix A presents the detailed historical incident analysis and Appendix B presents the data sets.

7 Alternatives Analysis: Bleach vs Chlorine

Bleach (sodium hypochlorite) is a substantially lower risk alternative to chlorine, particularly in the context of transportation through populated areas. Bleach is a significantly less toxic material than chlorine, and is commonly used as a substitute. Many industrial facilities that historically used chlorine for applications such as water treatment, have redesigned their systems to use bleach, reducing toxic risk and minimizing potential impacts to surrounding communities with an inherently safer chemical. This section presents an alternatives analysis comparing the rail transportation risks of bleach and chlorine, with an emphasis on inhalation toxicity, vapor cloud formation potential, dispersion behavior, and potential public impact in urban environments.

7.1 Key Chemical Properties

Chlorine is produced as a gas, but transported as a liquid under pressure. Chlorine has a boiling point of -29.2°F (-34°C) and a vapor pressure of 85.3 psig at 20°C (68°F), indicating it readily vaporizes upon and rapidly expands upon releasing to atmosphere. The gas is greenish-yellow and has a pungent, irritating odor detectable at 0.06 ppm.

Bleach, often referred to as liquid chlorine, is not the same as pure liquid chlorine. Bleach is a dilution of water and sodium hypochlorite (NaOCl), which is produced using chlorine gas as a raw material. Chlorine gas and caustic are mixed together to form sodium hypochlorite (bleach), salt and water, as shown in the following equation.



Bleach is a pale yellow liquid with a strong odor, and is typically transported as a liquid at a concentration of 13% sodium hypochlorite solution in water. Therefore, vapor pressure, boiling point, and evaporation rate of bleach are close to that of water. The boiling point of sodium hypochlorite is 231.8°F (111°C), which is well above normal ambient temperatures. Sodium hypochlorite solutions can release chlorine gas when mixed with acids or ammonia.

7.2 Risk Factors

Due to the properties of chlorine and transport conditions, liquid chlorine railcar transport presents the following risks:

- **High Hazard Potential:** Liquid chlorine can expand rapidly upon release to atmosphere, forming a dense toxic cloud that disperses near the ground and is capable of traveling large distances downwind
- **High Acute Toxicity:** Fatal if inhaled, posing a severe immediate threat in populated areas
- **Corrosivity:** Causes severe skin burns and eye damage upon contact
- **Environmental Hazard:** Very toxic to aquatic life and spills could devastate local ecosystems
- **Reactivity:** Can cause or intensify fires, and containers may explode if heated due to pressure buildup. It reacts dangerously with many common chemicals, including combustibles and organic products

Chlorine gas poses significant health risks upon inhalation, potentially causing severe respiratory issues, coughing, burning sensations, chest pain, and potentially pneumonia and pulmonary edema. Environmentally, chlorine is highly toxic to aquatic life, forming toxic mixtures in water even after dilution. It does not readily

biodegrade, but is highly reactive and does not persist in the environment. Chlorine is corrosive to most metals in the presence of moisture and can react explosively with organic materials, especially at high temperatures. Large-scale chlorine releases can have widespread and severe impacts to human health and the environment, often requiring complex emergency responses. These responses include general evacuation, containment, and neutralization strategies. For instance, leaking chlorine containers should be moved to isolated areas, and the gas can be absorbed into alkaline solutions. Fire-fighting procedures for chlorine incidents involve suppressing gases/vapors with a water spray jet and preventing surface or groundwater contamination.

Sodium hypochlorite, commonly known as bleach, presents very low hazards, compared to chlorine. Exposure to bleach may cause skin irritation and serious eye damage, with potential for permanent eye damage or blindness in severe cases. Inhalation of its vapors, particularly in high concentrations or when mixed with incompatible substances like acids or ammonia, can generate chlorine gas and cause respiratory tract irritation. Large release of bleach typically has a localized impact with negligible potential for fatalities and injuries compared to chlorine, however, bleach is still very toxic to aquatic life. Sodium hypochlorite is not expected to bioaccumulate or persist in the environment. Chronic health effects from prolonged bleach exposure are not extensively documented, although repeated exposure can lead to respiratory issues. Emergency response protocols for bleach releases are generally less complex than for chlorine, focusing on containing the spill and preventing environmental discharge.

Table 7-1 provides a qualitative summary of the risk factors associated with large scale releases chlorine and bleach.

Table 7-1: Risk Factors Comparison of Chlorine and Bleach

Risk Factor for Large Scale Release	Chlorine	Bleach
Acute inhalation hazard	Very high	Low
Impact scale	City-scale	Localized
Time to toxic effect	Minutes	Hours
Direct exposure hazards	Very high	Very low
Chemical reactivity hazards	High	Low
Reported fatalities (industry incidents)	Many	None
Shelter-in-place effectiveness	Limited	Effective
Emergency response complexity	Very High	Moderate
Vapor cloud formation	Immediate, very large	Minimal
Toxic Dispersion distance	Kilometers	Tens of meters
Dependence on weather	High	Low
Mitigation after release	Difficult	Feasible

7.3 Bleach Incidents

There have been no previous rail incidents in the TSB data involving sodium hypochlorite, as the material is more commonly transported on roads via tanker truck. Additionally, there are no NTSB reports in the United States involving sodium hypochlorite (bleach), as a release of the material is not hazardous enough to trigger a detailed federal investigation.

Limited vehicle accidents have been reported, such as a 2017 multi-vehicle weather-related pileup in Saint-Zotique, Quebec leading to a release of 20,000 liters of sodium hypochlorite, and a 2025 road accident in Phoenix, Arizona. Little information is available about either incident, but it was reported that the release in Quebec was confined by the highway median and that due to the cold temperatures, the release could be removed from the surface of the snow. Most importantly for this study, no injuries or fatalities related to exposure to the sodium hypochlorite were reported in either incident.

Sodium hypochlorite releases can be managed locally and without specialized hazmat response. In comparison, chlorine releases are difficult to mitigate as manual preventive actions cannot be conducted without specialized PPE and hazmat teams. A common thread between many of the chlorine release incidents was an immediate call to local first responders, who were not informed of or not capable of dealing with the hazmat threat, and necessitated a secondary call for backup response. In some cases, the first responders themselves sustained injuries. Chlorine releases present a more immediate and severe danger to first responders and surrounding communities due to the uncontrollable generation of vapors from the spill, and the significant toxicity of the vapors.

7.4 Operational Impacts

Transporting bleach (sodium hypochlorite) instead of chlorine by rail introduces several operational differences and impacts, primarily due to the lower concentration of active chlorine in bleach. Chlorine railcars typically contain nearly 100% active chlorine, whereas bleach solutions used for transportation usually have a concentration of 13% active chlorine by weight. To deliver the same amount of oxidizing capacity, approximately 6 to 10 times more bleach by mass is required compared to chlorine. Consequently, for a similar capacity railcar, a chlorine railcar delivers about 82 metric tonnes of active chlorine, while a bleach railcar delivers only 11 metric tonnes. This translates into a need for more bleach railcars to achieve the equivalent oxidizing power of a single chlorine railcar.

This increased volume of bleach transportation requirements leads to a higher number of railcars transported annually, increases in switching and staging activities, and greater rail congestion at terminals. While this heightens the frequency of minor incidents like handling errors or small leaks, the severity of such incidents is significantly reduced compared to those involving concentrated chlorine. This trade-off, where incident frequency increases but consequences drastically decrease, is often deemed acceptable under safety principles.

From a supply chain perspective, transporting more bleach shipments means easier sourcing and greater flexibility in the supplier base, enhancing resilience at the cost of increased logistical complexity. Chlorine, with fewer shipments, faces a higher impact if supply is disrupted and relies on a small number of specialized suppliers.

The safety and risk management implications strongly favor bleach, especially in urban/suburban areas such as Greater Vancouver. Chlorine transportation carries a low frequency but very high consequence risk, often requiring city-scale emergency planning and generating significant public concern. Bleach transportation, while occurring at a higher frequency, typically results in low-consequence incidents with localized spill responses that align better with municipal capabilities. Regulators are increasingly prioritizing the reduction of catastrophic consequences, even if it means an increase in lower-severity events.

The workforce and training impacts shift due based on operation frequency and risk exposure. Bleach operations may require more rail and transport operators, with training emphasis on spill response and chemical compatibility training. Chlorine, on the other hand, demands specialized hazardous material training, restricted personnel access, and heavy reliance on external emergency responders. Shipping bleach instead of chlorine distributes risk across routine operations, eliminating rare, disasters with high impact to the community.

Cost implications will be specific to the operation. While rail transport and storage capital expenditure are higher for bleach, expenditures for emergency preparedness, insurance, liability, and public/regulatory risks are lower. The overall lifecycle cost, when factoring in risk and insurance, tends to narrow the gap between the two.

While substituting chlorine with bleach for rail or truck transport necessitates a significantly higher number of railcars or tankers and increases operational complexity and storage volume, it dramatically reduces the potential and magnitude of catastrophic toxic releases, particularly in densely populated areas. Bleach does not present the same potential for sudden, large-scale toxic vapor cloud formation as pressurized liquid chlorine. This trade-off is widely considered acceptable, as it substantially lowers societal risk by managing smaller, localized incidents rather than potential widespread disasters. The use of bleach aligns with inherently safer design principles by reducing hazard severity at the source rather than relying solely on containment and emergency response controls. Furthermore, bleach logistics and handling infrastructure are already well established in many western Canadian water treatment facilities, demonstrating that the operational framework and supply chains required to support bleach transport are mature and proven. Considering public safety, regulatory risk, emergency response burden, insurance exposure, and societal impact, the substitution of liquid chlorine with bleach represents an inherently safer alternative, particularly for transportation through urban rail corridors where consequence severity drives community risk.

8 Scenario Development

The study considers hazardous scenarios for liquid chlorine railcar storage at Chemtrade's facility and during transport. This section details these scenarios, the railcar process conditions, and the release rate and duration limitations applied in the study. While other hazards may be present, the following scenarios were those evaluated.

8.1 Hazardous Scenarios and Conditions

Information was obtained from publicly available press releases, websites, and online datasets. The chlorine dispersion modeling considered average seasonal temperature and winds. The scenarios evaluated in this study and their release conditions are summarized in Table 8-1.

The scenario development was based on the following assumptions:

- The maximum number of railcars onsite is 32 full railcars and 159 unloaded railcars. Therefore, the study analyzed 16 full railcars and 79 empty railcars at each onsite railyard.
- Full railcars are assumed to contain 82 metric tonnes of liquid chlorine and unloaded railcars were assumed to contain 2.7 metric tonnes of liquid chlorine.
- Large and small release sizes were considered for each release scenario. The large release size was represented by a 9-inch leak and a small release was represented by 2-inch leak.
- Liquid chlorine storage conditions were assumed to be at ambient temperature and bubble point pressure.
- The risk analysis assumed for representative purposes that 1,000 fully loaded liquid chlorine railcars are transported from Chemtrade's facility to Langely per year

Table 8-1: Release Scenarios

Scenario No.	Scenario Description	Inventory (metric tonnes)
1	Release of chlorine onsite in Railyard 1 from one of 16 full railcars	82
2	Release of chlorine onsite in Railyard 1 from one of 79 empty railcars	2.7
3	Release of chlorine onsite in Railyard 2 from one of 16 full railcars	82
4	Release of chlorine onsite in Railyard 2 from one of 79 empty railcars	2.7
5	Full Railcar release during transit	82
6	Empty Railcar release during transit	2.7

8.2 Release Rates, Duration, and Inventory Limitations

Releases were modeled based on the assumptions for railcar tank design and analysis of historical railcar incidents. For each event scenario, two release sizes (large and small leak) were modeled. Inventories are included in Table 8-1.

9 Risk and Vulnerability Criteria

9.1 Vulnerability Criteria

To evaluate the results of this study, the consequence modeling hazard distances are processed into impacts using vulnerability criteria. For this work, criteria are based on toxic cloud downwind distance and heights to toxic concentrations. Table 9-1 summarizes the vulnerability criteria used in this study.

Table 9-1: Vulnerability Criteria – Toxic

Endpoint Criteria	Endpoint	Impact
Emergency Response Planning Guidelines (ERPGs)	1 ppm	ERPG-1 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing more than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor.
	3 ppm	ERPG-2 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.
	20 ppm	ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.
Lethality Probability	0.9, 0.5, 0.1, 0.01	Probability of lethality for person exposed to toxic dose of chlorine calculated using toxic probit equation

9.1.1 Vulnerability Criteria – Toxic Probit

The release of toxic chlorine may result in impacts to the railway operators and members of the public. Chlorine poses acute inhalation hazards and can result in damage to the respiratory system or other critical functions.

Chemical toxicity affects the extent of the hazard zone. In this analysis, a Probit equation is used to equate the exposure dosage of toxic materials to percent likelihood of fatality. Dosage at a fixed position is the integral of concentration over time at that position. Lower dosage levels lead to larger dispersion distances. As with release quantity, the effect is not linear. In other words, a reduction in dosage by a factor of 100 may result in an increase in the dispersion distance by a factor of 20. Since dosage is a function of concentration and exposure duration, both parameters can significantly alter the calculated hazard zone.

The probit formula is given as:

$$Y = a + b * \ln(C^n t)$$

Where:

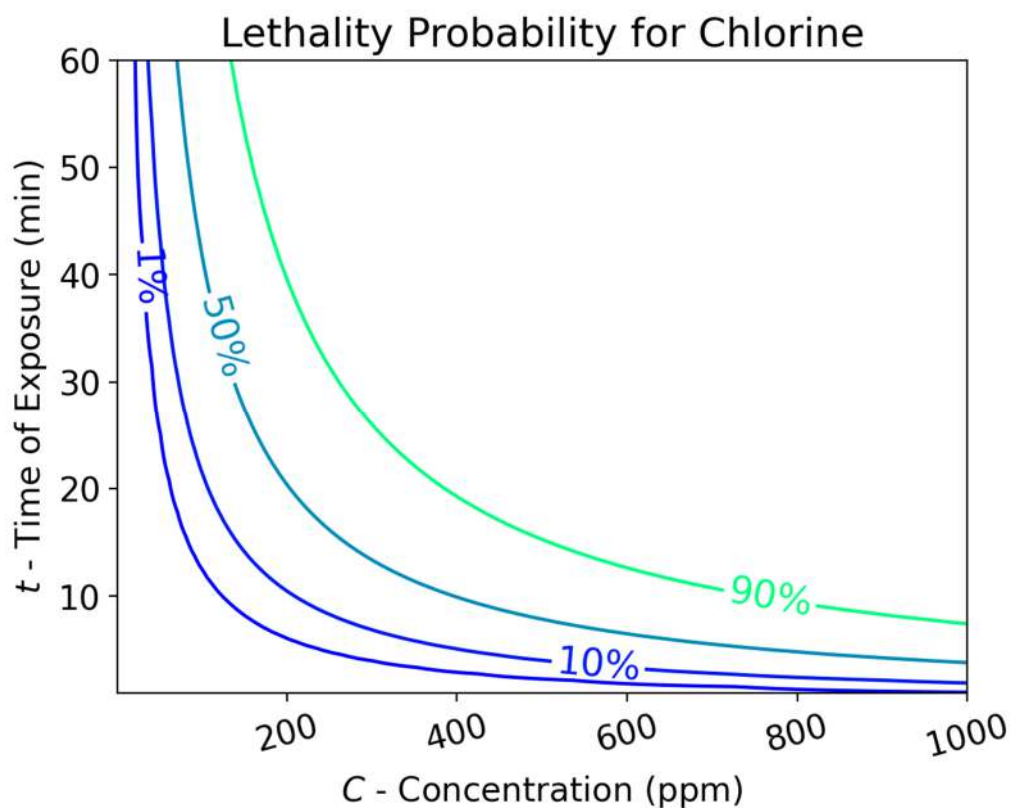
- Y : Probit Value (cumulative normal distribution function of mean 5 and standard deviation 1)
- a, b, n : Probit Constants, determined by toxicological study of the chemical
- C : concentration in parts per million (ppm)
- t : exposure duration in minutes

The probit constants for chlorine are based on the latest data from RIVM and are presented in Table 9-2 and the associated mortality/lethality probability plot is illustrated in Figure 9-1.

Table 9-2: Probit Constants for Toxic Materials

Material	a	b	n
Chlorine	-11.4535	1.93	1.04

Figure 9-1: Mortality Probability Plot for Chlorine

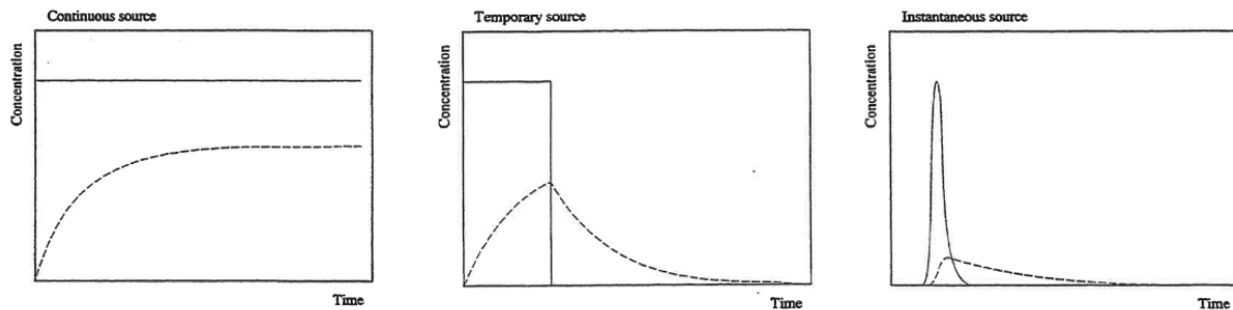


9.1.1.1 Indoor Vulnerability to Toxics

People located indoors are less vulnerable to toxic releases than those located outdoors as the building provides protection from the toxic vapors outdoors. For the person indoors to be impacted, the toxic vapors must enter the building through forced or natural ventilation routes. This results in the concentration in a building being lower than the concentration outdoors. The concentration indoors, and the nature of the indoor concentration

profile with respect to time is dependent on the air exchange rate of the building. Figure 9-2 illustrates the impact of outdoor toxic releases on the indoor concentration with time.

Figure 9-2: Illustration of the Indoor Concentration Profile Concept



In order to evaluate the impacts to people located indoors, an air-change model was developed in accordance with guidance from the TNO Green Book [3] to calculate the indoor concentration profiles for all locations and all release scenarios. An air change rate of 4 air changes per hour was assumed for residential and other buildings occupied by the public. This value represents the default value in the Phast and Safeti consequence modeling programs, and is representative of commercial or residential buildings as considered in the TNO Green Book [3].

9.2 Risk Presentation

The risks of the hazardous operations may be expressed from two perspectives: (1) the risk to individuals and (2) the risk to groups of people. These are referred to, respectively, as individual and societal risk. This siting study reports individual and societal risk results.

9.2.1 Individual Risk

Individual risk is defined as the risk to a single person exposed to a hazard; in other words, an individual in the potential effect zone. The scale of an incident, in terms of the number of people impacted, does not affect individual risk. This report presents individual risk results as individual risk contours, which show the geographic distribution of individual risk, and individual risk values which define the level of individual risk at defined locations.

The risk contours are calculated from the expected frequency of an event capable of causing the specified level of harm at a specified location, regardless of whether anyone is present at that location to suffer that harm. Thus, individual risk contour maps are generated by calculating individual risk at every geographic location assuming that somebody will be present, unprotected (e.g., outdoors), and subject to the risk 100% of the time (i.e., annual exposure of 8,760 hours per year). In contrast, other risk measures consider the fraction of the time that individuals are exposed to the risk. Individual risk results are associated with a particular location rather than a particular person. For this reason, this risk measure is sometimes referred to as location risk or geographical risk.

The individual risk results are expressed as the frequency of fatality per year. While all injuries are of concern, effect models for predicting degrees of injury often include additional uncertainties; thus, risk analysts often estimate the risk of fatal injury (death) as a less equivocal measure.

The calculation of individual risk is made with the understanding that the contributions of all incident outcome cases (i.e., event sequences) are additive. For example, the total individual risk to an individual working at a facility is the sum of the risks from all potentially harmful incidents considered separately.

9.2.2 Societal Risk

The societal risk expands upon the individual risk results by considering the actual population present around the facility. Societal risk expresses the cumulative risk to groups of people who might be affected by release events. The calculation uses the same consequence and frequency results as the individual risk calculation, but uses information about the number, geographical distribution, type, and occupancy levels of the population to determine the risk. Like the individual risk, the societal risk is cumulative, therefore the risk presented is the sum of all the risks from all potentially harmful incidents on all potentially harmed receptors.

The societal risk is expressed using an F-N curve, which is the most common method of depicting societal risk results. The F-N curve indicates the expected frequency (F) of release scenarios occurring which result in N or more fatalities. The x-axis of the F-N curve represents the number of fatalities, N. The number of fatalities is depicted on a logarithmic axis with a minimum value of 1. The y-axis of the F-N curve represents the cumulative frequency of the release scenarios with the number of fatalities equal to N or more. The cumulative frequency is depicted on a logarithmic scale.

9.3 Risk Criteria

In lieu of legally mandated criteria, internal company standards and published risk acceptance criteria from foreign governments or trade associations are available for interpreting risk results. As a standard industry practice, risk analysts and facility operators defer to these guidelines in the absence of any legally mandated risk criteria.

9.3.1 Individual Risk

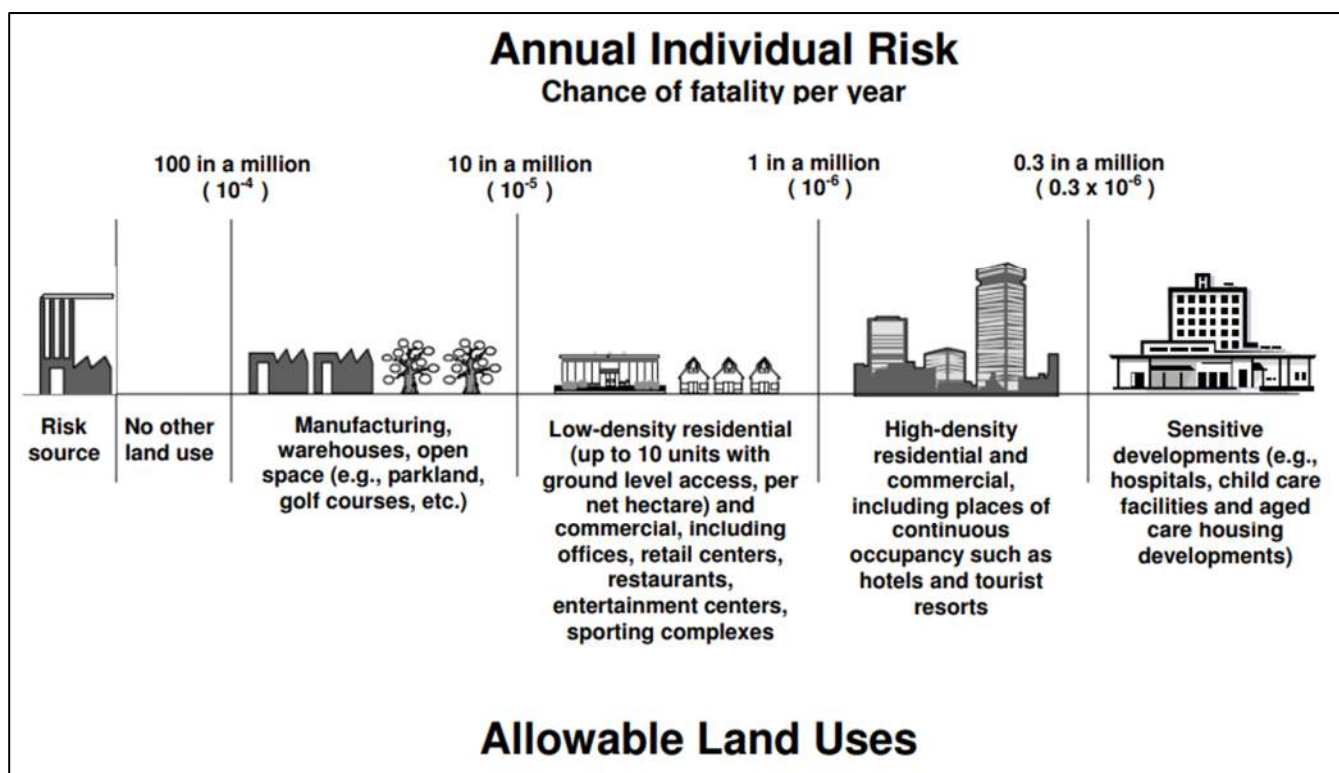
In Canada, there are no nationally defined individual risk criteria that define whether offsite public risk from major hazard facilities is acceptable or unacceptable. Instead, regulatory requirements generally focus on ensuring that hazards are identified, risks are assessed, and appropriate controls are in place. In the absence of defined individual risk criteria, recognized Canadian land-use planning guidance is commonly applied as a reference framework for evaluating offsite individual risk, with professional judgement used to interpret its applicability to the specific context of the assessment.

One such widely referenced guidance document is the Risk Assessment – Recommended Practices for Municipalities and Industry published by the Canadian Society for Chemical Engineering (CSCHE) under the Major Industrial Accidents Council of Canada (MIACC) [11]. This guidance presents a risk-based land-use planning methodology founded on individual risk of fatality contours expressed as annual probabilities. The approach defines indicative compatibility zones using individual risk levels of 10^{-4} , 10^{-5} , and 10^{-6} per year, with subsequent interpretations incorporating an additional lower criterion of 3×10^{-7} per year for particularly sensitive land uses [12].

Within the 10^{-4} per year contour, land use is generally restricted to the hazard source itself. Between the 10^{-4} and 10^{-5} per year contours, only low-occupancy and easy to evacuate land uses such as industrial facilities,

warehouses, or open space are considered acceptable. Between the 10^{-5} and 10^{-6} per year contours, commercial, office, and low-density residential uses may be acceptable. Outside the 10^{-6} per year contour, most residential and institutional developments are typically considered compatible; however, particularly sensitive developments, such as hospitals, schools, childcare facilities, and aged care housing, are generally expected to be located outside the more conservative 3×10^{-7} per year individual risk contour. MIACC's risk acceptability criteria is presented below in Figure 9-3.

Figure 9-3: MIACC Risk Acceptability Criteria



The individual risk levels referenced in Canadian guidance are broadly consistent with individual risk criteria applied internationally, including those used by the UK Health and Safety Executive (HSE). In the UK, individual risks to members of the public below approximately 1×10^{-6} per year are generally regarded as broadly acceptable, while risks above approximately 1×10^{-4} per year are considered intolerable, with risks between these values falling within the ALARP region and requiring risk reduction to a level that is as low as reasonably practicable [13]. While the UK HSE framework applies these criteria within a formal regulatory regime, the underlying numerical benchmarks for individual risk align closely with the guidance values commonly applied in Canada, supporting their use as a reasonable basis for evaluating offsite public risk.

Table 9-3: Individual Risk Criteria

Zone Type	Public Individual Risk Fatality (IRF) (/Year)	
	Broadley Acceptable	Intolerable
Risk source (no other land use)	-	$IRF \geq 1 \times 10^{-4}$
Manufacturing, warehouses, open space (e.g., parkland, golf courses, etc.)	$IRF < 1 \times 10^{-4}$	$1 \times 10^{-4} \leq IRF$
Low-density residential (up to 10 units with ground level access, per net hectare) and commercial, including offices, retail centers, restaurants, entertainment centers, sporting complexes	$IRF < 1 \times 10^{-5}$	$1 \times 10^{-5} \leq IRF$
High-density residential and commercial , including places of continuous occupancy such as hotels and tourist resorts	$IRF < 1 \times 10^{-6}$	$1 \times 10^{-6} \leq IRF$
Sensitive developments (e.g., hospitals, child care facilities and aged care housing developments)	$IRF < 0.3 \times 10^{-6}$	$0.3 \times 10^{-6} \leq IRF$

For the purposes of this study, offsite individual risk of fatality (IRF) will be evaluated with reference to the surrounding land uses, categorized in accordance with the zone types defined in the MIACC/CSChE guidance, as shown in Figure 9-3 and Table 9-3. Calculated IRF contours will be compared against the applicable risk acceptability thresholds for each land-use category (e.g., industrial/open space, commercial or low-density residential, and institutional or high-density residential). This approach ensures that the assessment of offsite public risk is aligned with recognized Canadian guidance and reflects the differing levels of risk tolerance associated with varying land-use sensitivities.

9.3.2 Societal Risk

Societal risk has not been assessed in this study since MIACC and Canadian regulations do not define societal risk criteria. Therefore, only individual risk as assessed in this study.

10 Consequence Analysis

In the terminology of risk assessment, consequence is a measure of the **expected outcome of an event** and is measured or expressed as a "hazard distance", "hazard zone", or a hazard value at a specific location. Consequence analysis is normally carried out using mathematical models and computer software addressing the physical and chemical phenomenon. Impact analysis considers the presence of people, property and sensitive environments that can be adversely affected by a chemical release.

Before conducting a consequence analysis, it is necessary to identify events that could follow the release of hazardous material. If an accident involves a release of toxic gas, the gas may disperse and expose people to hazardous toxic conditions.

Consequence analysis of the accidental release cases was conducted using Phast and Safeti, consequence and risk modeling software, version 9.11.

10.1 Dispersion Modelling

The Phast Unified Dispersion Model (UDM) was used to assess the impacts of the releases, the downwind dispersion distance, the concentration profile, and the width of toxic releases. Phast was used to determine toxic endpoints of concern.

Dispersion models use an averaging time to calculate the maximum concentration and the plume width. The averaging time is used to consider the effects of changes in the wind direction over the course of the release, as these changes can cause the dispersing cloud to meander from side to side, and reduce the concentration experienced at a given point below the full, centerline concentration. Typically, a longer averaging time is used for toxic dispersion effects since the long-term concentration is more important. For this project, an averaging time of 600 seconds is used for the toxic release scenarios. These values are consistent with the Phast model default parameters.

10.2 Weather Conditions

Atmospheric stability and wind speed are important factors for consequence analysis. Pasquill-Guilford stability class (P-G class) definitions are given in Table 10-1. Stability Class F is the most conservative for vapor dispersion distances since there is limited mixing of the released gas with air under these stable atmospheric conditions, and therefore the toxic gas cloud can travel a significantly long distance before it is diluted to non-hazardous concentrations.

Table 10-1: Pasquill-Guilford Stability Classes

Stability Class	Description
A	Very Unstable – Sunny, Light Winds
A/B	Unstable – As with A only less sunny or more windy
B	Unstable – As with A/B only less sunny or more windy
B/C	Moderately Unstable – Moderate sun and moderate wind
C	Moderately Unstable – Very windy/sunny or overcast/light wind
C/D	Moderately Unstable – Moderate sun and high wind
D	Neutral – Little sun and high wind or overcast/windy night

Stability Class	Description
E	Moderately Stable – Less overcast and less windy night than D
F	Stable – Night with moderate clouds and light/moderate winds
G	Very Stable – Possibly fog

Atmospheric conditions were based on 10 years of meteorological data spanning 2016-2026 from the Vancouver, Canada International Airport (YVR) as provided by the Iowa Environmental Mesonet [14]. This weather station was selected as it is the closest to the facility and railways assessed in this study and provided sufficient information on sky cover.

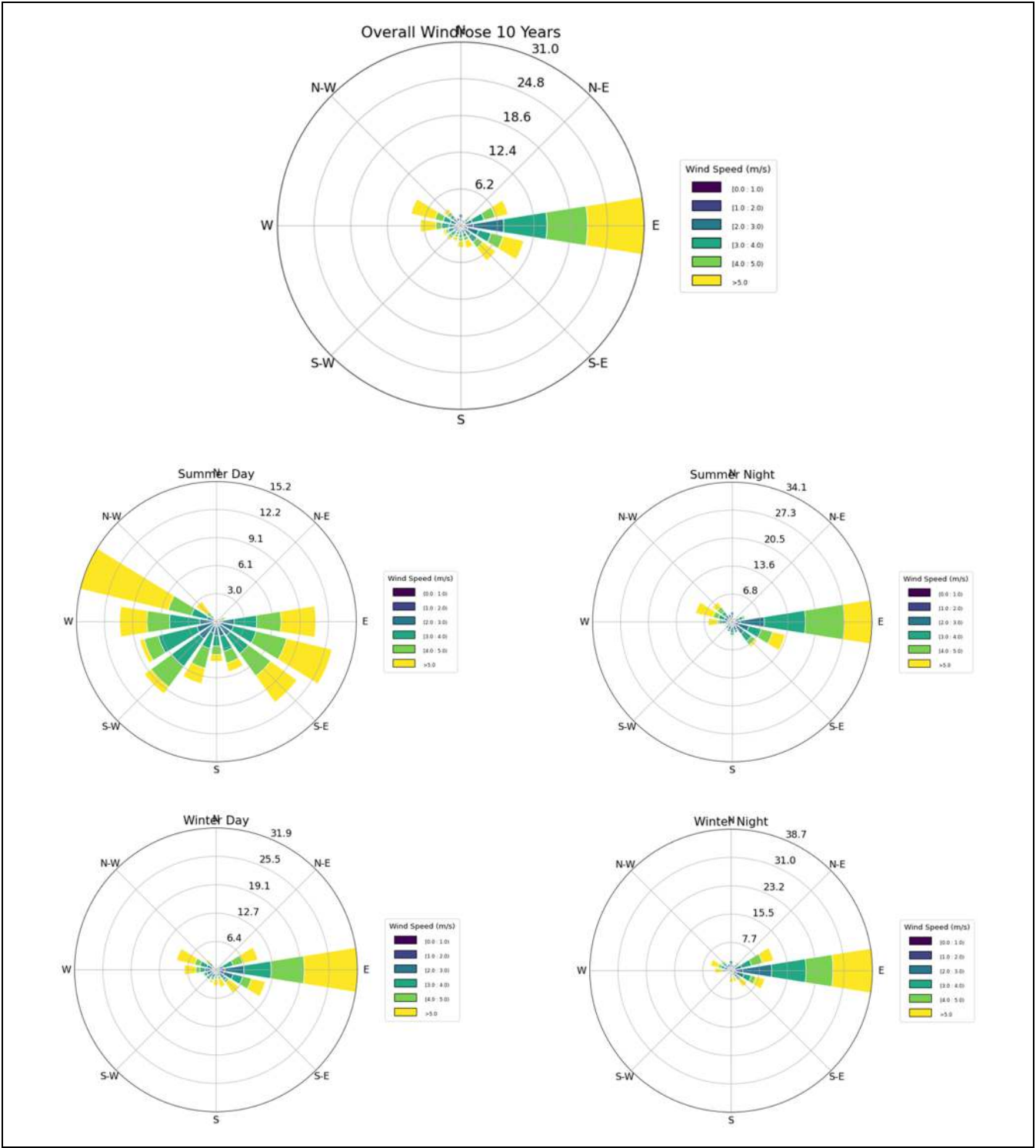
Summer and winter weather conditions, shown in Table 10-2, were calculated. Summer ambient temperature and relative humidity were based on average historical maximum temperatures for the months of June, July, and August. Winter temperature and relative humidity were based on average historical minimum temperatures for the months of December, January, and February. Wind speed and stability conditions were calculated from historical weather data and the methods described in CCPS “Guidelines for Consequence Analysis of Chemical Releases” [15]. Wind roses summarizing prevalent wind directions at the site are illustrated in Figure 10-1. Since seasonal weather conditions did not vary drastically, annual weather conditions were used in this study.

The model assumes a surface roughness of 1 meter, consistent with expected scattered large obstacles in urban areas.

Table 10-2: Weather Details

Parameter	Details	Value
Wind Speed and Stability	4/C (Average Summer daytime weather)	Wind: 4 m/s
		Pasquill Stability: C
	4/D (Average Summer nighttime weather)	Wind: 4 m/s
		Pasquill Stability: D
	4/D (Average Winter daytime weather)	Wind: 4 m/s
		Pasquill Stability: D
Average Temperature	4/D (Average Winter nighttime weather)	Wind: 4 m/s
		Pasquill Stability: D
	Summer Day	66.3 °F
	Summer Night	61.1 °F
Relative Humidity	Winter Day	41.7°F
	Winter Night	39.3 °F
	Summer Day	70.8 %
	Summer Night	81.8 %
	Winter Day	84.5 %
	Winter Night	90.1 %

Figure 10-1: Vancouver Windrose - 10 Year Data



10.3 Population Data

The rail route passes through the British Columbia census districts of North Vancouver (District Municipality), Seymour Creek, North Vancouver (City), Burnaby, New Westminster, Surrey, and Langley. As the North Vancouver (DM) district covers significantly more sparsely populated area to the north, the North Vancouver (CY) district was considered as being better representative of the population density in the area immediately surrounding the Chemtrade site. A map of the relevant census district boundaries is provided in Figure 10-2.

The population, land area, and population density of each district was extracted from Statistics Canada using data from the 2021 census [16]. This population data was incorporated into the model so that location-specific societal risk could be computed.

Figure 10-2: Census Districts of Greater Vancouver

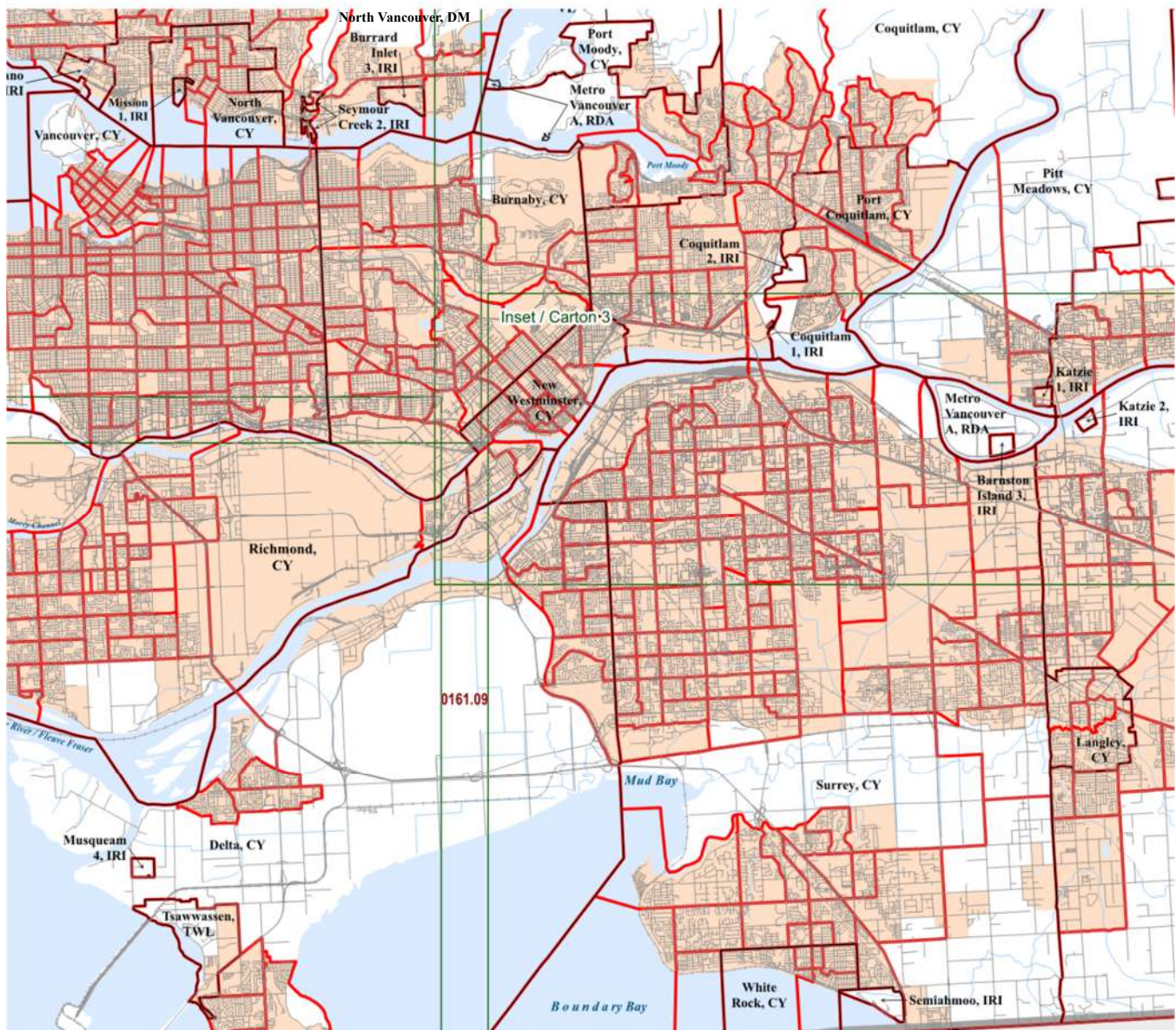


Table 10-3: Population Data

Census District	Population (2021)	Area (km ²)	Density (people/km ²)
North Vancouver (CY)	58,120	11.8	4,913.0
Seymour Creek	105	0.5	216.0
Vancouver (CY)	622,248	115.2	5,749.9
Burnaby	249,145	90.6	2,750.7
Surrey	568,322	316.1	1,797.9
Delta	108,455	179.7	603.7
Langley (CY)	28,963	10.2	2,845.2

11 Frequency Analysis

An important component of risk analysis is the estimation of the likelihood or frequency of each failure case or release scenario. Leak frequencies were developed using the Dutch Purple Book TNO guidance [4], historical incident data, and the operating frequency (fractional use time) of railcar equipment, and the likelihood of release cases was evaluated using event tree analysis.

11.1 Base Accident Rate

Base railcar accident frequencies were derived from Transportation Safety Board of Canada (TSB) occurrence data and are expressed on a per-railcar-km basis. This normalization allows accident likelihood to be scaled appropriately with number of railcars and route length. Separate frequencies were developed to reflect differences in train operating speed (≤ 40 km/h and >40 km/h) and track condition, with lower track classes associated with higher accident frequencies. These base frequencies form the starting point for subsequent scenario frequency calculations. Section A.3 contains further details of the incident data sets and frequency derivation.

Table 11-1: TSB Railcar Accident Frequencies by Railcar-km

Data Source	Geographic Scope	Accident Frequency (per Railcar-km)			
		Base	≤ 40 km/hr	>40 km/hr	Track Class 1
Transportation Safety Board of Canada (TSB)	Canada	1.45E-06	2.29E-06	1.14E-06	2.34E-06

11.2 Outflow Probability

Not all railcar accidents result in the release of hazardous material. Conditional probabilities of outflow given an accident were therefore applied to estimate the likelihood of loss of containment. These probabilities vary as a function of train speed and railcar type, with non-pressurized railcars exhibiting higher probabilities of release compared to pressurized railcars, particularly at higher operating speeds. The resulting conditional probabilities in Table 14-1 were combined with the base accident frequencies in Table 11-1 to estimate release frequencies for railcars in transit.

Table 11-2: Probability of Outflow for TSB and TNO

Train Speed	TSB of Canada	
	Non-Pressurized	Pressurized
≤ 40 km/hr	4.4E-02	6.9E-03
>40 km/hr	2.2E-01	2.0E-02

11.3 Railway Features

The Dutch Purple Book provides guidance on the application of modification factors to base railcar accident frequencies to account for train operating speed and the presence of specific railway features along a transit route. This approach recognizes that derailment likelihood is not uniform along a rail corridor and may increase

locally due to features such as railway switches (points/turnouts), as well as operating speed. Accident frequencies are adjusted using speed-dependent correction factors, with higher frequencies applied for train speeds exceeding 40 km/h and lower frequencies applied for speeds at or below 40 km/h. Where applicable, incremental accident frequencies associated with railway features are added on a per-km basis and combined with the speed-corrected base frequency to reflect localized increases in derailment likelihood along specific track segments.

The Dutch purple book defines the following:

- Generic accident frequency outside shunting yard: 3.6E-08
- Speed adjustment factors:
 - ≥ 40 km/hr: x1.26
 - < 40 km/hr: x0.62
- Railway feature frequency additions:
 - Set of points: 3.3E-08 /car-km
 - Level crossing: 0.8E-08 /car-km

11.4 Stationary Vessels

In addition to railcars in transit, stationary railcars were assessed separately to account for potential loss-of-containment events during storage or staging. Stationary railcars were treated similarly to stationary pressure vessels, and standard loss of containment (LOC) frequencies for instantaneous and continuous releases were applied. The total frequency of stationary release scenarios was calculated by multiplying the applicable LOC frequencies by the number of stationary railcars present. These frequencies were then incorporated into the overall risk assessment to ensure that both mobile and stationary hazards were consistently addressed.

Base LOC frequencies adopted from the TNO Purple Book [4] are summarized in Table 11-3, with the resulting total frequencies based on the number of stationary railcars presented in Table 11-4.

Table 11-3: Frequencies for LOCs for Stationary Vessels [4]

Installation (part)	G.1 Instantaneous	G.2 Continuous, 10 min	G.3 Continuous, $\varnothing$ 10mm
Pressure vessel	$5 \times 10^{-7} \text{ y}^{-1}$	$5 \times 10^{-7} \text{ y}^{-1}$	$1 \times 10^{-5} \text{ y}^{-1}$
Process vessel	$5 \times 10^{-6} \text{ y}^{-1}$	$5 \times 10^{-6} \text{ y}^{-1}$	$1 \times 10^{-4} \text{ y}^{-1}$
Reactor vessel	$5 \times 10^{-6} \text{ y}^{-1}$	$5 \times 10^{-6} \text{ y}^{-1}$	$1 \times 10^{-4} \text{ y}^{-1}$

Table 11-4: Adjusted LOC Frequency based on Number of Stationary Railcars

No. of Stationary Railcars	G2 Continuous	G3 Continuous
16	8.00E-06	1.60E-04
79	3.95E-05	7.90E-04

11.5 Population Assumption

In calculating societal risk, it is important to consider the fraction of time individuals spend indoors versus outdoors. Recommended occupancy factors are provided in the Purple Book [4] and implemented within DNV Safeti software. For this assessment, default Safeti values were applied, assuming 10% of the population outdoors and 90% indoors.

12 Results

12.1 Consequence of Chlorine Railcar Releases

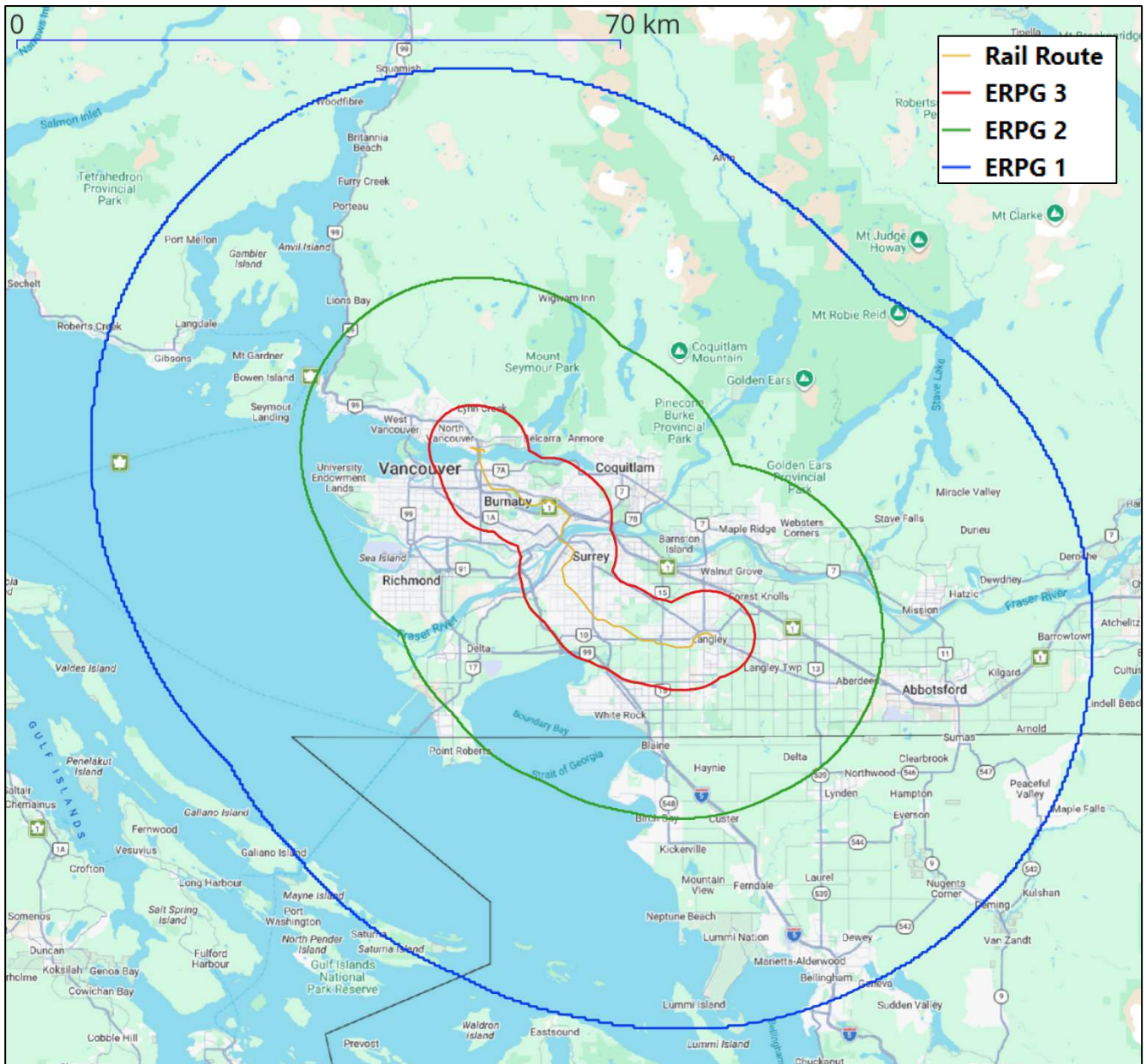
A total of six (6) scenarios were modelled, representing combinations of large and small release sizes for both loaded and unloaded railcars for a total of twelve (12) unique releases. The assessment considered representative average weather conditions and prevailing wind directions to evaluate potential impacts.

The following sections present the maximum cloud dispersion and corresponding downwind distances to toxic concentrations at the height of interest (HOI) within the vicinity of the railway. A summary of the scenarios and associated downwind impact distances is provided in Table 12-1. Figure 12-2 present the overall indoor and outdoor ERPG impact contours associated with chlorine railcars onsite and during transit. Figure 12-3 and Figure 12-4 illustrate the corresponding indoor and outdoor toxic lethality impacts associated with chlorine railcars onsite and during transit.

Table 12-1: Dispersion Summary

Scenario No.	Release Description	Maximum Distance to ERPG Levels Outdoor (ft)			Maximum Distance to Lethality Level Indoor (ft)			
		ERPG 1	ERPG 2	ERPG 3	0.1%	1%	10%	99%
1, 3, & 5	Railcar – Loaded – Large Release Size	117,274	50,582	12,870	5,808	4,405	3,077	1,285
1, 3, & 5	Railcar – Loaded – Small Release Size	94,662	29,996	5,098	7,928	6,121	4,301	1,265
2, 4, & 6	Railcar – Unloaded – Large Release Size	23,573	10,089	2,616	1,128	935	722	273
2, 4, & 6	Railcar – Unloaded – Small Release Size	26,786	12,366	3,523	1,004	803	618	271

Figure 12-1: Overall Outdoor Toxic ERPG Effect Levels



The map displays the Greater Vancouver Area with the following features:

- Legend:**
 - Rail Route:** Indicated by a yellow line.
 - ERPG 3:** Indicated by a red line.
 - ERPG 2:** Indicated by a green line.
 - ERPG 1:** Indicated by a blue line.
- Scale:** A scale bar at the top indicates distances from 0 to 70 km.
- Geographical Features:** The map shows the Fraser River, Strait of Georgia, and various islands and parks including Tetrahedron Provincial Park, Coquitlam Mountain, and the Gulf Islands National Park Reserve.
- Municipalities and Towns:** Labeled locations include Vancouver, Burnaby, Surrey, Langley, Richmond, Delta, White Rock, Blaine, Haynie, Delta, Northwood, Clearbrook, Lynden, Hampton, Everson, Nugent's Corner, Deming, Van Zandt, Wickersham, and others.
- Transportation:** Major highways (e.g., 99, 1, 7, 15, 17, 13, 5, 54, 542, 540, 544, 546, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600) and the proposed Rail Route are shown.

Figure 12-3: Overall Outdoor Toxic Lethality Effect Levels

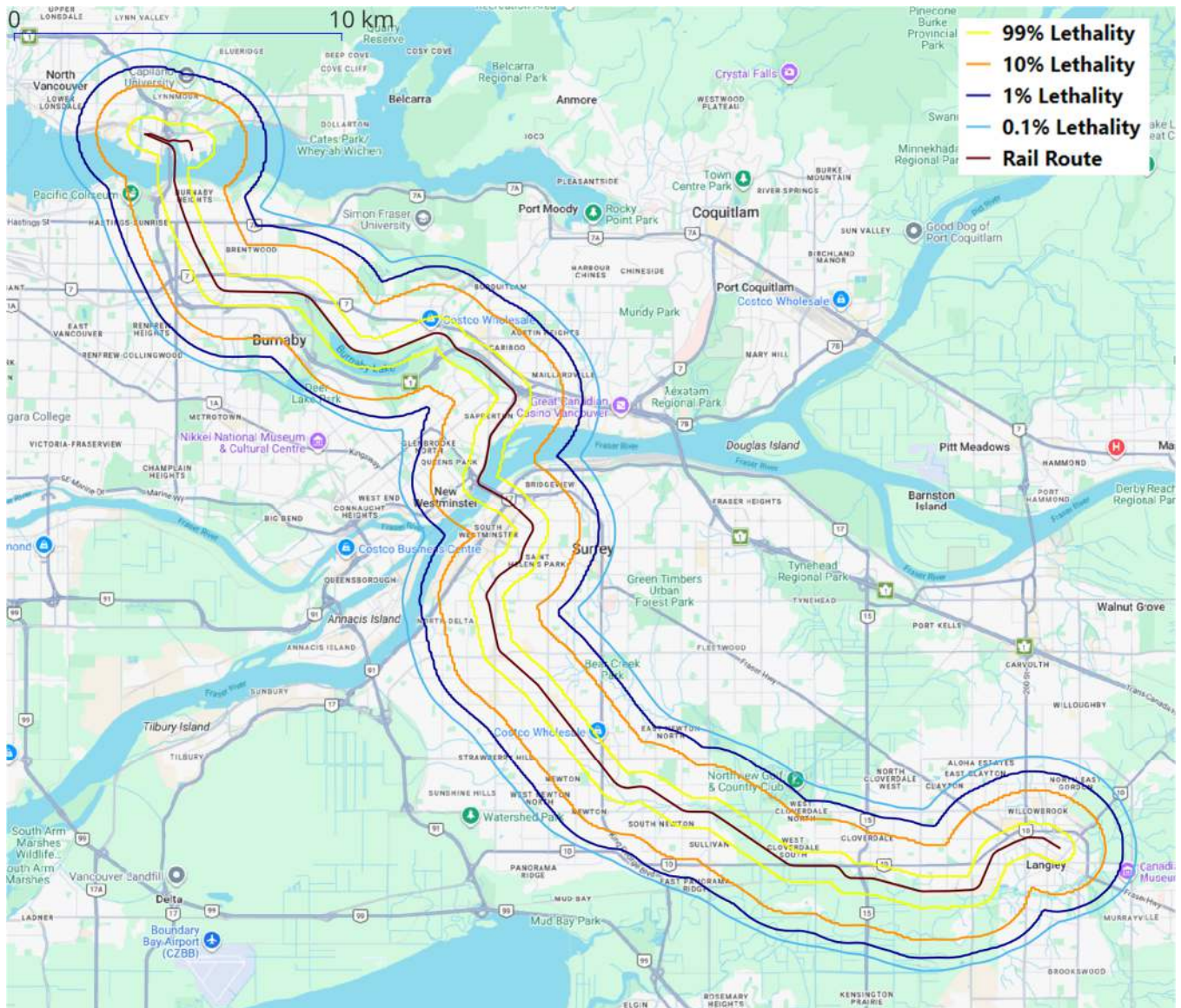
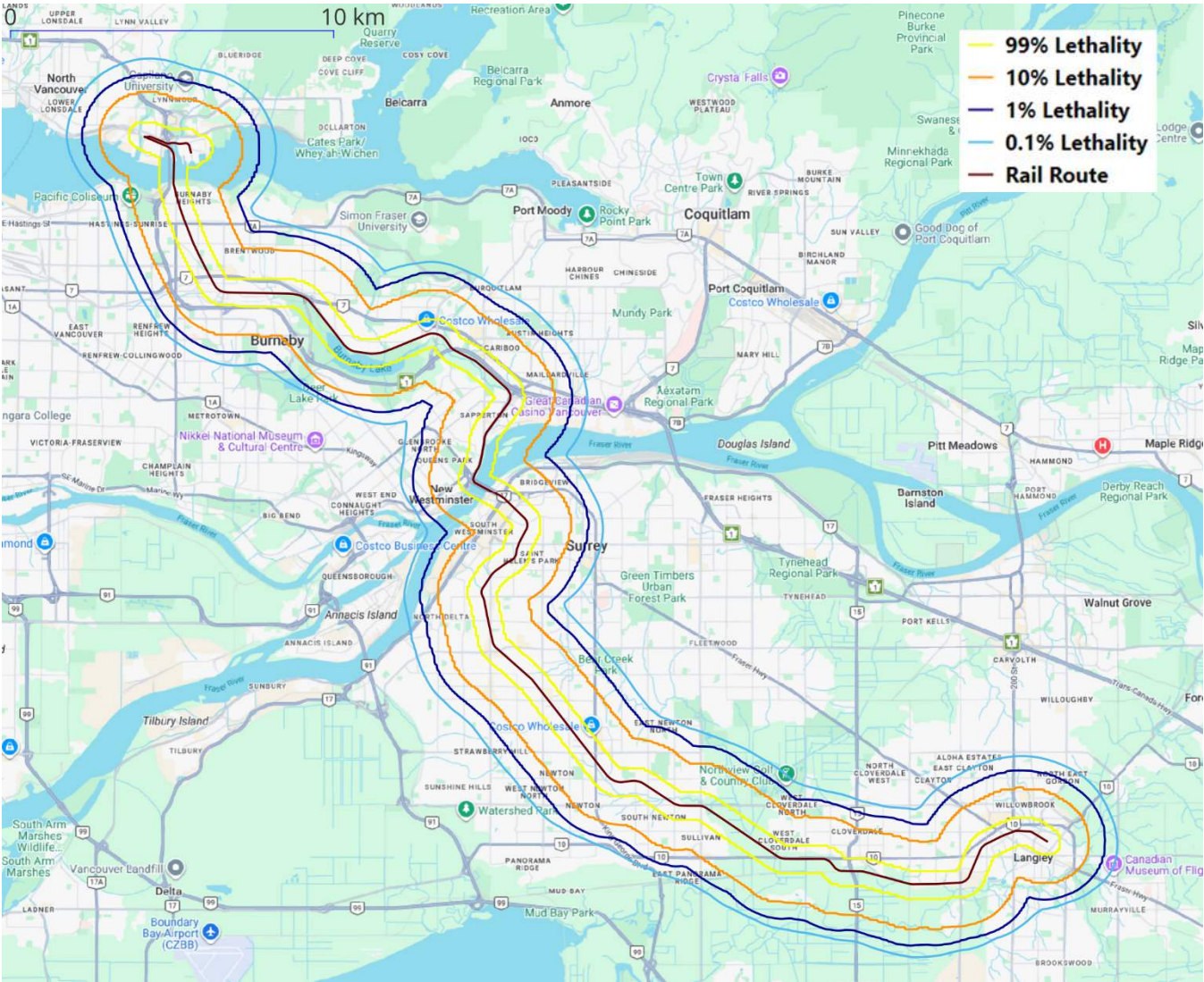


Figure 12-4: Overall Indoor Toxic Lethality Effect Levels



12.1.1 Stationary Railcar Scenarios

Scenarios 1 and 2 represent releases from stationary loaded railcars at Chemtrade's onsite railyards. Toxic indoor lethality and ERPG contours for scenarios 1 and 2 are shown in Figure 12-5 and Figure 12-6, respectively.

Figure 12-5: Toxic Indoor Lethality from Onsite Loaded Chlorine Railcar (Large Release)

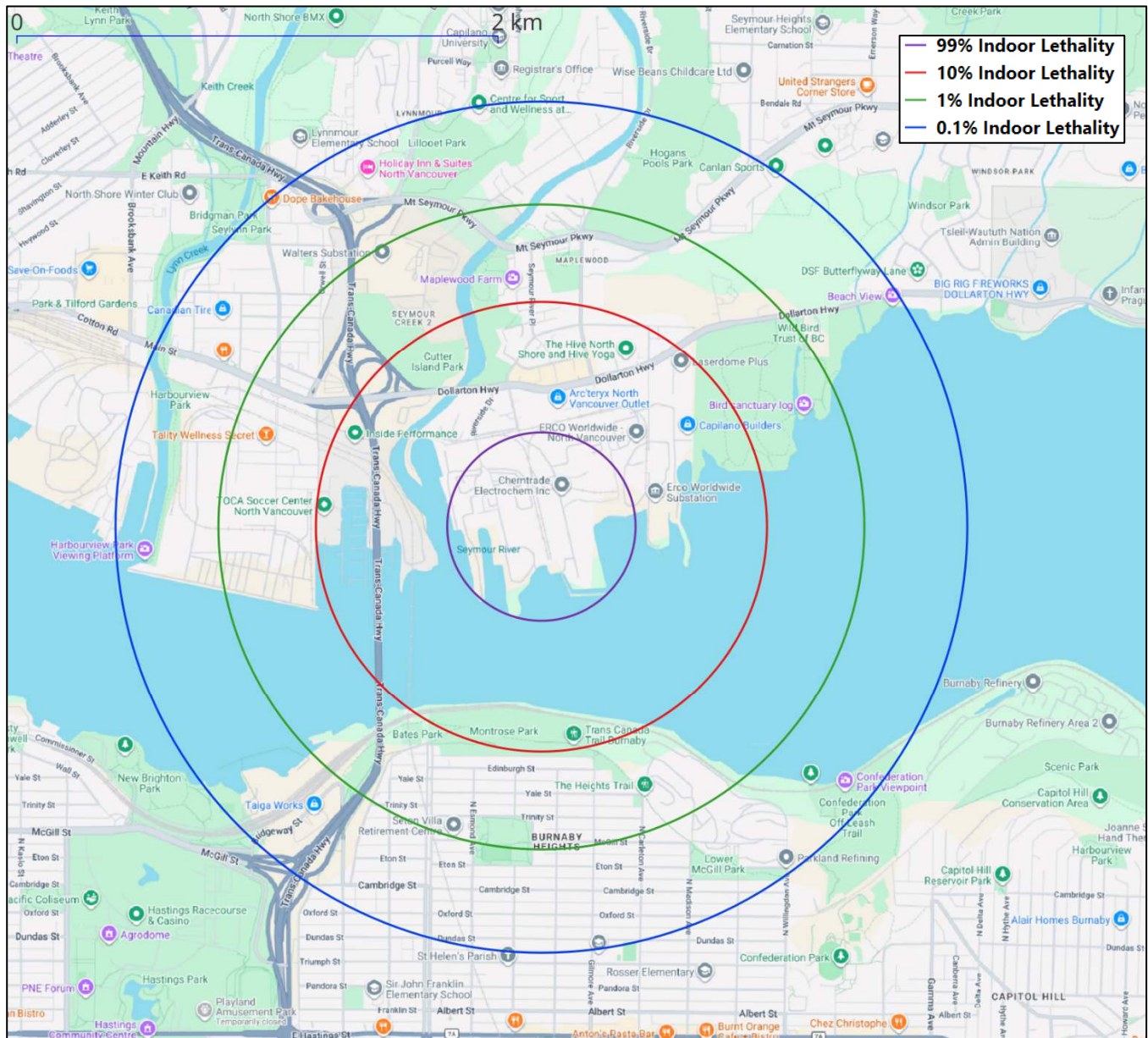


Figure 12-6: Toxic ERPG from Loaded Chlorine Railcar (Large Release)



Scenarios 3 and 4 represent releases from stationary unloaded railcars at Chemtrade's onsite railyards. Toxic indoor lethality and ERPG contours for scenarios 3 and 4 are shown in Figure 12-5 and Figure 12-6, respectively.

Figure 12-7: Toxic Indoor Lethality from Unloaded Chlorine Railcar (Large Release)

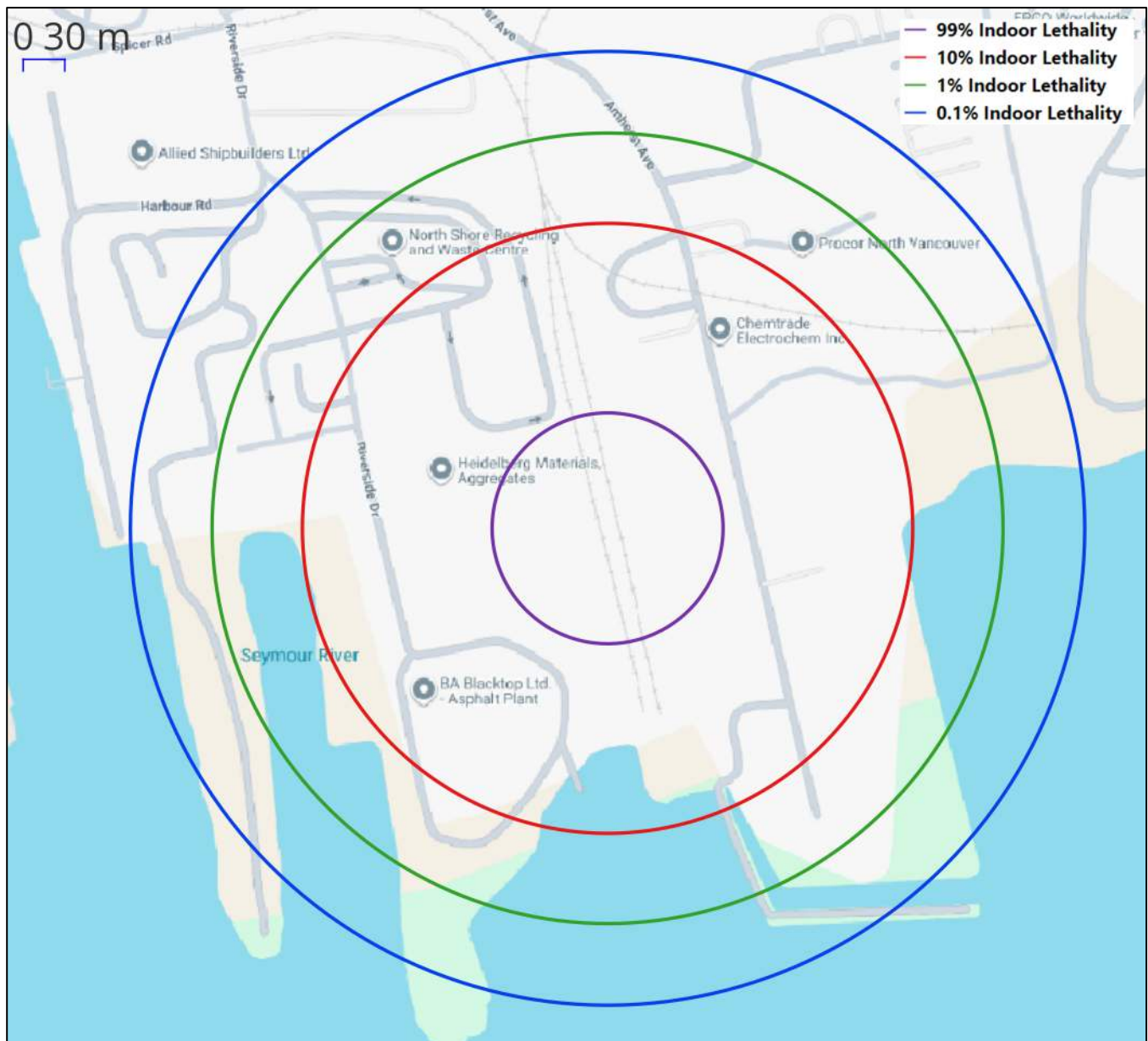
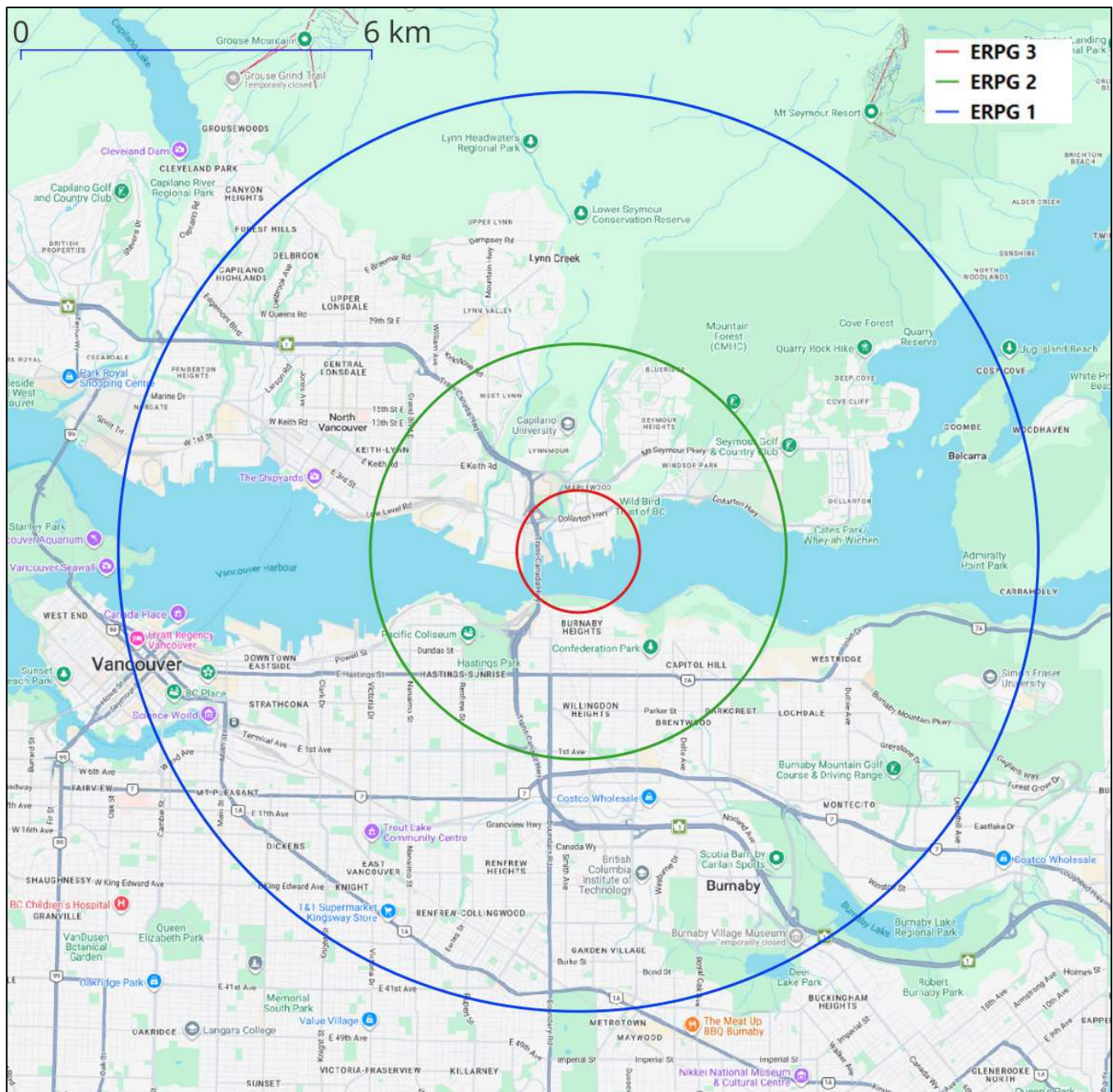


Figure 12-8: Toxic ERPG from Unloaded Chlorine Railcar (Large Release)



In general, loaded railcar scenarios and larger release sizes produced the greatest impact distances, as shown in Table 12-1, where the larger release cases dispersed over greater distances and governed the worst-case outcome.

However, the opposite trend is observed for the unloaded railcar scenarios, where smaller releases resulted in greater downwind impact distances. In this case, the smaller release scenarios occurred over longer durations, allowing more time for toxic concentrations to accumulate and increasing the resulting toxic dose at distance.

For the larger release size, this resulted in a rapid discharge and short-duration plume due to flashing and quick dispersion.

12.2 Individual Risk

Individual risk contours can be used to assess the allowable land uses using MIACC criteria for public areas that may be impacted by potential toxic hazards. Figure 12-9, Figure 12-10, and Figure 12-11 present the individual risk contours for toxic indoor exposure. Figure 12-12 and Figure 12-13 show the overall individual risk contours for indoor and outdoor exposure, respectively.

Figure 12-9: Individual Risk - Toxic Indoor around Chemtrade Facility

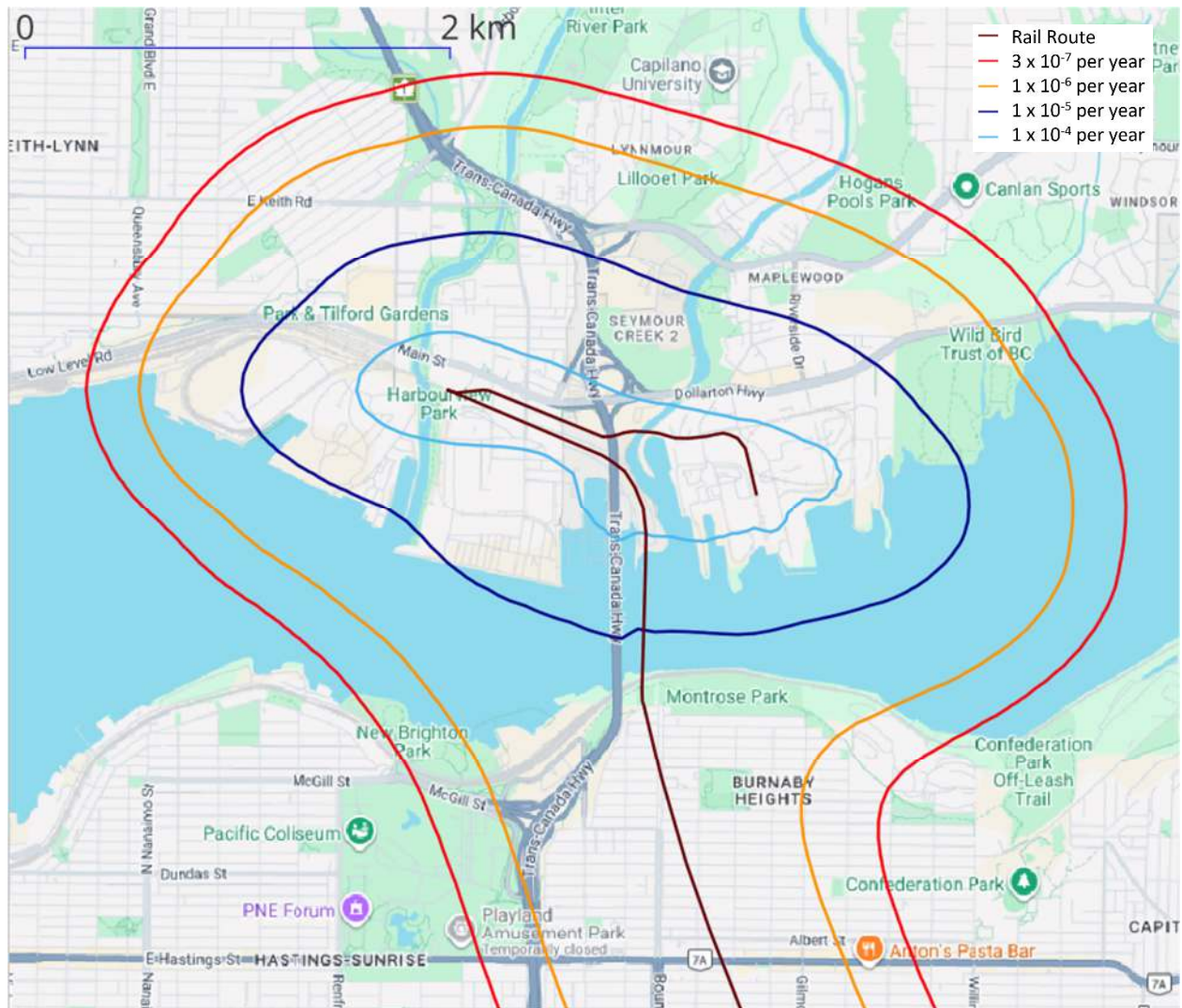


Figure 12-10: Individual Risk - Toxic Indoor near Burnaby and Surrey

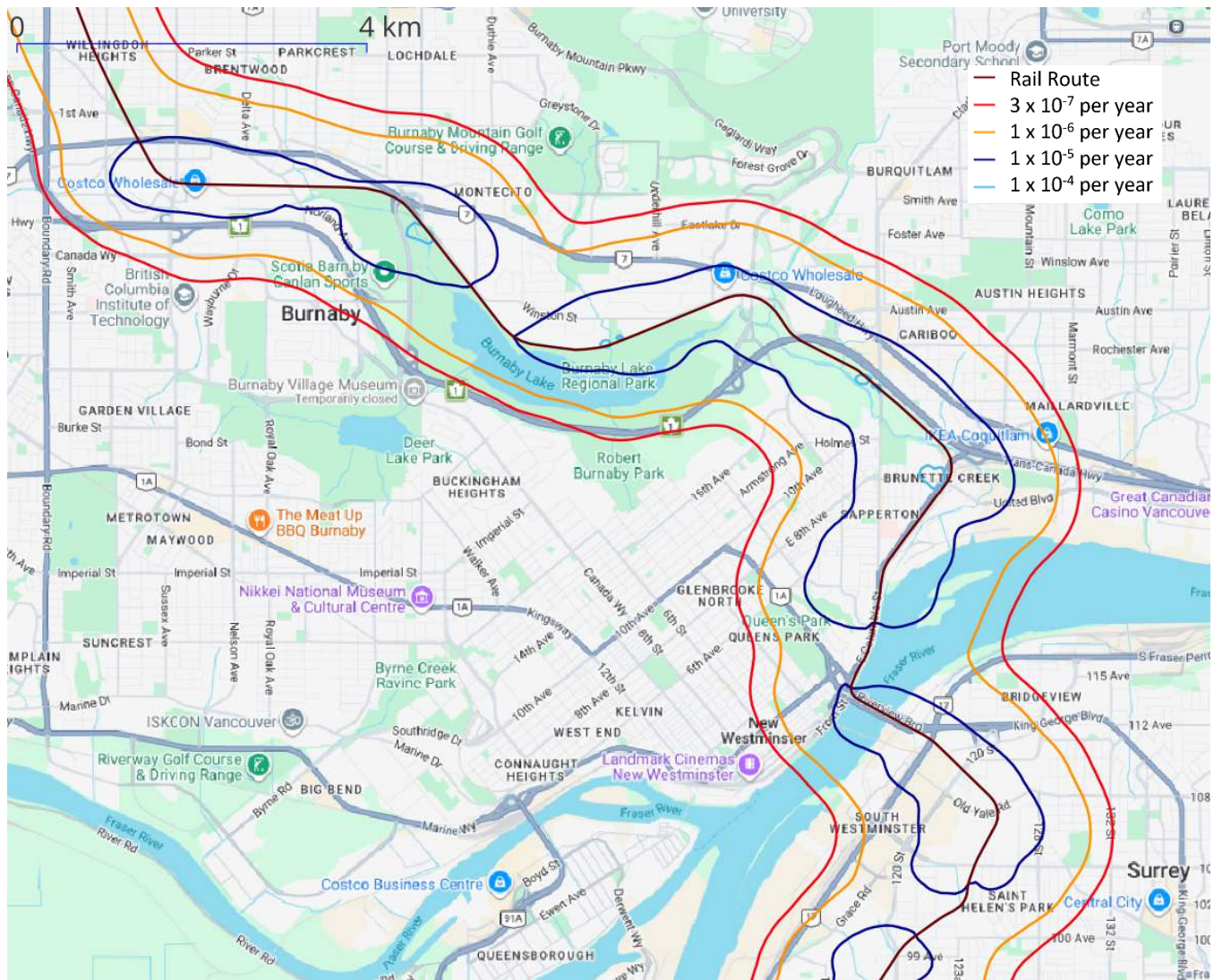


Figure 12-11: Individual Risk - Toxic Indoor near Langley

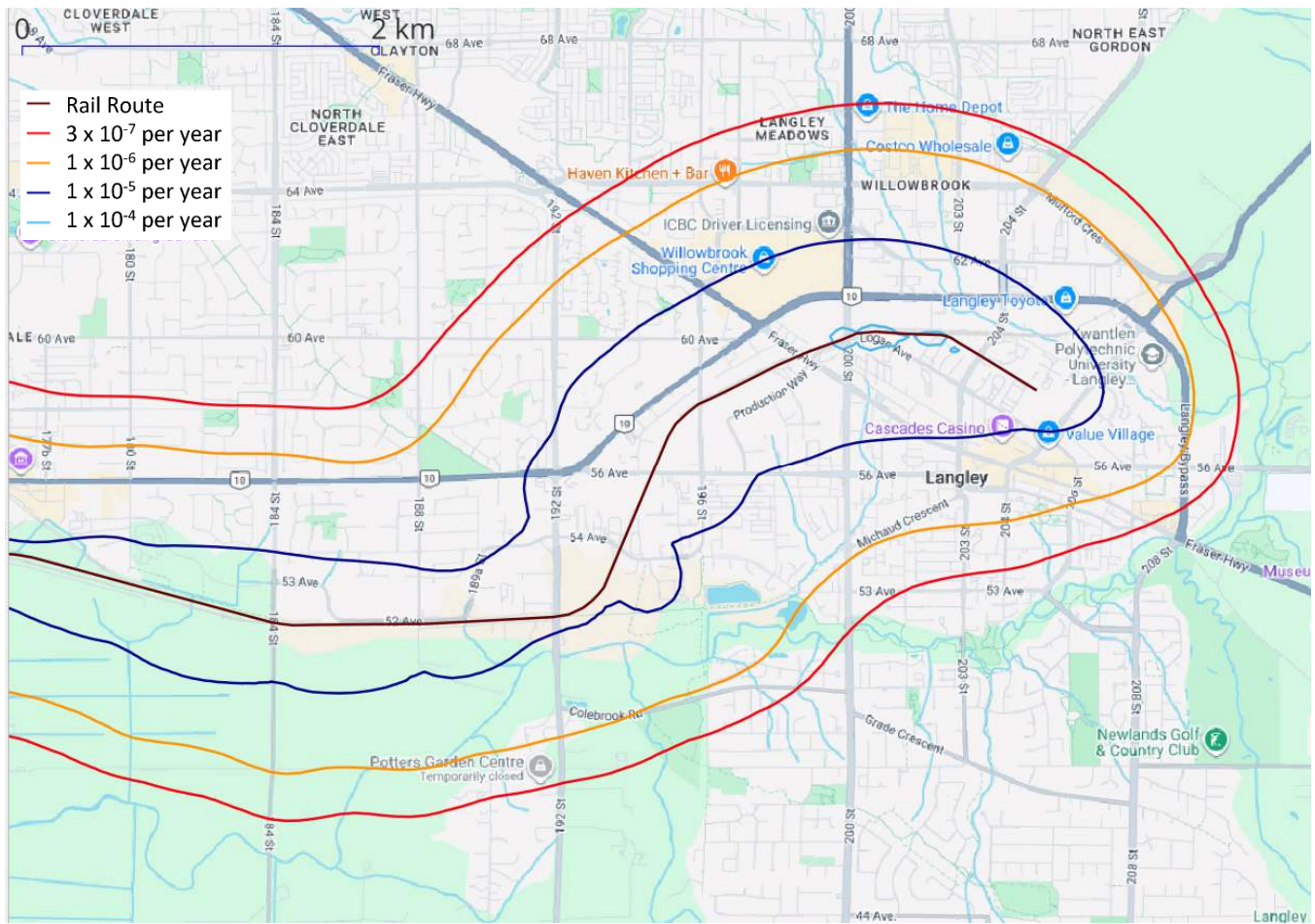


Figure 12-12: Individual Risk - Toxic Indoor

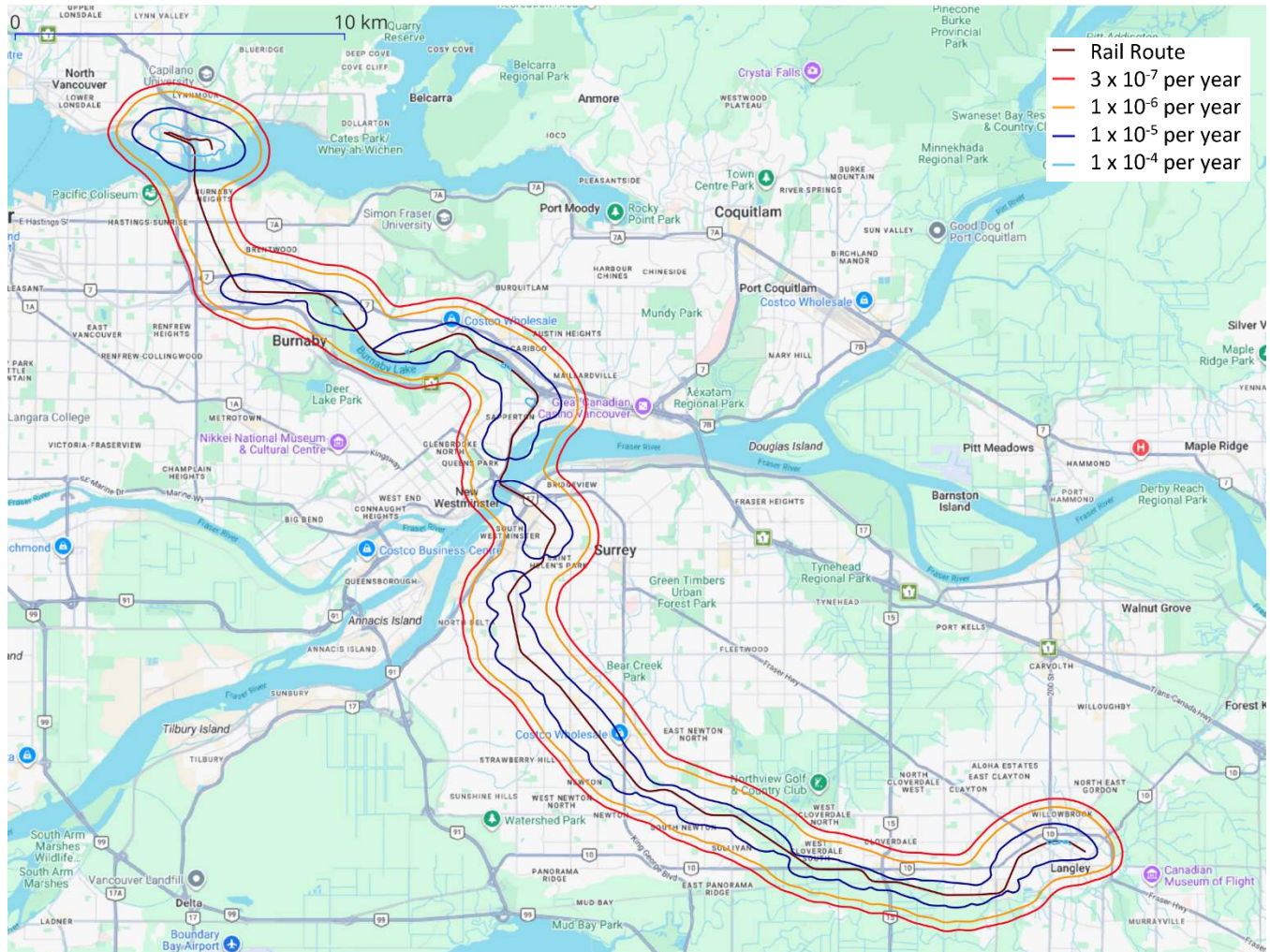
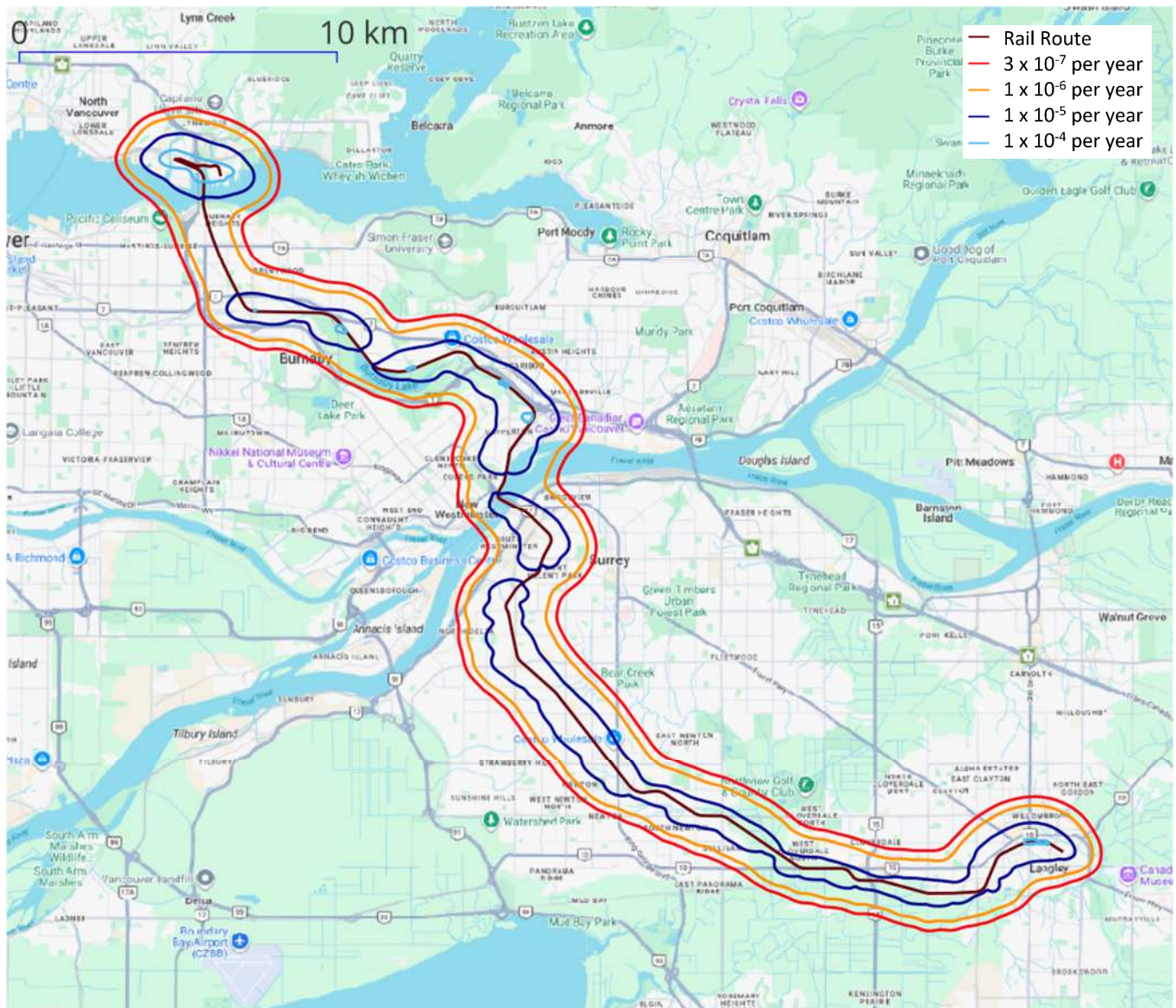


Figure 12-13: Individual Risk - Toxic Outdoor



12.2.1 Sensitive Receptors

There are hundreds of sensitive receptors in the vicinity of the rail route, which include schools, daycares, hospitals, senior care facilities, and apartment complexes. Many of these are situated within the 10^{-6} /year individual risk contour, which exceeds acceptable risk levels for high-density residential areas, commercial areas, and sensitive developments, such as daycares and hospitals, as defined by MIACC individual risk criteria [11]. It should be noted that only locations within the 10^{-6} /year contour were considered. Expanding the area to the more conservative 3×10^{-7} /year risk area for hospitals, senior facilities, and childcare facilities, would yield significantly more locations. Additionally, the numbers presented are an underestimation, as the search was

limited to named locations listed on Google Earth. As such, unnamed apartment buildings and childcare facilities were not included. These sensitive receptors are summarized in Table 12-2.

Table 12-2: Count of Sensitive Receptors within 10^{-6} IRF Contour

Receptor Type	Count
Schools & Daycares (private & public schools, daycare centers)	131
Senior Care Facilities (retirement villages, day centers, assisted living, nursing homes)	15
Hospitals	1
High-Density Housing (apartments, condominiums)	50

Figure 12-14, Figure 12-15, and Figure 12-16 show the schools and daycares, hospitals and senior facilities, and high-density housing locations within the 10^{-6} individual risk contour. The risk contour is shown in red, and the rail route itself is shown in yellow.

Figure 12-14: Schools and Daycares within 10^{-6} /year Risk Contour

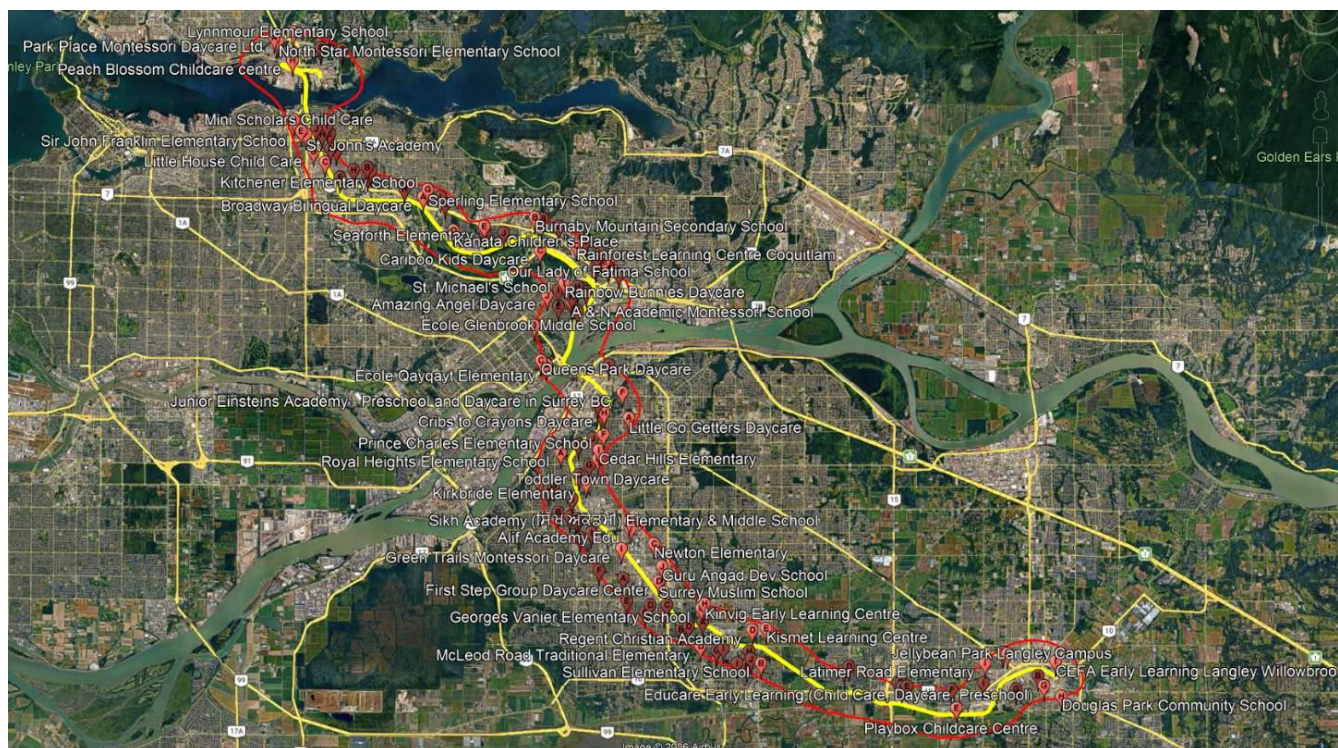


Figure 12-15: Hospitals and Senior Care Facilities within 10^{-6} /year Risk Contour

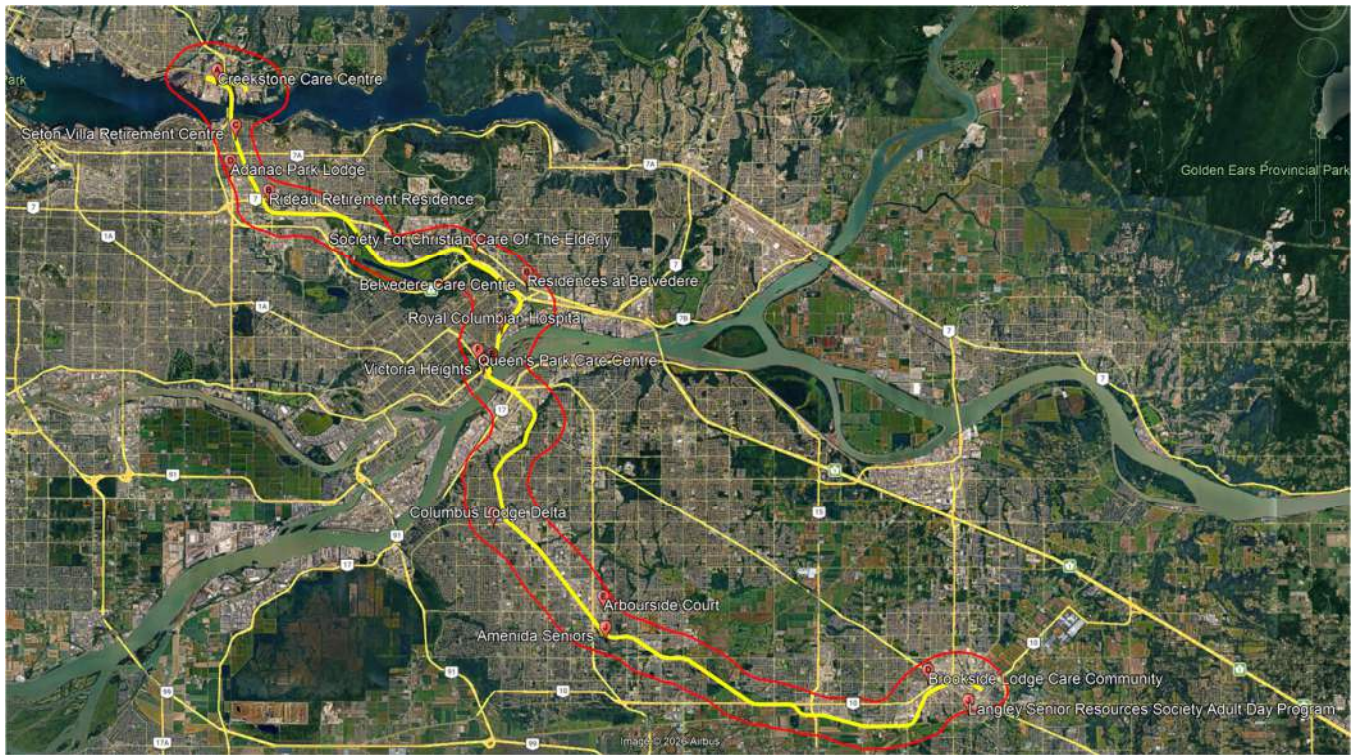
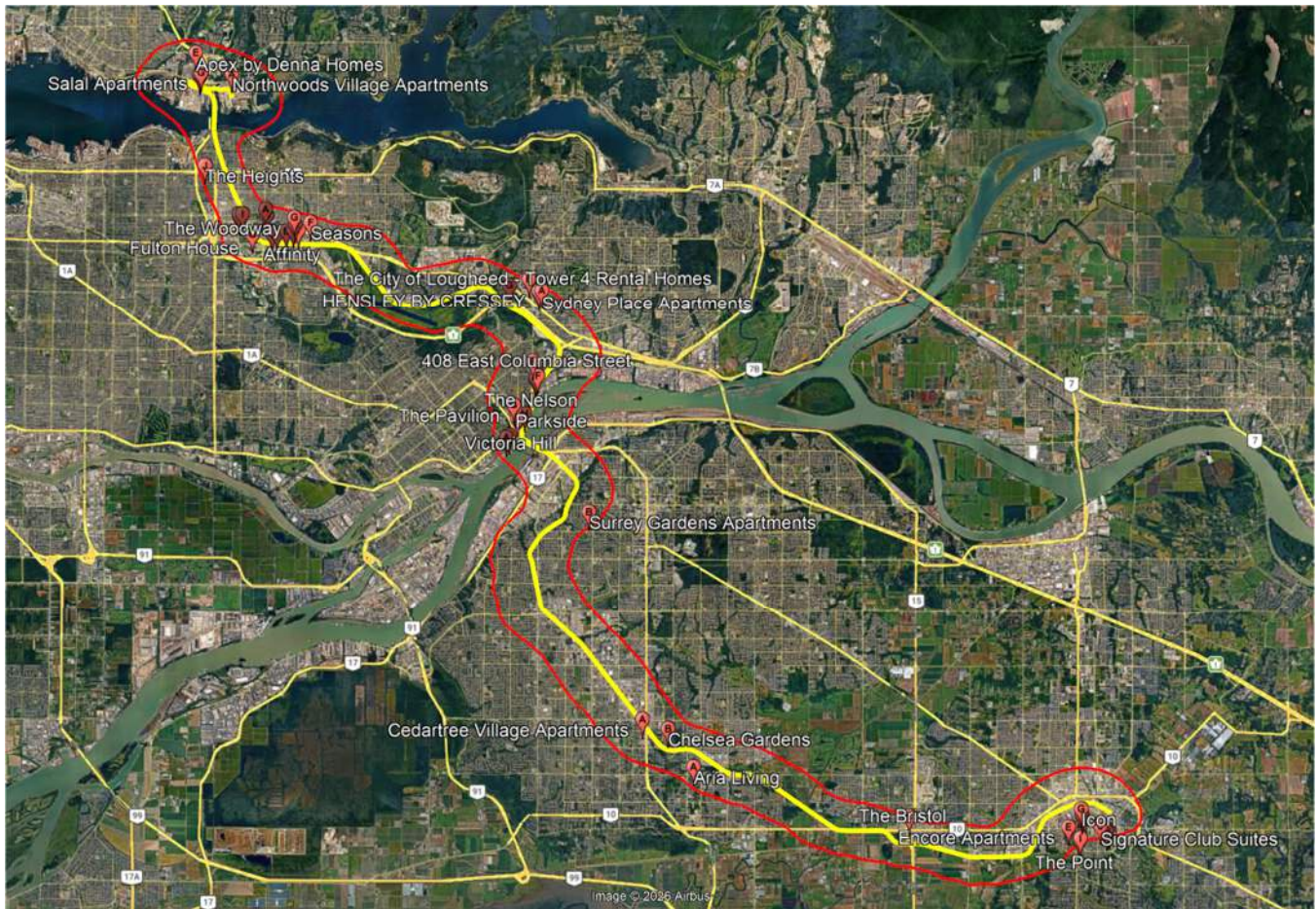


Figure 12-16: High-Density Housing Locations within 10^{-6} /year Risk Contour



13 Conclusions and Recommendations

The conclusions and recommendations within this section were based on the results of the quantitative risk assessment that considered the storage of chlorine railcars at Chemtrade's facility and transport of liquid chlorine railcars from Chemtrade's facility to Langley.

13.1 Conclusions

The analysis addressed the objectives of this dispersion modeling and impact study, which were to:

- Evaluate historical accident data and rail industry guidance to identify credible release scenarios associated with the **storage and transport of chlorine railcars** from the Chemtrade site;
- Estimate hazard distances associated with toxic vapor dispersion from credible chlorine railcar release events;
- Characterize toxic dispersion consequences, risks, and potential impact to the public;
- Provide recommendations to mitigate potential impacts.

The study assessed the representative railway route from Chemtrade's facility in North Vancouver through populated urban areas to Langley and found that transporting liquid chlorine railcars at an estimated volume of 1,000 railcars per year exposes the public to individual risks that exceeds acceptability risk criteria defined by the Major Industrial Accidents Council of Canada (MIACC). Individual risk (the chance of fatality per year) was assessed against MIACC risk criteria, which specifies allowable land uses based on individual risk presented by a hazard source. The assessment identified 131 schools and daycare centers, 50 hospitals, and 15 Senior Care Facilities that are exposed to risks exceeding MIACC acceptability criteria, indicating the need to implement risk reduction strategies.

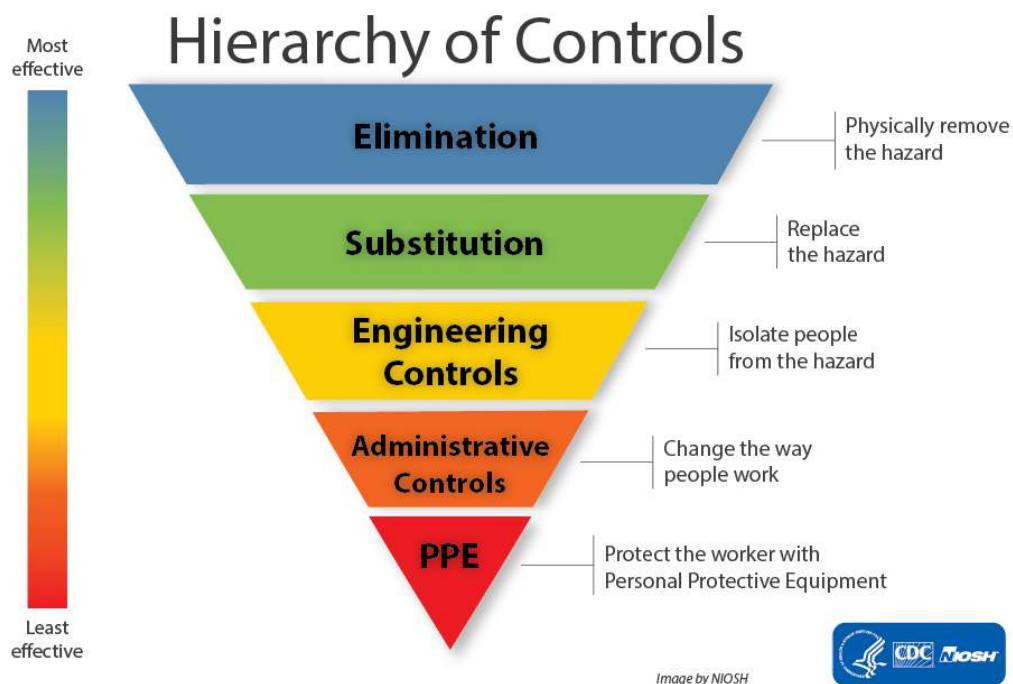
13.2 Recommendations

Based on the analysis and results of this study, the recommended risk reduction strategy is to substitute bleach in the place of chlorine for mass transport via rail or tanker truck. The consequence and risk assessment show the potential for catastrophic fatal impacts to the public. Following the structured approach of hierarchy of controls, as described by the US Center for Disease Control (CDC), the most effective safeguards are elimination and substitution of hazardous materials, followed by engineering controls, administrative controls, and personal protective equipment, as illustrated in Figure 13-1. Though elimination of the hazard is not a viable option, substitution of bleach in place of chlorine would drastically reduce the operational risk and public impact.

Compared to chlorine, bleach does not generate toxic vapor clouds that present significant acute toxic risks. A release of bleach results in only localized impacts near the liquid spill, drastically reducing the potential for catastrophic toxic releases, particularly in urban settings. While transporting bleach would necessitate a higher volume of railcars and increase operational complexities at the Chemtrade site, the conversion would effectively eliminate the catastrophic toxic risks associated with transporting chlorine outside of the Chemtrade site. An increased frequency of incidents with bleach, due to the increased rail traffic, would be offset by the substantial

reduction in the severity of potential consequences, prioritizing public safety and limiting risk to the public. Bleach substitution is an industry recognized strategy to eliminate the risks of chlorine, and it is utilized by companies and operators globally to prioritize safety and reduce the burden of managing catastrophic risks.

Figure 13-1: Hierarchy of Controls



14 References

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Appendix A: Historical Incident Review

Historical Incident Statistics

A.1 General

A literature review of railcar accidents was undertaken to evaluate the public risk associated with transporting chlorine railcars from a site in North Vancouver, Canada into the United States. The review focused primarily on Canadian accident data, supplemented by U.S. data where relevant, to improve statistical robustness and to better characterize hazardous materials (hazmat) accident types and consequences.

Primary data sources included Transportation Safety Board of Canada (TSB) rail occurrence data and U.S. Federal Railroad Administration (FRA) accident databases. Additional sources, including the U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA), detailed incident investigation reports, and industry guidance commonly applied in quantitative risk assessments (QRAs), such as the TNO “Purple Book”, were also reviewed. These sources were used to develop an understanding of accident precursors, causal factors, failure mechanisms, and the pathways by which initiating events can propagate to hazardous material release and consequences.

Based on data completeness, relevance to hazardous materials transport, and the ability to link accident types to credible release scenarios, the TSB and FRA datasets were identified as the most suitable primary sources for this assessment. Results were benchmarked against established risk assessment guidance, including the TNO Purple Book, and key insights from each dataset are summarized in the sections that follow.

A.2 Statistical Trends Relevant to Hazardous Materials Release

Across the literature, derailments are consistently identified as the dominant accident type associated with hazardous material releases. However, the severity of a derailment and the number of tank cars damaged or releasing hazardous materials can vary widely and are governed by a combination of operational, mechanical, and train-specific factors.

A detailed statistical analysis of multi-car hazardous material releases by Liu et al. [17] identified several key parameters influencing the number of tank cars damaged or releasing in a derailment, including:

- Train length
- Derailment speed
- Accident cause (e.g., track defects, human factors, equipment failure)
- Point of derailment, particularly the position of the first car derailed
- Distribution and positioning of tank cars
- Tank car design (e.g., pressurized vs non-pressurized)

These findings show that derailments span a range of severities rather than a single failure mode, with the likelihood of multi-car involvement strongly dependent on the factors discussed above. This has direct

implications for consequence modeling, especially when defining credible release scenarios and associated hazardous impacts (e.g., full rupture versus small leak).

For this assessment, rail movements are limited to Track Class 1, where freight train operating speeds are restricted to 10 mph (~16 km/h). Consistent with Liu et al. [17], lower derailment speeds are generally associated with reduced derailment severity and a lower likelihood of extensive tank car damage. Observations from large accident datasets further indicate that, for low-speed derailments, a substantial proportion of incidents involving hazardous materials do not result in a release; this behavior is examined in more detail using FRA and TSB data in the sections that follow.

A.2.1 Distribution of Track Class

In the absence of sufficiently detailed, publicly available track class mileage data for Canada, U.S. rail infrastructure data was used to inform the track class distribution adopted in this assessment. Track class and route mileage information for the State of Georgia was sourced from the Georgia State Rail Plan – Appendix B: Georgia’s Existing Railway System Technical Memorandum (2021) [18].

The Georgia dataset provides detailed information on railroad subdivisions, including Federal Railroad Administration (FRA) track class designations and corresponding route mileage for Class I and short line railroads operating within the state. Each subdivision was reviewed, and total route mileage was summed and categorized by FRA track class. The cumulative mileage by track class was then normalized to derive a percentage distribution of track class across the Georgia rail network.

The resulting distribution indicates that FRA Class 4 track dominates the network, with route mileage distributed as follows:

- Class 4: ~54% of total route mileage
- Class 2: ~19%
- Class 3: ~14%
- Class 1: ~9%
- Class 5: ~5%

Overall, this reflects a network characterized by a substantial proportion of mainline freight corridors (Classes 3–5), supported by lower-speed branch lines, terminals, and industrial spurs (Classes 1–2). In the absence of additional supporting data, this study adopts the same track class distribution to derive a suitable normalized accident rate.

A.3 Canadian Rail Accident Insights (TSB Data)

A.3.1 Accident Type Trends

Analysis of Canadian rail occurrence data indicates that derailments dominate the national accident profile, particularly outside of mainline operations. Based on data from 1983 to 2026, the most frequently reported accident types are:

- Non-main-track derailments (approximately 29% of reported occurrences)
- Grade crossing accidents (approximately 20%)
- Dangerous goods (DG) leaker incidents (approximately 12%)
- Main-track derailments (approximately 10%)

However, the contribution of dangerous goods “leaker” incidents is strongly influenced by historical data from the late 1980s and early 1990s. A pronounced decline in DG leaker events is observed beginning in the early 1990s, with the proportion peaking around 1991 and decreasing substantially in subsequent years. This timing coincides with the introduction and early implementation of the Transportation of Dangerous Goods Act, 1992, which strengthened requirements for handling, inspection (including regular inspections of unattended or stored DG railcars), and emergency response.

Consistent with this long-term trend, TSB data indicate that less than 0.1% of reported rail accidents between 2016 and 2026 are attributable to DG leaker incidents. The aggregate 12% contribution over the full historical dataset is skewed by operational practices in the late 1980s and early 1990s and does not reflect current rail practices. While a direct causal relationship cannot be established from the data alone, the timing and nature of the decline are consistent with the regulatory intent to reduce releases associated with valve, fitting, and closure failures.

In contrast, non-main-track derailments remain consistently prominent throughout the entire period of record. While year-to-year variability is observed, non-main-track derailments continue to represent the single largest accident category in recent decades, reflecting the prevalence of switching operations, yard movements, and industrial trackage within the Canadian rail network.

Grade crossing accidents show a relatively stable contribution over the long term, with year-to-year variability but no sustained decline comparable to that observed for dangerous goods release incidents. This indicates that grade crossing risk is primarily influenced by exposure and interactions with public roadways, rather than by rail-specific regulatory changes.

Given the introduction of the Transportation of Dangerous Goods Act, 1992, and the sustained decline observed in certain accident types, TSB data from the most recent 20-25-year period are considered more representative of current operating and regulatory conditions and are therefore emphasized in the subsequent analysis.

Table B-2 in Appendix B presents the full distribution of Canadian rail accident types from 1983 to 2026.

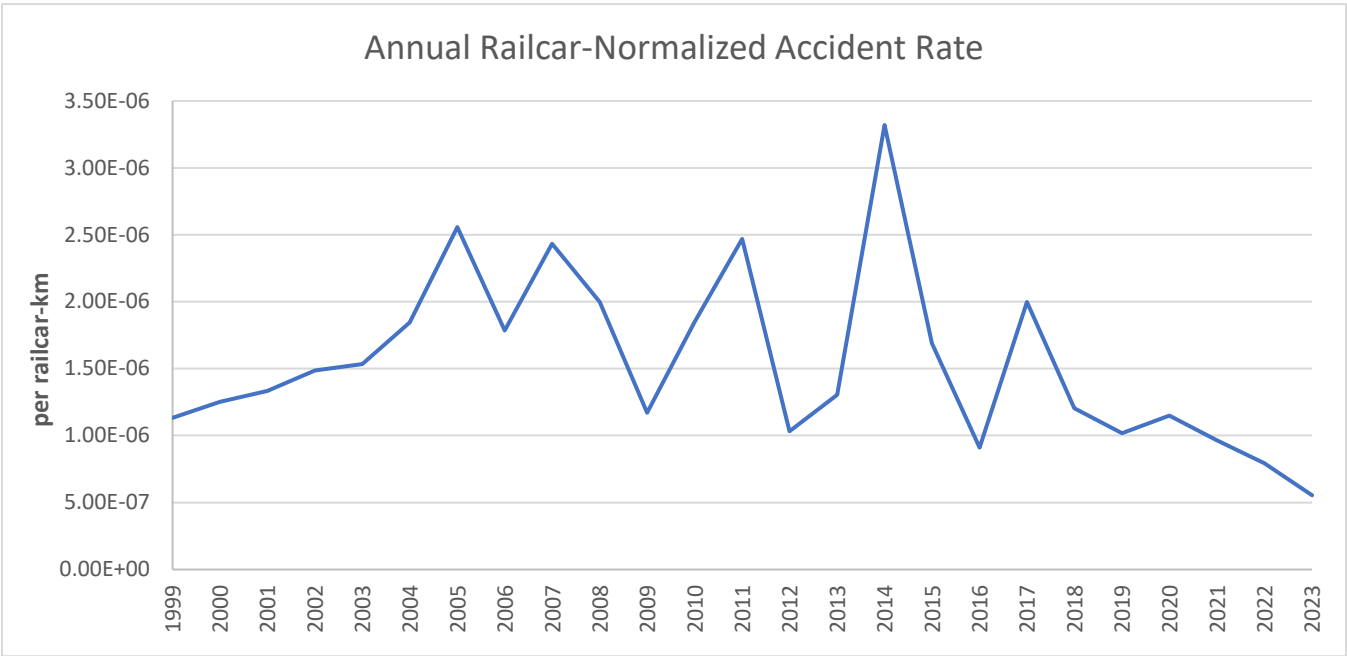
A.3.2 Rail Accident Trends

From 1999 to the present, numerous railcar accidents have occurred on Canadian railways. To account for year-to-year variations in rail activity, accident rates were calculated by comparing the number of freight railcars involved in main-line accidents each year with the total distance travelled by all freight railcars over the same period [19]. Using this normalization, accident rates have remained on the order of 10^{-7} to 10^{-6} per railcar-km (Figure 14-1), corresponding to a long-term average accident rate of approximately 1.45×10^{-6} per railcar-km.

The year-to-year variability observed in Figure 14-1 is driven primarily by a small number of major derailments involving large numbers of railcars, such as St-Hilaire (1999), Lac-Mégantic (2013), and the Gogama derailments

(2015), rather than by routine accident occurrence. The underlying annual exposure and accident data are summarized in Table B-3 in Appendix B.

Figure 14-1: Railcar Accident Rate on Canadian Railroads per Freight Railcar-km (1999–2023)



To further examine this variability, accident rates were evaluated by operating speed and inferred track class. Figure 14-2 presents railcar-normalized accident rates for rail speeds below 25 mph (40 km/h), representative of Track Classes 1-2, and above 25 mph (40 km/h), representative of Track Classes 3 and higher. On average, accident rates are higher for speeds below 40 km/h, at approximately 2.29×10^{-6} per railcar-km, compared with 1.14×10^{-6} per railcar-km for speeds above 40 km/h.

Further breakdown of the lower-speed results show that Track Class 1 alone has an average accident frequency of 2.34×10^{-6} per railcar-km (Table B-6), closely aligned with the overall <40 km/h average. This suggests that Track Class 1 operations are the primary contributor to the higher accident rates observed at lower speeds. These differences likely reflect the characteristics of lower track classes, which are designed for lower operating speeds and operate under different inspection and maintenance requirements than higher-class track.

The annual exposure and accident data supporting the lower-speed and higher-speed accident rates are summarized in Table B-4 and Table B-5, respectively, with Track Class 1-specific exposure and accident data provided in Table B-6 in Appendix B.

Figure 14-2: Railcar Accident Rate on Canadian Railroads per Freight Railcar-km and Operating Speed (1999–2023)

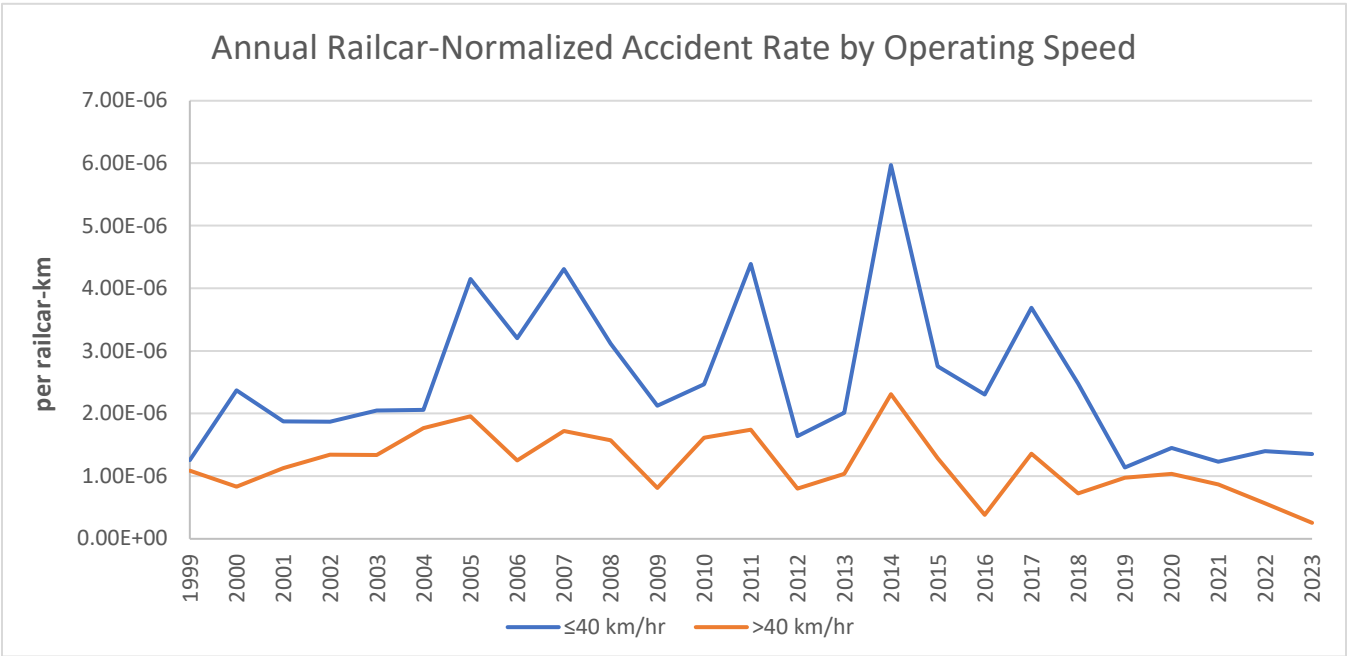
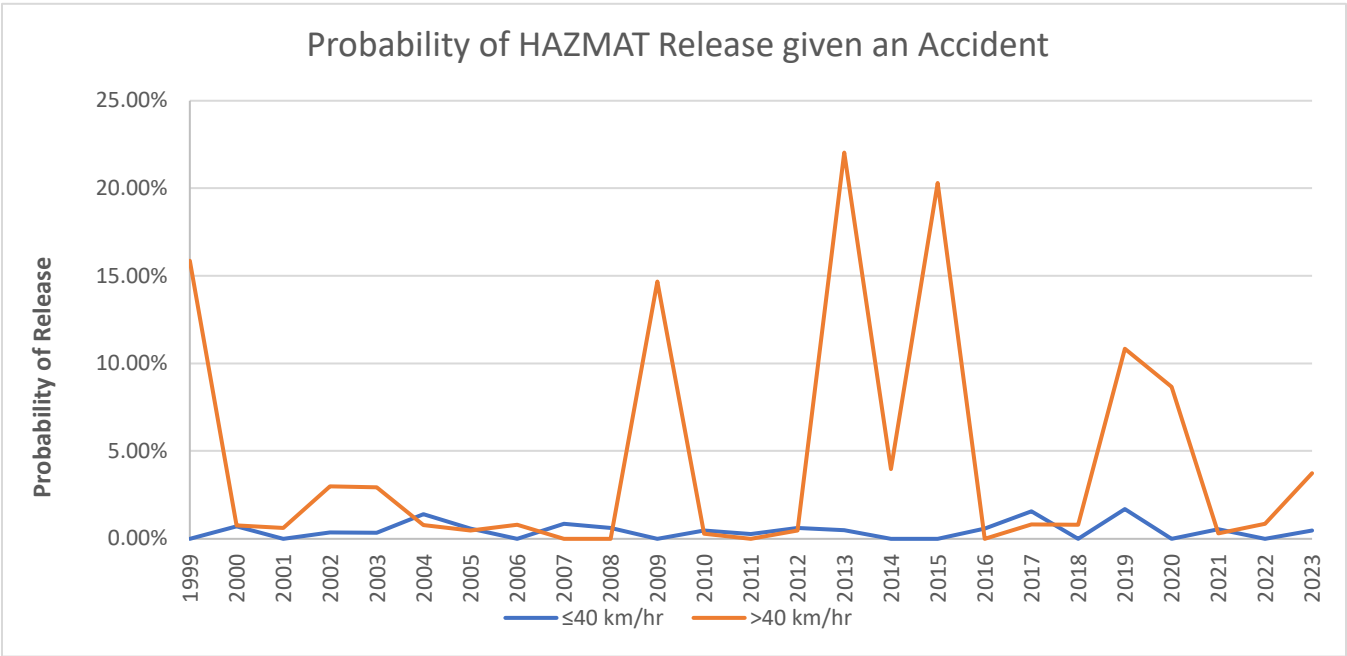


Figure 14-3 complements this frequency-based analysis by showing the conditional probability of hazardous materials (HAZMAT) release given that an accident has occurred, using the same speed groupings. While lower-speed movements account for a greater share of accidents overall, the probability of a HAZMAT release is substantially higher for accidents occurring at speeds above 40 km/h. Year-to-year spikes in release probability within the higher-speed category are driven by a small number of high-consequence derailments involving multiple railcars.

The annual accident and release data used to calculate these conditional probabilities are also summarized in Table B-4 and Table B-5 in Appendix B

Figure 14-3: Railcar Accident Rate on Canadian Railroads per Freight Railcar-km and Operating Speed (1999–2023)



Overall, accident frequencies are higher at lower operating speeds, particularly in Track Class 1, whereas higher-speed mainline accidents are less frequent but more likely to result in hazardous material releases due to increased derailment severity and multi-car involvement. This trend is consistent with findings reported in the literature, including Liu et al. [17].

A.3.3 HAZMAT Release Conditional Probabilities

To further refine the evaluation of hazardous materials (HAZMAT) release outcomes, the TSB accident data were processed to examine the probability of release as a function of tank car type and operating speed. Accidents were grouped into non-pressurized (atmospheric) and pressurized tank cars, recognizing that vessel design strongly influences release likelihood once an accident occurs. The resulting conditional probabilities of outflow given an accident are summarized in Table 14-1.

Table 14-1: Probability of Outflow for TSB and TNO

Train Speed	TSB of Canada		TNO Purple Book [4]	
	Non-Pressurized	Pressurized	Non-Pressurized	Pressurized
≤40 km/hr	4.4E-02	6.9E-03	7.9E-02	7.9E-04
>40 km/hr	2.2E-01	2.0E-02	5.6E-01	2.8E-03

As shown in Table 14-1, non-pressurized tank cars show a substantially higher probability of outflow than pressurized tank cars across both speed groupings. While release probabilities increase for both vessel types at higher operating speeds (>40 km/h), the relative reduction in release likelihood for pressurized cars remains evident, reflecting their greater structural robustness and pressure-rated design.

These trends are consistent with reference values reported in the TNO Purple Book [4], which similarly indicate lower probabilities of significant outflow from pressurized tank cars compared with atmospheric designs. Although absolute values differ due to differences in dataset scope and release definitions, the relative behavior between vessel types and speed categories shows good agreement.

This distinction is particularly relevant for chlorine transport, as chlorine is conveyed in pressurized tank cars. The lower conditional probability of release associated with pressurized vessels indicates that, even when accidents occur, chlorine releases are less likely than releases from non-pressurized hazardous cargos, especially at lower operating speeds.

A.4 U.S. Rail Accident Insights (FRA Data)

A.4.1 Accident Type Trends

The FRA accident database provides a large and detailed population of rail incidents, enabling accident characteristics to be evaluated by accident type, track class, hazardous material involvement, and other factors. Based on data from 1975 to 2025, the distribution of reported accidents indicates that:

- Derailments are the dominant accident type, accounting for approximately 64% of events
- Side collisions account for approximately 10%
- Other impacts account for approximately 10%
- Highway–rail grade crossing collisions account for approximately 6%

Over the period from 1975 to 2025, derailments consistently represent the dominant rail accident type, accounting for the majority of reported occurrences in every year. While derailments comprise approximately 70–75% of accidents in the mid-1970s, their relative contribution gradually declines over time, stabilizing closer to 50–60% in more recent years. Despite this reduction, derailments remain the most common accident type throughout the period.

Over the same period, several non-derailment accident types increase in relative importance. Highway–rail crossing accidents show a clear upward trend, rising from a small fraction of total accidents in earlier decades to approximately 8–12% in recent years, likely reflecting increased road–rail interface exposure. Similarly, the “other impacts” category grows steadily over time, suggesting either broader classification practices or an increasing contribution from miscellaneous impact mechanisms. In contrast, collision-related accident types such as head-on, rear-end, and side collisions remain infrequent and generally decline or remain stable, indicating sustained effectiveness of train control and operating practices.

Consistent with approaches commonly applied in TSB analyses, greater emphasis is placed on the most recent 25 years of data, which better reflect current operating practices, regulatory controls, and accident reporting frameworks. Therefore, FRA accident data from this period are considered more representative of current operating and regulatory conditions and are emphasized in the subsequent analysis.

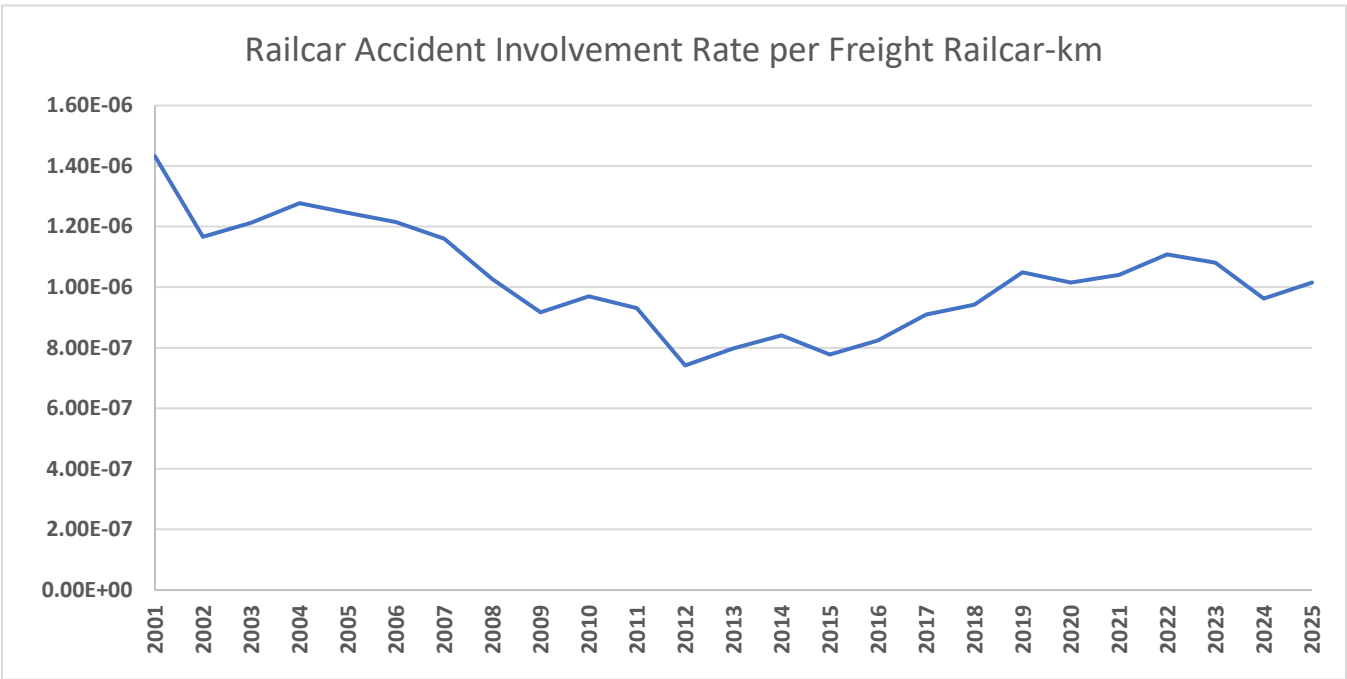
Table C-2 in Appendix B presents the full distribution of US rail accident types from 1975 to 2026.

A.4.2 Rail Accident Trends

From 2001 to the present, railcar accidents on U.S. railways have occurred infrequently relative to the overall volume of freight rail traffic. To allow for comparison across years with differing levels of rail activity, accident rates were calculated by comparing the number of freight railcars involved in main-line accidents each year with the total distance travelled by freight railcars over the same period. Using this normalization, accident rates have remained on the order of 10^{-6} per railcar-km, corresponding to a long-term average accident rate of approximately 1.03×10^{-6} per railcar-km (Figure 14-4).

For the U.S. analysis, freight movement data were reported in terms of train-km rather than railcar-km [20]. To express accident rates on a consistent railcar-km basis, total freight railcar-km were estimated by applying an average number of freight cars per train derived from Canadian TSB data [19]. The resulting annual freight railcar-km, railcar accident involvement counts, and normalized accident rates are summarized in Table C-3 in Appendix B.

Figure 14-4: Railcar Accident Involvement Rate on U.S. Railroads per Freight Railcar-km (2001–2025)



To further examine the observed variability, U.S. accident rates were evaluated by operating speed using the same speed groupings applied in the Canadian analysis. Figure 14-5 presents railcar-normalized accident rates for rail movements below 25 mph (40 km/h) and above 25 mph (40 km/h), based on FRA-reported train speeds immediately prior to each accident.

On average, accident rates for speeds below 40 km/h are higher, at approximately 1.15×10^{-6} per railcar-km, compared with 9.84×10^{-7} per railcar-km for speeds above 40 km/h. Further breakdown of the lower-speed results shows that Track Class 1 alone has an average accident frequency of 1.72×10^{-6} per railcar-km (Table C-6), exceeding the <40 km/h average and indicating that Track Class 1 is the primary contributor within the lower-

speed grouping. These differences are consistent with the trends observed in the Canadian (TSB) dataset in Section A.3.2).

The annual exposure and accident data underlying the lower-speed and higher-speed accident rates are summarized in Table C-4 and Table C-5 in Appendix B, respectively, with Track Class 1-specific exposure and accident data provided in Table C-6.

Figure 14-5: Railcar Accident Rate on Canadian Railroads per Freight Railcar-km and Operating Speed (1999–2023)

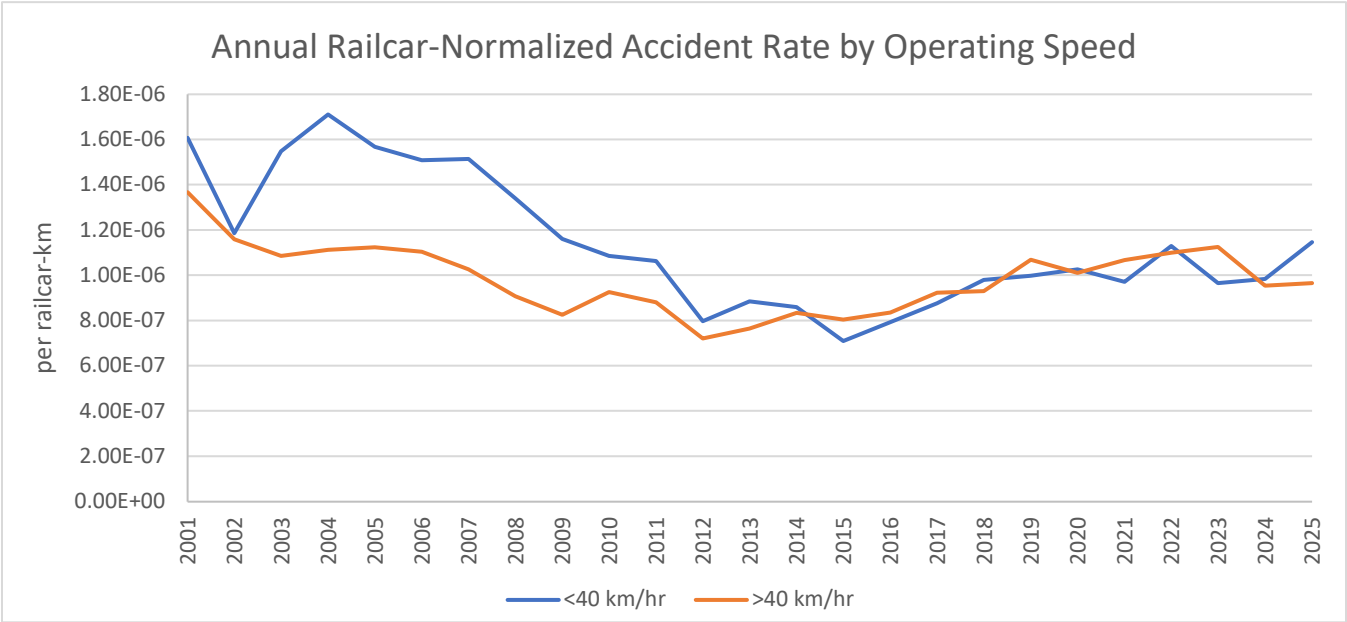
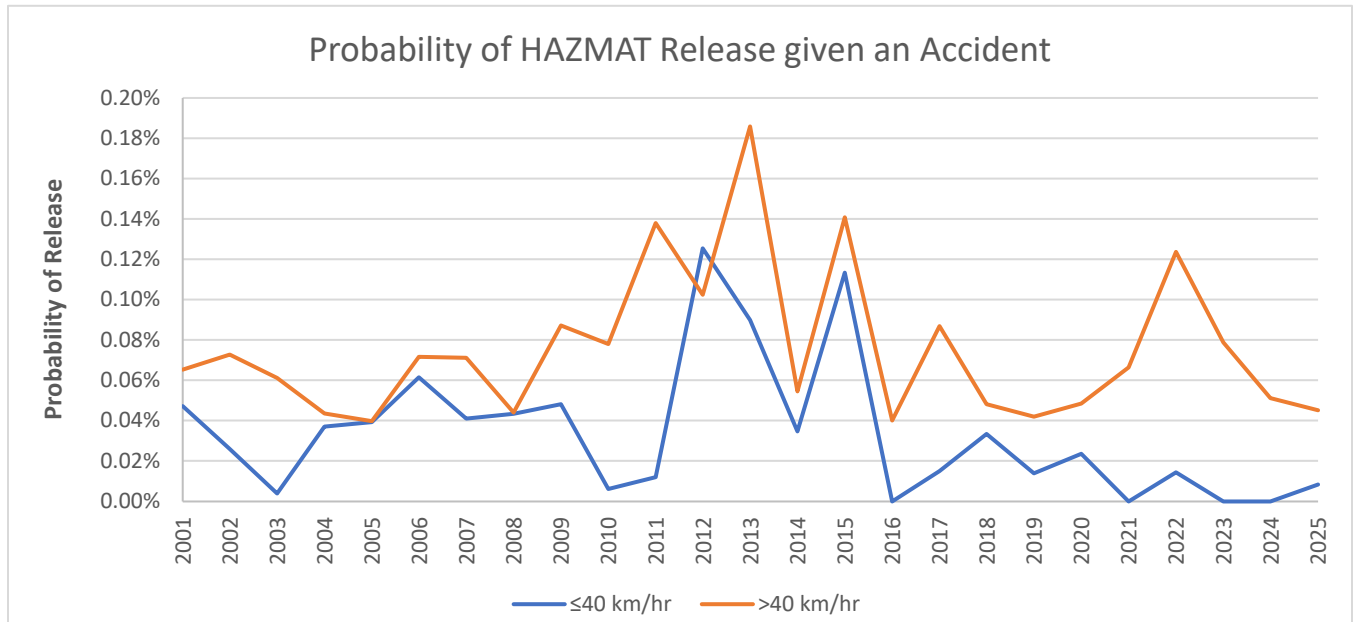


Figure 14-6 complements the frequency-based analysis by presenting the conditional probability of hazardous materials (HAZMAT) release given that an accident has occurred, using the same speed-based groupings. While lower-speed movements account for a larger proportion of accidents overall, the probability of a HAZMAT release is consistently higher for accidents occurring at speeds above 40 km/h. As observed in the Canadian analysis, year-to-year variability in release probability for higher-speed accidents is driven by a limited number of high-consequence derailments involving multiple railcars.

The annual accident and release data used to calculate these conditional probabilities are summarized in Table C-4 and Table C-5 in Appendix B.

Figure 14-6: Railcar Accident Rate on Canadian Railroads per Freight Railcar-km and Operating Speed (1999–2023)



Overall, the FRA data shows a pattern consistent with that observed in the Canadian TSB dataset. Accident frequencies are higher within lower-speed groupings, driven largely by lower track classes, while higher-speed mainline accidents, although less frequent on a railcar-km basis, are more likely to result in hazardous material releases due to increased derailment severity and multi-car involvement.

A.4.3 TNO Data

The TNO “Purple Book” is a widely recognized reference used in quantitative risk assessment (QRA) to support the analysis of hazardous material transport and fixed installations. It provides a structured set of generic accident frequencies, conditional probabilities, and modeling assumptions that are intended to be practical and broadly applicable across a range of risk studies. Owing to its consistency, transparency, and ease of application, the Purple Book is commonly used as a benchmark source in QRA where detailed, location-specific data are limited or unavailable.

For railway transport outside shunting yards, the Purple Book specifies a generic accident frequency of 3.6×10^{-8} per railcar-km, with adjustments based on operating speed. Where train speeds exceed 40 km/h, the accident frequency is increased by a factor of 1.26, while speeds below 40 km/h apply a reduction factor of 0.62. Additional modifiers are applied for track features, including increases for points (switches) and level crossings, reflecting their elevated derailment potential. These adjustments provide a structured means of accounting for infrastructure and operational influences on accident likelihood.

The speed-dependent trend implied by the Purple Book, lower accident frequencies at speeds below 40 km/h and higher frequencies at speeds above 40 km/h, differs from patterns observed in the Canadian TSB and U.S. FRA datasets (see Sections A.3 and A.4), where railcar-normalized accident frequencies are generally higher within lower-speed groupings. This difference may reflect the origin and intended application of the Purple Book

data, which are derived from European railway experience and are intended to represent generic mainline rail transport outside of shunting yards. While the Purple Book provides a useful benchmark, the specific composition and operating history underlying its railway dataset are not fully defined. As a result, accident frequency trends derived from the FRA and TSB datasets, which are based on detailed and transparent North American operating history, are considered more representative for this assessment.

Despite these differences in accident frequency trends, the Purple Book is consistent with both the TSB and FRA analyses in terms of conditional release behavior. In particular, pressurized tank cars exhibit substantially lower probabilities of release than non-pressurized (atmospheric) tank cars across both speed regimes. This alignment supports the conclusion that tank car design, rather than operating speed alone, is a primary determinant of release likelihood once an accident occurs and reinforces the applicability of Purple Book release probabilities for pressurized cargos such as chlorine.

A.4.4 Accident Frequency Comparison

The comparison of accident frequencies from each data source are summarized in Table 14-2.

Table 14-2: Comparison of Railcar Accident Frequencies Normalized by Railcar-km

Data Source	Geographic Scope	Section	Accident Frequency (per Railcar-km)			
			Base	≤40 km/hr	>40 km/hr	Track Class 1
Transportation Safety Board of Canada (TSB)	Canada	A.3	1.45E-06	2.29E-06	1.14E-06	2.34E-06
Federal Railroad Administration (FRA)	United States	A.4	1.03E-06	1.15E-06	9.84E-07	1.72E-06
TNO Purple Book	Netherlands / Europe	A.4.3	3.30E-08	2.23E-08	4.54E-08	-

The accident frequencies adopted in this study were based on the datasets provided by Transportation Safety Board of Canada.

Appendix B: TSB Raw Statistical Data

Table B-1: TSB Accident Types

Accident Code	Description
15	Crossing
16	Fire On-Board R/S
17	Explosion
20	Dg Leaker
22	Uncontrolled Movement Of R/S
23	Trespasser
29	Main-Track Train Collision
30	Main-Track Train Derailment
31	Non-Main-Track Train Collision
32	Non-Main-Track Train Derailment
33	Collision Involving Track Unit
34	Derailment Involving Track Unit
37	Main-Track Switch In Abnormal Position
38	Movement Exceeds Limits Of Authority
39	Signal Less Restrictive Than Required
40	Unprotected Overlap Of Authorities
42	Historical
43	R/S Damage Without Derail./Coll.
44	R/S Coll. With Abandoned Vehicle
45	R/S Coll. With Object
46	Employee
47	Passenger
48	Trespasser
49	Non-Main-Track Train Collision (No Derailment, No Damage)
50	R/S Coll. With Object (No Derailment, No Damage)
51	R/S Coll. With Abandoned Vehicle (No Derailment, No Damage)
52	Main-Track Train Derailment (No Damage)
53	Derailment Involving Track Unit (No Damage)
54	Non-Main-Track Train Derailment (No Damage)
55	Component Failure That Affects Safe Operation Of R/S
56	Fire On Railway Right-Of-Way

Table B-2: Distribution of Canadian Rail Accident Types (1983-2026, TSB Data)

Accident Type	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
15	36%	35%	38%	34%	31%	34%	35%	28%	23%	24%	25%	24%	22%	21%	20%	17%	20%	21%	17%	17%	17%	15%
16	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	3%	2%	3%	3%	2%	2%	1%	1%	1%
17	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20	18%	24%	21%	25%	28%	28%	29%	29%	36%	30%	17%	13%	14%	15%	14%	14%	10%	12%	9%	9%	8%	7%
22	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	1%	1%	1%	1%	1%	0%	1%	1%	1%
23	7%	6%	7%	5%	6%	7%	6%	6%	5%	5%	5%	4%	5%	6%	5%	4%	6%	5%	4%	4%	3%	6%
29	2%	1%	1%	1%	1%	0%	1%	0%	0%	1%	0%	1%	2%	1%	1%	1%	1%	1%	1%	1%	0%	0%
30	13%	12%	11%	10%	9%	7%	8%	7%	6%	11%	19%	16%	15%	15%	15%	11%	9%	10%	9%	9%	14%	14%
31	4%	5%	3%	4%	5%	5%	5%	5%	5%	5%	7%	7%	7%	7%	8%	8%	7%	8%	7%	8%	6%	8%
32	3%	3%	6%	8%	9%	10%	9%	15%	12%	14%	20%	24%	27%	23%	24%	30%	30%	29%	42%	41%	41%	41%
33	3%	2%	2%	2%	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
34	1%	1%	1%	1%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
37	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	0%	1%	1%	1%	1%	0%	0%	1%	1%
38	0%	0%	0%	0%	0%	0%	0%	2%	6%	4%	3%	4%	4%	3%	5%	6%	7%	6%	5%	5%	5%	5%
39	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
40	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	0%	0%	1%	0%
42	7%	4%	5%	5%	4%	2%	2%	3%	2%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
43	2%	2%	2%	2%	1%	1%	0%	0%	0%	1%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%
44	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
45	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	0%	1%	1%	0%	1%	1%	0%	0%
46	3%	3%	2%	2%	2%	2%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%	1%
47	0%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
48	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
49	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
50	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
51	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
52	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
53	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
54	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
55	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
56	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Accident Type	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
15	17%	16%	15%	16%	15%	13%	13%	15%	14%	13%	12%	11%	11%	11%	12%	11%	11%	12%	12%	14%	14%	16%
16	1%	1%	2%	1%	2%	2%	2%	1%	1%	2%	2%	3%	2%	2%	4%	3%	4%	3%	3%	5%	4%	5%
17	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20	6%	4%	5%	4%	6%	5%	6%	7%	7%	4%	2%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
22	1%	1%	1%	1%	1%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	1%	1%	1%	1%	1%	0%
23	4%	5%	6%	5%	6%	6%	5%	6%	4%	4%	3%	6%	6%	5%	4%	5%	5%	5%	6%	8%	8%	5%
29	0%	0%	1%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	1%	0%	1%	1%	0%	1%	0%
30	14%	12%	11%	9%	5%	9%	9%	6%	7%	8%	5%	5%	6%	6%	6%	6%	6%	5%	4%	4%	5%	5%
31	6%	7%	7%	7%	7%	7%	7%	8%	7%	7%	7%	6%	8%	7%	7%	6%	5%	5%	5%	5%	4%	0%
32	43%	43%	41%	41%	40%	43%	40%	41%	41%	33%	37%	37%	41%	41%	40%	40%	32%	32%	33%	29%	25%	21%
33	1%	1%	2%	2%	2%	2%	2%	1%	2%	1%	2%	1%	2%	2%	2%	2%	3%	2%	2%	3%	3%	5%
34	0%	0%	0%	0%	2%	1%	1%	1%	1%	0%	1%	1%	2%	1%	1%	1%	1%	2%	2%	1%	1%	0%
37	0%	0%	0%	1%	0%	0%	1%	0%	1%	0%	1%	1%	1%	0%	1%	0%	1%	1%	1%	0%	0%	16%
38	4%	5%	6%	8%	8%	7%	9%	9%	7%	9%	10%	11%	9%	10%	9%	12%	9%	10%	13%	13%	11%	11%
39	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%
40	0%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%
42	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
43	1%	1%	1%	1%	1%	1%	2%	1%	2%	1%	1%	1%	1%	0%	0%	0%	0%	1%	0%	0%	0%	0%
44	0%	0%	1%	1%	1%	1%	0%	1%	1%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%
45	0%	1%	0%	0%	1%	0%	1%	1%	2%	1%	1%	3%	2%	2%	2%	2%	3%	3%	4%	4%	5%	5%
46	0%	1%	1%	1%	1%	1%	1%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%	1%	0%
47	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
48	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
49	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
50	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
51	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
52	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
53	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%	1%	0%	0%	1%	1%	1%	0%
54	0%	0%	0%	0%	0%	0%	0%	0%	0%	11%	9%	8%	5%	7%	4%	3%	3%	8%	5%	6%	10%	11%
55	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
56	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	4%	12%	6%	4%	4%	4%	0%

Table B-3: Annual Freight Railcar Exposure, Accident Involvement, and Dangerous Goods Release Metrics on Canadian Railroads (1999–2023)

Year	Total freight car-km	Total number of rail cars involved in accidents	Total DG Released Cars	Accident frequency per car-km	Probability of HAZMAT release given an accident
1999	625,994,936	709	78	1.13E-06	11.0%
2000	659,560,893	826	6	1.25E-06	0.7%
2001	598,624,784	798	3	1.33E-06	0.4%
2002	554,592,192	824	17	1.49E-06	2.1%
2003	527,675,501	809	16	1.53E-06	2.0%
2004	503,441,195	929	9	1.85E-06	1.0%
2005	456,219,972	1167	6	2.56E-06	0.5%
2006	421,011,144	752	3	1.79E-06	0.4%
2007	394,846,323	961	4	2.43E-06	0.4%
2008	380,414,597	760	2	2.00E-06	0.3%
2009	256,065,720	300	22	1.17E-06	7.3%
2010	312,940,293	578	2	1.85E-06	0.3%
2011	312,316,729	771	1	2.47E-06	0.1%
2012	369,003,477	381	2	1.03E-06	0.5%
2013	381,681,657	498	64	1.30E-06	12.9%
2014	225,861,199	750	15	3.32E-06	2.0%
2015	285,705,556	483	54	1.69E-06	11.2%
2016	273,644,510	249	1	9.10E-07	0.4%
2017	251,651,791	503	6	2.00E-06	1.2%
2018	482,964,221	582	2	1.21E-06	0.3%
2019	564,411,019	574	46	1.02E-06	8.0%
2020	555,387,328	638	36	1.15E-06	5.6%
2021	554,210,020	535	2	9.65E-07	0.4%
2022	586,692,023	465	2	7.93E-07	0.4%
2023	584,384,558	325	5	5.56E-07	1.5%
TOTAL	11,119,301,638	16,167	404	1.45E-06	2.5%

Table B-4: Annual Freight Railcar Exposure, Accident Involvement, and Dangerous Goods Release Metrics for Canadian Rail Car Transits ≤ 40 km/h (1999–2023)

Year	Total freight car-km (Normalized) ¹	Total number of rail cars involved in accidents	Total DG Released Cars	Accident frequency per car-km	Probability of HAZMAT release given an accident
1999	172,740,810	217	0	1.26E-06	0.0%
2000	182,003,202	431	3	2.37E-06	0.7%
2001	165,188,125	309	0	1.87E-06	0.0%
2002	153,037,507	286	1	1.87E-06	0.3%
2003	145,609,953	298	1	2.05E-06	0.3%
2004	138,922,593	286	4	2.06E-06	1.4%
2005	125,892,085	522	3	4.15E-06	0.6%
2006	116,176,349	372	0	3.20E-06	0.0%
2007	108,956,270	469	4	4.30E-06	0.9%
2008	104,973,893	327	2	3.12E-06	0.6%
2009	70,660,316	150	0	2.12E-06	0.0%
2010	86,354,628	213	1	2.47E-06	0.5%
2011	86,182,558	378	1	4.39E-06	0.3%
2012	101,825,040	167	1	1.64E-06	0.6%
2013	105,323,533	212	1	2.01E-06	0.5%
2014	62,325,498	372	0	5.97E-06	0.0%
2015	78,839,310	217	0	2.75E-06	0.0%
2016	75,511,113	174	1	2.30E-06	0.6%
2017	69,442,310	256	4	3.69E-06	1.6%
2018	133,272,054	330	0	2.48E-06	0.0%
2019	155,746,973	177	3	1.14E-06	1.7%
2020	153,256,921	222	0	1.45E-06	0.0%
2021	152,932,048	188	1	1.23E-06	0.5%
2022	161,895,327	226	0	1.40E-06	0.0%
2023	161,258,592	218	1	1.35E-06	0.5%
TOTAL	3,068,327,008	7017	32	2.29E-06	0.5%

¹ Freight railcar-km were normalized by track class using the track class distribution for the State of Georgia (see Section A.2.1).

Table B-5: Annual Freight Railcar Exposure, Accident Involvement, and Dangerous Goods Release Metrics for Canadian Rail Car Transits > 40 km/h (1999–2023)

Year	Total freight car-km (Normalized) ¹	Total number of rail cars involved in accidents	Total DG Released Cars	Accident frequency per car-km	Probability of HAZMAT release given an accident
1999	453,254,126	492	78	1.09E-06	15.9%
2000	477,557,691	395	3	8.27E-07	0.8%
2001	433,436,659	489	3	1.13E-06	0.6%
2002	401,554,685	538	16	1.34E-06	3.0%
2003	382,065,548	511	15	1.34E-06	2.9%
2004	364,518,602	643	5	1.76E-06	0.8%
2005	330,327,887	645	3	1.95E-06	0.5%
2006	304,834,795	380	3	1.25E-06	0.8%
2007	285,890,053	492	0	1.72E-06	0.0%
2008	275,440,704	433	0	1.57E-06	0.0%
2009	185,405,404	150	22	8.09E-07	14.7%
2010	226,585,665	365	1	1.61E-06	0.3%
2011	226,134,171	393	0	1.74E-06	0.0%
2012	267,178,437	214	1	8.01E-07	0.5%
2013	276,358,124	286	63	1.03E-06	22.0%
2014	163,535,701	378	15	2.31E-06	4.0%
2015	206,866,246	266	54	1.29E-06	20.3%
2016	198,133,397	75	0	3.79E-07	0.0%
2017	182,209,481	247	2	1.36E-06	0.8%
2018	349,692,167	252	2	7.21E-07	0.8%
2019	408,664,046	397	43	9.71E-07	10.8%
2020	402,130,407	416	36	1.03E-06	8.7%
2021	401,277,972	347	1	8.65E-07	0.3%
2022	424,796,696	239	2	5.63E-07	0.8%
2023	423,125,966	107	4	2.53E-07	3.7%
TOTAL	8,050,974,630	9,150	372	1.14E-06	4.1%

Table B-6: Annual Freight Railcar Exposure, Accident Involvement, and Dangerous Goods Release Metrics for Track Class 1 Canadian Rail Car Transits (1999–2023)

Year	Total freight car-km (Normalized) ¹	Total number of rail cars involved in accidents	Total DG Released Cars	Accident frequency per car-km	Probability of HAZMAT release given an accident
1999	53,731,837	86	0	1.60E-06	0.0%
2000	56,612,947	168		2.97E-06	0.0%
2001	51,382,539	112	0	2.18E-06	0.0%
2002	47,603,033	117	1	2.46E-06	0.9%
2003	45,292,657	115		2.54E-06	0.0%
2004	43,212,523	97	4	2.24E-06	4.1%
2005	39,159,322	168	3	4.29E-06	1.8%
2006	36,137,197	78	0	2.16E-06	0.0%
2007	33,891,358	143	0	4.22E-06	0.0%
2008	32,652,621	87	0	2.66E-06	0.0%
2009	21,979,222	48	0	2.18E-06	0.0%
2010	26,861,011	69	0	2.57E-06	0.0%
2011	26,807,488	107	0	3.99E-06	0.0%
2012	31,673,155	58	0	1.83E-06	0.0%
2013	32,761,378	55	0	1.68E-06	0.0%
2014	19,386,638	81	0	4.18E-06	0.0%
2015	24,523,336	60	0	2.45E-06	0.0%
2016	23,488,085	76	0	3.24E-06	0.0%
2017	21,600,355	54	0	2.50E-06	0.0%
2018	41,454,896	89	0	2.15E-06	0.0%
2019	48,445,825	50	0	1.03E-06	0.0%
2020	47,671,282	57	0	1.20E-06	0.0%
2021	47,570,229	89	0	1.87E-06	0.0%
2022	50,358,299	94	0	1.87E-06	0.0%
2023	50,160,239	74	1	1.48E-06	1.4%
TOTAL	954,417,471	2,232	9	2.34E-06	0.4%

Appendix C: FRA Raw Statistical Data

Table C-1: FRA Accident Types

Accident Code	Description
01	Derailment
02	Head-on collision
03	Rear-end collision
04	Side collision
05	Raking collision
06	Broken train collision
07	Highway-rail crossing
08	Railroad grade crossing
09	Obstruction
10	Explosive-detonation
11	Fire / violent rupture
12	Other impacts
13	Other (described in narrative)

Table C-2: Distribution of USA Rail Accident Types (1975-2025, FRA Data)

Accident Type	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	73%	70%	70%	70%	69%	68%	68%	67%	70%	68%	66%	66%	64%	61%	62%	64%	62%	63%	63%	62%	61%	64%	63%	59%	62%	60%
2	1%	2%	2%	2%	2%	2%	1%	2%	1%	1%	1%	2%	2%	1%	1%	2%	2%	1%	1%	2%	1%	1%	1%	1%	1%	0%
3	3%	4%	4%	3%	4%	3%	4%	4%	2%	2%	1%	2%	2%	2%	2%	2%	1%	1%	1%	2%	1%	1%	1%	1%	1%	1%
4	11%	13%	13%	14%	15%	15%	14%	12%	12%	12%	12%	13%	12%	11%	10%	11%	9%	9%	8%	9%	9%	9%	7%	6%	7%	7%
5	3%	2%	2%	2%	2%	3%	2%	2%	2%	2%	2%	1%	2%	1%	2%	2%	3%	2%	1%	1%	2%	2%	2%	1%	2%	2%
6	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
7	3%	3%	3%	2%	2%	3%	3%	3%	3%	4%	4%	5%	5%	6%	6%	5%	5%	6%	6%	6%	5%	5%	6%	6%	6%	7%
8	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	1%	0%	1%	0%	1%	1%	1%	1%	2%	2%	2%	1%	1%	2%	2%	2%	2%	2%	3%	3%	3%	3%	3%	2%	2%	2%
10	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
11	2%	2%	2%	2%	2%	2%	2%	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	1%	1%	0%	1%	1%	1%
12	2%	2%	3%	4%	3%	4%	5%	7%	7%	7%	10%	9%	12%	13%	13%	12%	15%	15%	16%	14%	16%	14%	11%	10%	14%	14%
13	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	4%	12%	6%	5%

Accident Type	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	62%	61%	61%	58%	60%	60%	61%	60%	58%	60%	60%	59%	59%	58%	59%	59%	57%	54%	54%	53%	50%	52%	48%	50%
2	1%	1%	0%	0%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
3	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	1%	1%	1%	1%	1%	1%	1%	0%	0%	1%	0%
4	6%	6%	7%	8%	6%	8%	7%	6%	5%	5%	7%	6%	5%	6%	4%	4%	3%	5%	6%	6%	5%	4%	4%	4%
5	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	4%	3%	4%	3%	2%	1%	2%	1%	1%	1%	1%	1%	1%	1%
6	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
7	7%	6%	6%	7%	8%	8%	7%	8%	9%	8%	8%	9%	8%	9%	10%	9%	10%	10%	8%	9%	10%	9%	10%	12%
8	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	2%	2%	2%	2%	2%	2%	2%	3%	4%	3%	2%	3%	3%	4%	5%	5%	4%	4%	5%	5%	4%	4%	6%	7%
10	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
11	1%	1%	1%	1%	1%	0%	0%	1%	1%	1%	1%	1%	2%	2%	4%	2%	3%	2%	2%	1%	1%	1%	1%	1%
12	14%	16%	16%	16%	16%	14%	16%	13%	13%	12%	10%	11%	10%	11%	11%	14%	13%	14%	17%	18%	21%	19%	20%	16%
13	4%	4%	4%	4%	4%	4%	4%	5%	6%	5%	6%	6%	7%	7%	6%	5%	6%	7%	6%	6%	7%	8%	8%	7%

Table C-3: Annual Freight Railcar Exposure, Accident Involvement, and Dangerous Goods Release Metrics on U.S. Railroads (2001-2025)

Year	Total freight car-km	Total number of rail cars involved in accidents	Total DG Released Cars	Accident frequency per car-km	Probability of HAZMAT release given an accident
2001	57,341,411,885	82,154	49	1.43E-06	0.060%
2002	59,048,076,237	68,841	41	1.17E-06	0.060%
2003	60,473,157,179	73,307	30	1.21E-06	0.041%
2004	62,914,321,448	80,341	33	1.28E-06	0.041%
2005	64,792,570,444	80,727	32	1.25E-06	0.040%
2006	66,491,969,376	80,788	55	1.22E-06	0.068%
2007	64,346,985,721	74,623	45	1.16E-06	0.060%
2008	62,289,531,430	63,957	28	1.03E-06	0.044%
2009	51,902,886,412	47,613	35	9.17E-07	0.074%
2010	55,582,721,821	53,873	30	9.69E-07	0.056%
2011	56,853,235,939	52,914	52	9.31E-07	0.098%
2012	58,043,733,430	43,049	47	7.42E-07	0.109%
2013	59,326,313,215	47,296	74	7.97E-07	0.156%
2014	60,812,572,545	51,130	25	8.41E-07	0.049%
2015	58,616,685,924	45,575	61	7.78E-07	0.134%
2016	53,820,945,334	44,312	13	8.23E-07	0.029%
2017	55,165,784,328	50,166	34	9.09E-07	0.068%
2018	55,641,112,237	52,451	23	9.43E-07	0.044%
2019	52,321,277,064	54,877	19	1.05E-06	0.035%
2020	45,089,657,309	45,754	19	1.01E-06	0.042%
2021	44,854,192,975	46,657	23	1.04E-06	0.049%
2022	44,695,084,969	49,509	46	1.11E-06	0.093%
2023	45,216,579,987	48,846	29	1.08E-06	0.059%
2024	45,344,711,327	43,617	16	9.62E-07	0.037%
2025	38,020,367,533	38,594	13	1.02E-06	0.034%
TOTAL	1,379,005,886,069	1,420,971	872	1.03E-06	0.061%

Table C-4: Annual Freight Railcar Exposure, Accident Involvement, and Dangerous Goods Release Metrics for U.S. Rail Car Transits ≤ 40 km/h (1999–2023)

Year	Total freight car-km (Normalized) ²	Total number of rail cars involved in accidents	Total DG Released Cars	Accident frequency per car-km	Probability of HAZMAT release given an accident
2001	15,823,134,264	25,420	12	1.61E-06	0.047%
2002	16,294,081,495	19,314	5	1.19E-06	0.026%
2003	16,687,326,907	25,818	1	1.55E-06	0.004%
2004	17,360,956,465	29,694	11	1.71E-06	0.037%
2005	17,879,251,796	28,034	11	1.57E-06	0.039%
2006	18,348,194,164	27,658	17	1.51E-06	0.061%
2007	17,756,294,466	26,866	11	1.51E-06	0.041%
2008	17,188,548,148	23,030	10	1.34E-06	0.043%
2009	14,322,394,817	16,624	8	1.16E-06	0.048%
2010	15,337,830,744	16,651	1	1.09E-06	0.006%
2011	15,688,424,056	16,659	2	1.06E-06	0.012%
2012	16,016,937,097	12,748	16	7.96E-07	0.126%
2013	16,370,859,882	14,481	13	8.85E-07	0.090%
2014	16,780,987,225	14,423	5	8.59E-07	0.035%
2015	16,175,041,057	11,469	13	7.09E-07	0.113%
2016	14,851,675,538	11,772	0	7.93E-07	0.000%
2017	15,222,778,503	13,338	2	8.76E-07	0.015%
2018	15,353,943,347	15,023	5	9.78E-07	0.033%
2019	14,437,848,051	14,393	2	9.97E-07	0.014%
2020	12,442,311,378	12,754	3	1.03E-06	0.024%
2021	12,377,335,932	12,015	0	9.71E-07	0.000%
2022	12,333,430,712	13,921	2	1.13E-06	0.014%
2023	12,477,335,185	12,043	0	9.65E-07	0.000%
2024	12,512,692,518	12,305	0	9.83E-07	0.000%
2025	10,491,569,015	12,026	1	1.15E-06	0.008%
TOTAL	380,531,182,762	438,479	151	1.15E-06	0.034%

² Freight railcar-km were normalized by track class using the track class distribution for the State of Georgia (see Section A.2.1).

Table C-5: Annual Freight Railcar Exposure, Accident Involvement, and Dangerous Goods Release Metrics for U.S. Rail Car Transits > 40 km/h (1999–2023)

Year	Total freight car-km (Normalized) ¹	Total number of rail cars involved in accidents	Total DG Released Cars	Accident frequency per car-km	Probability of HAZMAT release given an accident
2001	41,518,277,621	56,734	37	1.37E-06	0.065%
2002	42,753,994,741	49,527	36	1.16E-06	0.073%
2003	43,785,830,273	47,489	29	1.08E-06	0.061%
2004	45,553,364,982	50,647	22	1.11E-06	0.043%
2005	46,913,318,648	52,693	21	1.12E-06	0.040%
2006	48,143,775,212	53,130	38	1.10E-06	0.072%
2007	46,590,691,255	47,757	34	1.03E-06	0.071%
2008	45,100,983,283	40,927	18	9.07E-07	0.044%
2009	37,580,491,595	30,989	27	8.25E-07	0.087%
2010	40,244,891,077	37,222	29	9.25E-07	0.078%
2011	41,164,811,884	36,255	50	8.81E-07	0.138%
2012	42,026,796,332	30,301	31	7.21E-07	0.102%
2013	42,955,453,334	32,815	61	7.64E-07	0.186%
2014	44,031,585,320	36,707	20	8.34E-07	0.054%
2015	42,441,644,868	34,106	48	8.04E-07	0.141%
2016	38,969,269,795	32,540	13	8.35E-07	0.040%
2017	39,943,005,825	36,828	32	9.22E-07	0.087%
2018	40,287,168,890	37,428	18	9.29E-07	0.048%
2019	37,883,429,013	40,484	17	1.07E-06	0.042%
2020	32,647,345,931	33,000	16	1.01E-06	0.048%
2021	32,476,857,042	34,642	23	1.07E-06	0.066%
2022	32,361,654,257	35,588	44	1.10E-06	0.124%
2023	32,739,244,802	36,803	29	1.12E-06	0.079%
2024	32,832,018,809	31,312	16	9.54E-07	0.051%
2025	27,528,798,518	26,568	12	9.65E-07	0.045%
TOTAL	998,474,703,307	982,492	721	9.84E-07	0.073%

Table C-6: Annual Freight Railcar Exposure, Accident Involvement, and Dangerous Goods Release Metrics for Track Class 1 U.S. Rail Car Transits (1999–2023)

Year	Total freight car-km (Normalized) ¹	Total number of rail cars involved in accidents	Total DG Released Cars	Accident frequency per car-km	Probability of HAZMAT release given an accident
2001	4,921,859,944	11,602	3	2.36E-06	0.026%
2002	5,068,350,284	9,636	5	1.90E-06	0.052%
2003	5,190,671,109	11,090	0	2.14E-06	0.000%
2004	5,400,206,735	14,657	7	2.71E-06	0.048%
2005	5,561,424,922	13,533	6	2.43E-06	0.044%
2006	5,707,291,640	13,286	7	2.33E-06	0.053%
2007	5,523,178,469	13,026	5	2.36E-06	0.038%
2008	5,346,578,321	11,186	0	2.09E-06	0.000%
2009	4,455,047,917	8,361	7	1.88E-06	0.084%
2010	4,770,904,014	6,200	0	1.30E-06	0.000%
2011	4,879,957,703	7,516	1	1.54E-06	0.013%
2012	4,982,143,222	5,820	3	1.17E-06	0.052%
2013	5,092,232,560	6,101	1	1.20E-06	0.016%
2014	5,219,804,589	6,127	0	1.17E-06	0.000%
2015	5,031,322,198	4,846	0	9.63E-07	0.000%
2016	4,619,683,162	5,534	0	1.20E-06	0.000%
2017	4,735,116,476	6,746	1	1.42E-06	0.015%
2018	4,775,915,914	5,884	0	1.23E-06	0.000%
2019	4,490,960,186	7,130	0	1.59E-06	0.000%
2020	3,870,239,167	4,455	0	1.15E-06	0.000%
2021	3,850,028,251	5,686	0	1.48E-06	0.000%
2022	3,836,371,327	6,796	1	1.77E-06	0.015%
2023	3,881,133,487	6,883	0	1.77E-06	0.000%
2024	3,892,131,551	6,104	0	1.57E-06	0.000%
2025	3,263,451,629	5,250	0	1.61E-06	0.000%
TOTAL	118,366,004,776	203,455	47	1.72E-06	0.023%

Appendix D: Canadian Railway Safety Management System Regulations, 2015, Sections 13, 14, & 15

Process for Identifying Safety Concerns

Analyses

13 A railway company must, on a continual basis, conduct analyses of its railway operations to identify safety concerns, including any trends, any emerging trends or any repetitive situations. The analyses must, at a minimum, be based on

- (a) any reports of railway occurrences;
- (b) any internal documentation relating to railway occurrences;
- (c) any reports of injuries;
- (d) the results of any inspections conducted by the railway company or by a railway safety inspector;
- (e) any reports of contraventions or safety hazards that are received by the railway company from its employees;
- (f) any complaints relating to safety that are received by the railway company;
- (g) any data from safety monitoring technologies;
- (h) the conclusions of the annual report referred to in subsection 29(3); and
- (i) the findings of any audit reports.

Procedure

14 A railway company must include, in its safety management system, a procedure for conducting the analyses referred to in section 13.

Risk Assessment Process

Risk assessment

- **15 (1)** A railway company must conduct a risk assessment in the following circumstances:
 - (a) when it identifies a safety concern in its railway operations as a result of the analyses conducted under section 13;
 - (b) when it proposes to begin transporting dangerous goods, or to begin transporting dangerous goods different from those it already transports; or
 - (c) when a proposed change to its railway operations, including a change set out below, may affect the safety of the public or personnel or the protection of property or the environment:
 - (i) the introduction or elimination of a technology, or a change to a technology,
 - (ii) the addition or elimination of a railway work, or a change to a railway work,
 - (iii) an increase in the volume of dangerous goods it transports,
 - (iv) a change to the route on which dangerous goods are transported, or

- (v) a change affecting personnel, including an increase or decrease in the number of employees or a change in their responsibilities or duties.

Components

(2) The risk assessment must

- **(a)** describe the circumstances that triggered the requirement to conduct the risk assessment;
- **(b)** identify and describe the risks associated with those circumstances;
- **(c)** identify the factors taken into account in the risk assessment, including the persons who may be affected and whether property or the environment is affected;
- **(d)** indicate, for each risk, the likelihood that the risk will occur and the severity of its consequences;
- **(e)** identify the risks that require remedial action; and
- **(f)** identify the remedial action for each of those risks.

From: Rick Hind [REDACTED]
Sent: February 24, 2026 12:01 PM
To: DNV Input
Subject: 2006 Dept Homeland Security: "A Security Event May Be Larger Than EPA Worst-Case Analysis"

EXTERNAL: Do not click links or open attachments unless you trust the sender and content.

Dear Council Members,
I am sharing a few items ahead of tonight's hearing to give you more time to read in advance of my oral remarks.
Rick Hind
[REDACTED]

When looking at chlorine disaster scenarios, it's also important to consider the impact of intentional events.
"If it is credible to involve more than the largest single vessel containing the hazardous material in a single incident, the security event may be larger than the typical EPA RMP worst-case analysis." p.78315 Federal Register Department of Homeland Security rule making "Chemical Facility Anti-Terrorism Standards," (CFATS) December 28, 2006.

78315
Federal Register / Vol. 71, No. 249 / Thursday, December 28, 2006 / Proposed Rules

DEPARTMENT OF HOMELAND SECURITY
CFATS Part II
(2006-2006-0075)
PP-1001-0001
Chemical Facility Anti-Terrorism Standards
Summary: Department of Homeland Security
Keywords: Advance Notice of Rulemaking

Comments: Section 106 of the Homeland Security Appropriations Act of 2007 ("Section 106") requires the Department of Homeland Security to publish advance notice of rulemaking for the development of "system level" security standards for chemical facilities. The Department is publishing this notice to solicit comments from the public on the proposed rulemaking. The notice is published for the purpose of soliciting comments on the proposed rulemaking and is not intended to be a final rule. The notice is published for the purpose of soliciting comments on the proposed rulemaking and is not intended to be a final rule. The notice is published for the purpose of soliciting comments on the proposed rulemaking and is not intended to be a final rule.

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06-9903
PDF Document - 2.1 MB

Rick Hind
[REDACTED]

From: Rick Hind [REDACTED]
Sent: February 24, 2026 12:00 PM
To: DNV Input
Subject: Chlorine and 2010 Olympics a Dangerous Mix? | The Tyee
Attachments: yellowblob.webp

Follow Up Flag: Follow up
Flag Status: Completed

EXTERNAL: Do not click links or open attachments unless you trust the sender and content.

Dear Council Members,
I am sharing a few items ahead of tonight's hearing to give you more time to read in advance of my oral remarks.
Rick Hind
[REDACTED]

Trains carrying chlorine and other hazmats have the potential raise safety AND security issues far and wide. In this case the 2010 Olympics raised security concerns in Vancouver that are also relevant every year.

"...Minutes from an April 2008 North Shore CAP meeting, however, confirm Canexus met with VANOC to discuss security concerns associated with facility upgrades and the Olympics. According to the minutes, Rick Denton said, "We have met with VANOC to start preliminary discussions with respect to plant operations [and] construction activities during the Games period."

<https://thetyee.ca/News/2009/11/30/DangerousChlorine/>

Chlorine and Olympics a Dangerous Mix?

Angry residents of Belmont, Washington say toxic chemicals will be parked close to their homes because of Olympics security plans.

Linda Solomon is the publisher of [The Vancouver Observer](#), where a version of this article first appeared in two parts, and she is an occasional contributor to the Tyee.

Megan Stewart is a reporter for The Vancouver Observer.

Thomas and Holly Bieker moved to a big farmhouse 150 feet from a railroad track in Belmont, Washington ten years ago, because they loved the beauty and solitude of the pristine landscape. They were even willing to drive more than 35 miles to their university jobs five days a week to live in the midst of nature. The green fields around them looked like a park and the little house fit them perfectly. "We truly felt blessed in the choice of our dear little home," Holly Biecker said.

But this week, their peace of mind was shattered by news that the North Vancouver-based [Canexus Chemicals Canada](#) had won permission from the State of Washington to store 50 rail cars full of chlorine at the edge of their property line, just over the tracks.

Biecker told [the Vancouver Observer](#) that a Canexus official told him those cars were considered to be a security threat and a potential terrorist target during the 2010 Olympic Games. “He said their plan was to just bring it down during the Winter Olympics, but because they need a place to store their chemicals anyway, there’s a 98 per cent chance that they’ll store cars here forever.”

“I feel as if I have been blindsided,” Biecker wrote Marty Cove, logistics manager for Canexus, after learning of Canexus’s proposal on the six o’clock news. It was Cove’s job to visit the Bieckers and the ten other families that live in Belmont and inform them of the company’s proposal.

The company plans on building a \$250,000 barbed wire fence around the cars and has said it will provide round the clock armed guards to protect it.

Biecker referred to a document he said the company sent to homeowners around the community that asked, “Are there any benefits for the community?” and then answered: “Yes, there will be additional employment in the area. Washington Railroad will be hiring six local people to provide security services for the storage facility and the rail cars.”

“The weird thing was we didn’t have a clue about any of this. They went and got their permits before anyone knew. The county waived their rights. They just said we don’t want anything to do with it. They went to the state of Washington. The feds, whatever they had to do. That’s who they went through and got all their permits from them and it was all approved,” Biecker said.

According to Biecker, county commissioner Greg Partch told him the county had waived its rights to stop the plant. “Everybody’s broke,” Biecker said. “All the states and the counties.”

He said Partch told him he had a right to file a lawsuit against Canexus for parking the chemicals so close to his home. “I called an attorney but the attorney said, ‘I’m sure they have a lot more money than you do.’ He said it’d just go back and forth so far that it’d just be hard to win the case.”

‘We never imagined’

Beicker said he harbours no animosity towards the Olympics or Canada. Still, he said he feels violated by Canexus’ plans. “He [Marty Cove] told me you could take a 50-caliber rifle and you couldn’t put a dent in the thing [chlorine rail cars.] He said, ‘I could almost betcha’ that even a hand grenade couldn’t put a dent in the thing.’”

But, Biecker added, “These are old tracks. Every tie is rotten. You get 50 railcars that are full of chlorine gas. If they tip over, what happens? If there’s a fire in the fields right here and it catches the ties on fire and the tanks. . . it’s not going to do us any good.”

“He said they’ve been in business 50 years and never had a spill. But when you’ve got any kind of business, there’s gotta be problems. He was saying, ‘hell, we have these tanks in downtown Seattle, Portland, Vancouver, Houston. . . they’re all over the world and nothing’s ever happened and it’s no big deal.’”

But chlorine is a deadly chemical and spills happen. On September 16, 2009, in the small town of [Clarines, Venezuela](#) a chlorine tanker overturned and leaked, killing eight and injuring over 100 people. Apparently, the eight people died after the chlorine reacted with the mucus in their lungs and formed hydrochloric acid. The entire population was evacuated from the town.

On January 6, 2005 a train carrying chlorine derailed in [Graniteville, South Carolina](#). The leaking chlorine [killed eight](#) and [injured 250](#). Over five thousand people had to be evacuated. On March 29, 2005 in [Huai'an, China](#) a truck carrying 30 tons of chlorine was in an accident and the leak that resulted left 28 dead, 350 hospitalized and 10,000 evacuated. And in [Bexar County, Texas](#), on June 28, 2004 residents awoke to see a “strange cloud” engulfing their homes caused by a chlorine leak in a breached train car that left three dead and 43 injured.

Biecker is a hazardous waste technician at University of Idaho and no stranger to chemicals. “You gotta have chlorine to make water clean,” he said. “But to park it in someone’s front yard, it’s just not something we would ever have imagined.”

‘Chemical a big part of our security prep’

The 52-year-old Canexus industrial chemical plant on the North Shore will close for at least four weeks this winter, likely during the time when Vancouver’s population swells with visitors for the Olympic Games. Stopping production will reduce the chlorine and caustic soda shipped off-site.

“Chemical warfare is one of the elements that we prepare for and plan for,” said corporal Bert Paquet, a spokesperson for the Integrated Security Unit (ISU), the policing branch of the Vancouver Olympic Committee (VANOC).

“It would be irresponsible for us not to consider all the possibilities and risks involved and obviously chemical is a big part of our security preparation.”

Canexus management will not specify when the facility will close or if it will even shut down for one day during the Games. Management also denies the 30- to 40-day closure is deliberately timed to coincide with the largest security risk ever seen in Vancouver. However, meeting minutes from the North Shore Community Advisory Panel show that VANOC representatives have met with Canexus management and to discuss Olympic safety concerns.

While the [chlorine](#) facility presents one concern, transportation experts argue the risks of shipping liquidized chlorine through densely populated urban areas by rail supersede the dangers of the plant itself.

“Because of the nature of the chemicals and the accessibility of the chemicals, 90-ton tank cars are like elephants tip-toeing through the tulips,” said Fred Millar from his office near Washington D.C., where he works as a hazardous materials transportation security consultant.

Millar, also a former staffer at the environmental lobby group, Friends of the Earth, believes chlorine would make a formidable terrorism target.

Single biggest terrorist threat?

The Canexus plant is located in a neighbourhood of 2,500 residents in North Vancouver called Maplewood. The Maplewood Advisory Committee, a body that includes regional planners, local business owners, conservation groups and area residents, criticized the Vancouver Port Authority in 2007 for extending their lease with Canexus until 2032. The extension hinges on the upgrades now underway and permits Canexus to manufacture enough chlorine to fill one additional rail car each day, bringing the average to six.

“The idea of having a chlorine plant in the middle of a dense residential community is ridiculous enough, and is further enhanced by the fact that the plant is in a high risk earthquake zone,” wrote co-chairs Tom Young and John Walkley.

“This is of particular concern to the railcar shipment of chlorine. The probability of a terrorist action against a railcar is also far greater than one against the plant itself. The U.S. Transport Security Administration says that unguarded railcars filled with toxic chemicals such as chlorine are the single biggest terrorist threat related to the nation’s railroads.”

Canexus ranks among North America’s largest chlor-alkali producers and is one of the country’s 500 largest companies. It manufactures chlorine and other products essential to the pulp and paper industry as well as the household cleaners and plastics we use every day.

Previously part of the chemical division of Alberta oil giant Nexen, Canexus produces an average annual 154,000 tonnes of chlorine. Following the upgrades and plant expansion, the North Shore facility could pump out nearly 200,000 tonnes of chlorine each year, equivalent to an estimated 2,400 rail cars.

Just how lethal?

Information from the U.S. Naval Research Laboratory shows that the worst-case release from a 90-ton railcar could injure or kill 100,000 people. Classified as a TIH, or toxic by inhalation, chlorine gas is lethal at high concentrations and hazardous even as it disperses. The 90-ton rail cars that leave Canexus carry 82 metric tonnes (82,000 kilograms) of pressurized liquid chlorine, which evaporates into the highly hazardous gas.

Downtown Vancouver is less than 15 kilometers from Canexus, which is located on the waterfront to the east of the Second Narrows Crossing in North Vancouver. Rail lines leaving the facility travel across the Burrard Inlet and through residential neighbourhoods. The tracks pass through Vancouver near Gastown at the north end of Main Street and through East Vancouver, Burnaby and New Westminster. Rail lines continue to Surrey, past a rail yard between the Pattullo and Port Mann bridges and finally travel through White Rock before entering the U.S. at the Peace Arch border crossing.

Arthur Dungan, the president of the Virginia-based [Chlorine Institute](#), an industry advocate and lobby group that includes Canexus as a member, said the worst-case scenarios from his institution err on the side of caution. The institute provides emergency responders with resources in the event of a

catastrophic accident involving chlorine. Pamphlet 74 shows how chlorine gas from a ruptured 90-ton railcar would travel downwind as far as 64 km in a few minutes, with low-lying gas concentrating in lethal amounts closest to the leak.

Twenty-four km downwind, The institute's pamphlet predicts a chlorine gas concentration of 20 parts per million, a strength described as "the maximum airborne concentration" people can tolerate for up to one hour "without experiencing or developing life-threatening health effects."

"At 20 parts per million for an hour, you're going to be seriously impaired," said Dungan. "Maybe not killed, but seriously impaired." Dungan, however, said he doubts the chemical would be of any interest to would-be criminals. "You can determine, with not a lot of imagination, a terrorist attack putting a hole in a tank. That could happen. But there are plenty of things terrorists can do -- why would they go to a rail car with chlorine?"

Shipping details shrouded in secrecy

Chlorine is one of the most hazardous gases found in nature and was used to poison thousands during the First World War. It travels out of North Vancouver at the average rate of five rail cars a day.

"A tank full of chlorine, if you're going to blow something up, that's going to be the sort of thing you're going to go for," said John Walkley, former co-chair of the Maplewood Advisory Committee.

Walkley wishes the plant would be permanently closed on the North Shore and moved to an unpopulated area. He welcomed the temporary closure for the Olympics.

"I think it's a sensible thing to do. The danger of the plant lies more in the transportation than in the manufacturing," he said.

When a Canadian Pacific freight train derailed in suburban Toronto 30 years ago, 11 propane tanks rumbled off the tracks followed by 13 other cars carrying a combustible and toxic load that, once erupted, sent flames and gas flares more than 1,000 meters in to the air. A leaking chlorine car was identified as an extreme hazard and the gas was contained. The accident forced 218,000 residents out of their homes for five days and a newspaper declared the catastrophe "[the Mississauga miracle](#)" because there were no immediate deaths.

The derailment sparked amendments to the Transportation of Dangerous Goods Act. Added in 1992, Part 7 of the act requires all shippers to prepare and submit an [Emergency Response Assistance Plan](#) to Transport Canada, giving first responders and authorities the information they need to mitigate destruction and death.

Friends of the Earth and transportation security expert Millar petitioned Canexus for these details in October 2007 and also advocated that the chemical facility move closer to the majority of their buyers in Texas. Canexus responded in March 2008, saying the company embraces the principles of responsible care from Canada's [Chemical Producers Association](#) and is a member of the American Chemistry Council as well as the Chlorine Institute.

“Nevertheless, I don’t think I need to explain to you the integral role chlorine plays in ensuring that healthy lifestyles we enjoy in North America,” Marty Cove, a Canexus logistics manager responded. “As a chlorine producer, we must move our products to customers if we are to help to ensure the continuing health and safety of our communities.

“We regret that we are unable to provide you with any details pertaining to the routes, destinations, our dwell times of our chlorine shipments. We trust you understand that revealing any of this information would compromise the safety and security of our shipments.”

SmartRail, a Lower Mainland group that advocates for safe and efficient rail transportation, has made the same request.

Canexus will not make this information public.

This disturbs Phil Le Good, who sits on the White Rock municipal committee for transportation and infrastructure and is a past president of SmartRail.

“The community has a right to know what would occur if just one 90-ton rail car loaded with chlorine was to catastrophically rupture either from an accident or from a deliberate attack,” states a SmartRail letter to the Vancouver Port Authority (now the Port Metro Authority) dated to 2007 when Canexus was renegotiating the terms of its long-term lease with the port.

Le Good has the experience to make him particularly informed of the risks of chlorine production and transportation in urban areas. An appointed transportation committee member, Le Good is also a federally certified technician and supervises the inspection of industrial sites. For six years, until 1998, he inspected the chlor-alkali facilities at Canexus.

Le Good stresses the vulnerability of Metro Vancouver during the Olympics. Like Millar of Friends of the Earth, he believes a gas as dangerous as chlorine could prove a verifiable and effective target for anyone wanting to create mass chaos.

More dangerous to ship than a nuclear bomb?

Safety precautions at Canexus are taken extremely seriously, according to multiple members of the North Shore Community Advisory Panel, a group of municipal, environmental, residential and port representatives who hear from three industrial manufacturers, including Canexus.

Canexus has also received recognition from railway companies employed to ship its products. Canadian National (CN) granted Canexus its safe handling award for preventing a non-accidental releases (NAR) eight years out of the past decade. The spokesperson for CN said companies do not receive the safe handling award if they have been responsible for the accidental release of their cargo.

“As a shipper. . . you’ve allowed something to escape. Even if it’s minor, a release is a release,” said Bryan Tucker, who would not give specifics regarding any NARs related to Canexus.

Rick Denton, the plant manager of the Canexus facility in North Vancouver, said human error can never be factored out. But he expressed confidence in extensive safety precautions and emergency planning, including the additional fleet of specialized railcars that feature thicker insulation to lessen the risk of a release should the car leave the rails.

“You can ship nuclear weapons safely,” Denton said, making the point that even the most dangerous human-made cargo is transported with little incident.

SmartRail’s Phil Le Good considers the comparison disingenuous, reasoning that nuclear weapons are not transported by rail and are shipped under heightened security with the detonator and firing mechanisms removed, “like having a bullet without a gun.”

“This is something that brings instant fear to anyone. However, in a dishonest way [Denton] failed to mention that without their firing mechanisms they are far safer than chlorine,” Le Good wrote in an email. He said shipping pressurized chlorine in fact poses a greater potential risk than transporting nuclear material.

“Shipping nuclear weapons would be no different in terms of safety than shipping radioactive sources for medical or industrial radiography purposes.

“Yes, the weapons do have nuclear materials in them, but like any nuclear material, it is only hazardous when released but in this case there would be no mushroom cloud, but raw material spilled. Not much different than chlorine, only that chlorine is more dangerous in that it can spread much further than radiation from a nuclear weapon that has not been fired or exploded.”

Ultimately, Le Good said the comparison underscores the danger of shipping chlorine through urban areas. Even if shipments slow or stop during the Olympics, the risks will not disappear after the Games are over. One of the most dangerous chemicals in the world will continue to make its way across Vancouver and onward to points across the continent.

“How do you protect people?” asked Le Good.

His particular fears focus on the lack of security and ease of access to rail yards throughout the Lower Mainland. At the Thorton rail yard on the Fraser River in Surrey, Le Good watches propane tanks roll by. The graffiti on their exteriors suggest rail cars can be an easy target for tampering.

“I don’t think you’ll ever prevent someone who is determined on a high level of destruction,” he said.

Gary Kubera, President and CEO of Canexus, said the idea that the chemical manufacturer could be a target of sabotage is “wildly speculating.”

The upgrades require the North Shore facility to close for 30 to 40 days, and while Kubera said exact closure dates have yet to be finalized, he rebuffed the suggestion the timing is deliberate or his company was influenced by risks associated with the Olympics.

Asked if VANOC or the ISU had any influence in the timing of the closure, Kubera answered last month from Houston: “It’s possible but I wouldn’t venture to comment on that.”

Minutes from an April 2008 North Shore CAP meeting, however, confirm Canexus met with VANOC to discuss security concerns associated with facility upgrades and the Olympics. According to the minutes, Rick Denton said, “We have met with VANOC to start preliminary discussions with respect to plant operations [and] construction activities during the Games period.”

Now it is becoming clearer how such plans will affect some people just south of the Canada-U.S. border. Tom Beiker sent The Vancouver Observer an email last week that read: “I live in Belmont, Washington. Canexus plans on storing 50 railcars in my front yard during the Olympics and possibly longer. There are 10 people who live in our little community. We were not informed by Canexus until after the channel 4 news got hold of the story. The cars will be 150 feet from my house. We do not want this to happen. What can we do?”

Read more: [2010 Olympics](#), [Health](#)

From: Rick Hind [REDACTED]
Sent: February 24, 2026 12:02 PM
To: DNV Input
Subject: 2007 CSB Investigation of 48K lb Release of Chlorine & Survey Found 30% of Users Rely on Excess Flow Valves to Stop CL Flow
Attachments: CSBChlorineShutdownBulletin.pdf

EXTERNAL: Do not click links or open attachments unless you trust the sender and content.

Dear Council Members,

I am sharing a few items ahead of tonight's hearing to give you more time to read in advance of my oral remarks.

Rick Hind
[REDACTED]

U.S. Chemical Safety and Hazard Investigation Board (CSB) issued this bulletin: **Emergency Shutdown Systems for Chlorine Transfer** "...CSB investigators found that approximately 30 percent of the bulk chlorine users contacted during this investigation continue to rely only on excess flow valves to stop chlorine flow in the event of a transfer hose rupture." In other words this kind of an event could happen at almost a third of other US facilities.

Safety Bulletin

U.S. Chemical Safety and Hazard Investigation Board



No. 2005-06-I-LA | June 2007

Emergency Shutdown Systems for Chlorine Transfer

Summary

The U.S. Chemical Safety and Hazard Investigation Board (CSB) issues this Safety Bulletin to emphasize the importance of installing, testing, and maintaining chlorine detection and emergency shutdown devices on chlorine railcar transfer systems.

This bulletin compares two chlorine releases investigated by the CSB. In both, a railcar unloading hose failed and chlorine was released. In the first incident, an emergency shutdown system malfunctioned, resulting in a release of 48,000 pounds of chlorine and a significant community impact. In the second, the emergency shutdown system worked to minimize the release, and the community was not impacted.



Figure 1. August 14, 2002, chlorine release at DPC Enterprises in Festus, Missouri

Uncontrolled Release Event

In 2002, the CSB investigated a chlorine release at DPC Enterprises (DPC) in Festus, Missouri, that resulted when a chlorine railcar transfer hose ruptured. The CSB determined that although the supplier's manufacturing records and identification tag indicated that the metal braid on the failed hose was made of Hastelloy C, as specified by DPC, it was actually made of stainless steel. Neither the manufacturer nor DPC confirmed that the hose was constructed of the proper material before it was put into chlorine service. Chlorine rapidly degraded the braid and the hose ruptured¹ (CSB, 2003).

¹ The braided metal hose was Teflon-lined.

DPC had an emergency shutdown system to stop chlorine releases from the railcar, which included remotely activated emergency shutdown valves installed at each end of the chlorine transfer hose. These valves were supposed to close automatically when detectors identified chlorine in the area or if operators pushed an emergency shutdown button. However, on the day of the incident, even though the chlorine detectors detected the release and the operators pushed the shutdown button, the valves remained open.^{2, 3} Furthermore, the excess flow valve (internal to the railcar) did not close.

Consequently, 48,000 pounds of chlorine was released into the neighboring community, resulting in hundreds of residents being evacuated or sheltered-in-place. Sixty-three local residents sought medical evaluation; three were admitted to the hospital. The chlorine caused tree leaves and vegetation around the facility to turn brown.

The CSB recommended that DPC develop a quality assurance system for chlorine hoses, and implement procedures and practices to ensure that the emergency shutdown system operates reliably. The CSB also recommended that the hose fabricator implement a materials' verification procedure to improve quality and ensure that hastelloy chlorine hoses are readily identifiable.

Controlled Release Event

On August 11, 2005, a chlorine transfer hose ruptured at Honeywell International's (Honeywell) Baton Rouge chemical plant.⁴

² The CSB determined that the valves were not adequately maintained or tested by DPC to ensure they would operate when needed.

³ Employees pressed the remote emergency shutdown button to close the isolation valves every day during the transfer system shutdown. However, DPC did not require employees to verify that the valves actually closed.

⁴ Microscopic examination of the hose revealed that corrosion of the wire hose braid at the failure site had reduced the diameter and pitted the failed wires. The CSB investigated the operating and environmental conditions the hose was subject to prior to the failure, but did not identify a likely cause of the corrosion.

Chlorine began to escape from the railcar. A newly installed chlorine detector alerted control room operators of the release; a shift supervisor who was outside saw the escaping chlorine and sounded the evacuation alarm. A control room operator stopped the release by remotely closing the emergency shutdown valves on the chlorine transfer hose. The release lasted less than one minute.

Although contractors working in the area heard the alarm and evacuated, some inhaled chlorine and were taken to the hospital where they were treated and released. All returned to work the next day. Immediately after the release, Honeywell tested for chlorine at the facility property line and found none.

In contrast to the 2002 incident at DPC, the rapid and successful activation of the emergency shutdown system at Honeywell prevented a major release and off-site impact.

The August 2005 incident at Honeywell demonstrated that properly maintained chlorine detection and emergency shutdown systems are critical for protecting workers, adjacent communities, and the environment.



Figure 2. Honeywell ruptured chlorine transfer hose

Since 1994, the CSB and the Chlorine Institute have recorded at least five hose failures that resulted in chlorine releases. Additionally, one hose manufacturer reported that 6 of 2,781

chlorine hoses had been returned for failure analysis between January 2000 and September 2006. This data indicates that chlorine hoses are susceptible to failure, and that emergency shutdown systems are needed to prevent human exposure to chlorine that is released during a hose failure.

Chlorine Background

Chlorine Properties

Molecular Formula – Cl_2
Boiling Point – 29.2 °F
Vapor Pressure – 53.5 psi at 32 °F

Chlorine is highly toxic and corrosive. It irritates the mucous membranes of the nose, throat, and lungs, and exposure to relatively low concentrations can be fatal. The National Institute for Occupational Safety and Health (NIOSH) and OSHA have determined that 10 ppm is immediately dangerous to life and health (IDLH). Table 1 summarizes the health effects of acute chlorine inhalation.

Chlorine is used for water and wastewater disinfection, and to manufacture products such as household bleach, pesticides, medicines, plastic

Table 1: Health effects of short term chlorine inhalation

Concentration (parts per million)	Health Effects
1-3	Mild mucous membrane irritation, tolerable up to one hour
5-15	Moderate irritation of upper respiratory tract
30	Immediate chest pain, vomiting, dyspnea, and coughing
40-60	Toxic pneumonitis and pulmonary edema
430	Death within 30 minutes
1,000	Death within a few minutes

Source: Ellenhorn and Barceloux, 1988.

pipings, silicon chips, and automotive parts. Facilities that use chlorine are located throughout the country, sometimes close to residential communities. Many of these facilities receive chlorine in railcars; according to the Surface Transportation Board Carload Waybill Sample almost 3 million tons of chlorine was shipped by railcar in 2005 in the United States (Surface Transportation Board, 2005).

Chlorine Railcar Unloading Systems

The most basic chlorine railcar unloading system consists of hoses and manual valves. Pressurized nitrogen or dry air is fed to the railcar through one hose to force liquid chlorine through a second hose. The railcars themselves are equipped with an internal excess flow valve (EFV) designed to close if the rate of chlorine flow becomes excessive (7,000 to 32,000 pounds per hour depending on the design parameters for the specific application). For instance, excessive flow might occur if the manual valve breaks off during an accident in transit.^{5, 6}

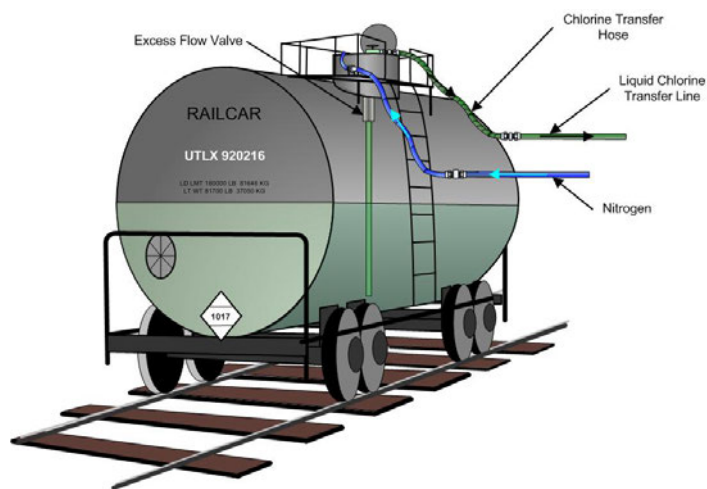


Figure 3. Basic unloading system

⁵ DOT Hazardous Materials Regulations (49 CFR 173.314 (k)) require that chlorine railcars be equipped with excess flow valves (HMR, 2006).

⁶ The Chlorine Institute Pamphlet 66, "Recommended Practices for Handling Chlorine Tank Cars," contains recommendations for excess flow valve design.

With this basic system, the EFV is the only physical safeguard to prevent a large chlorine release into the atmosphere if an unloading hose ruptures. However, the design of EFVs requires a compromise: they must be designed to allow a reasonable flow such as what may occur during routine unloading, but close if the flow becomes very large. Hence, an EFV is unlikely to stop a small to moderate leak from a ruptured hose. The Federal Railroad Administration (FRA) warns that when unloading equipment is attached to a railcar, product flow “will not be sufficient to activate the EFV” (FRA, 2003).

Numerous incidents have demonstrated that EFVs should not be relied upon solely to stop a hazardous material release during unloading.⁷ As an example, the National Transportation Safety Board (NTSB) investigated a July 2001 methyl mercaptan release from a railcar at ATOFINA Chemicals, Inc. (ATOFINA), and found that reliance on the excess flow valve to stop a leak contributed to the size of the release. The release started when “a pipe attached to a fitting on the unloading line of a railroad tank car fractured and separated” (NTSB, 2002). The methyl mercaptan, which is both toxic and flammable, ignited, causing a large fire. Three ATOFINA employees were killed, and several other employees and local residents were injured.

In response to an NTSB recommendation, the U.S. Environmental Protection Agency (EPA) issued a Chemical Safety Hazard Alert titled “Failures of Excess Flow Valves in Hazardous Materials Service” (EPA, 2004). The Hazard Alert describes four significant incidents where excess flow valves failed to stop hazardous material releases. The Hazard Alert noted that the National Propane Gas Association, Chlorine Institute, National Fire Protection Agency, and Compressed Gas Association either “recommend or require” that additional protections be used to supplement EFVs (EPA, 2004).

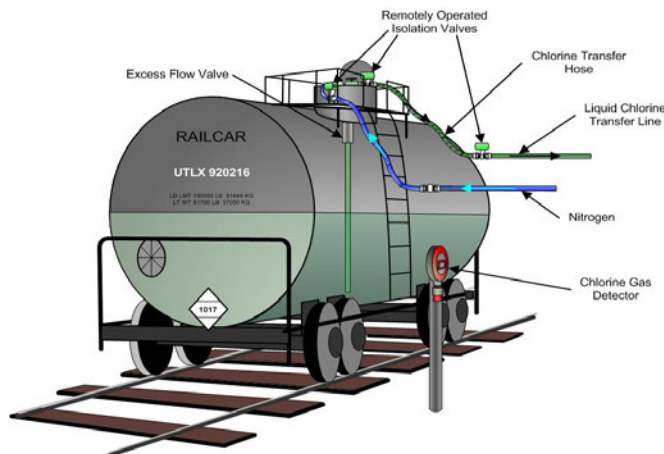


Figure 4. Chlorine railcar unloading system with an emergency shutdown system

Despite these warnings, the CSB investigators found that approximately 30 percent of the bulk chlorine users contacted during this investigation continue to rely only on excess flow valves to stop chlorine flow in the event of a transfer hose rupture.⁸

At a minimum, chlorine railcar unloading systems (Figure 4) should include the following components:

- Automatic shutdown valves, which are capable of isolating the unloading system within 8-10 seconds, located on the nitrogen or dry air hose-to-railcar connection, and at both ends of the chlorine transfer hose.
- Emergency shutoff switches, to activate the shutdown valves, installed in at least two easily accessible remote locations.
- Leak detection equipment that either automatically activates the shutdown valves or alerts personnel to manually activate them. This equipment may include atmospheric monitoring systems, video monitoring, loading line pressure monitoring, or railcar derailer position sensors.

⁷ Excess flow valves will not close if the flow rate through them is less than the design rate, or if some foreign material prevents the ball from seating.

⁸ The CSB investigators contacted approximately 30 bulk chlorine users.

Furthermore, these systems should be designed to be highly reliable⁹ to ensure that they will function when required. The emergency shutdown system should be regularly tested and maintained.¹⁰ Chlorine transfer and emergency shutdown procedures should be in writing and employees should be trained on them.

OSHA and EPA Regulations

The OSHA Process Safety Management (PSM) standard (29 CFR 1910.119) and the EPA Risk Management Program (40 CFR 68) require that facilities handling significant amounts of chlorine (more than 1,500 pounds for PSM and more than 2,500 pounds for the Risk Management Program) implement comprehensive management systems to prevent or minimize the consequences of a release (OSHA, 2006),(EPA, 2006).

These regulations require:

- “[T]hat equipment complies with recognized and generally accepted good engineering practices” [29 CFR 1910.119(d)(3)(ii); 40 CFR 68.65 (d)(2)];
- A comprehensive process hazards analysis that addresses “[e]ngineering and administrative controls applicable to the hazards...” [§ 1910.119(e)(3)(ii); §68.67(c)(7)]; and that
- Equipment “inspections and tests shall be performed...” [§ 1910.119(j)(4)(i); §68.73(d)(1)].

Because these are performance-based regulations, neither have specific requirements for chlorine railcar unloading systems.

DOT Regulations

The Department of Transportation (DOT) Hazardous Materials Regulations (HMR; 49 CFR 171 through 180) govern transportation of hazardous materials by rail, aircraft, vessel, and motor vehicle tank truck (DOT, 2006). The HMR requires emergency shutdown equipment for motor vehicle tank truck chlorine transfer systems but not for railcar chlorine transfer systems.

On October 30, 2003, the DOT issued a final rule clarifying the scope of the HMR, which defines transportation as “the movement of property and loading, unloading, or storage incidental to the movement.” The final rule explained that transportation, and therefore DOT regulatory authority, ends when the consignee takes possession of the material (DOT, 2003).

When hazardous materials are delivered to a facility by tank truck, the carrier usually unloads the material for the consignee, who then takes possession after unloading. When hazardous materials are delivered by railcar, the consignee commonly takes possession when the railcar is placed onsite; the material is later unloaded by the consignee. As a result of this distinction, the HMR covers tank truck unloading but not railcar unloading.

The NTSB identified this as a regulatory gap in its investigation of the 2002 ATOFINA incident and recommended that the DOT develop safety requirements that include “emergency shutdown measures” for railcar unloading (NTSB, 2002).¹¹ However, the DOT did not implement the recommendation; the NTSB classified the DOT response “Open-Unacceptable Response,” and asked the DOT to reconsider.¹²

⁹ For more information about safety integrity levels for critical components, see International Electrotechnical Commission (IEC), 2004. 61511, “Functional Safety Instrumented Systems for the Process Industry Sector.”

¹⁰ For detailed information, see The Chlorine Institute, Inc., 2003. “Emergency Shut-off System for Bulk Transfer of Chlorine,” Pamphlet 57, 4th ed., October 2003.

¹¹ During the 2001 ATOFINA investigation, the NTSB interviewed nine companies that handled hazardous materials and found that six relied solely on excess flow valves to stop leaks (NTSB, 2002).

¹² As of the writing of this bulletin, the NTSB recommendation to DOT remains classified as “Open-Unacceptable Response.”

The Chlorine Institute Recommendations

The Chlorine Institute, Inc. is a trade association that represents companies that manufacture, distribute, and use chlorine. The Chlorine Institute members produce 98 percent of chlorine manufactured in the United States and Canada (Chlorine Institute, 2007). The Chlorine Institute develops and publishes technical and safety pamphlets with recommendations for handling and distributing chlorine, which include requirements for railcar unloading. Its members agree to adhere to these recommendations and to a signed safety and security commitment.

The Chlorine Institute requires its members to also ensure that their customers:

- Are adhering to The Chlorine Institute safety recommendations,
- Have a risk management program in place, and
- Are in compliance with the “Chlorine Customers Generic Safety and Security Checklist” in The Chlorine Institute Pamphlet 85, “Recommendations for Prevention of Personal Injuries for Chlorine Production and Use Facilities” (Chlorine Institute, 2005).¹³

Pamphlet 85 specifically requires “a remotely operated or automatically actuated emergency shutoff valve system in place which can safely isolate both ends of transfer hoses/flexible piping.”

Lessons Learned

- Excess flow valves should not be relied upon as the sole means to stop chlorine releases during railcar unloading.
- Effective emergency shutdown systems are critical in preventing major chlorine releases.
 - Emergency shutdown systems should be designed in accordance with industry best practices, such as those published by The Chlorine Institute.
 - Procedures for using emergency shutdown systems should be in writing, and personnel should be trained on their use.
 - Emergency shutdown systems should be maintained and tested periodically to verify their operability.

¹³ Bulk chlorine customers (those that receive chlorine by railcars, barges, or tank trucks) must comply by December 31, 2007. Packaged chlorine customers (those who receive chlorine in 2,000 pound containers or cylinders) must comply by December 31, 2008.

Recommendations

US Department of Transportation

2005-06-I-LA-R1

Expand the scope of DOT regulatory coverage to include chlorine railcar unloading operations. Ensure the regulations specifically require remotely operated emergency isolation devices that will quickly isolate a leak in any of the flexible hoses (or piping components) used to unload a chlorine railcar. The shutdown system must be capable of stopping a chlorine release from both the railcar and the facility chlorine receiving equipment. Require the emergency isolation system be periodically maintained and operationally tested to ensure it will function in the event of an unloading system chlorine leak.

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From: Rick Hind [REDACTED]
Sent: February 24, 2026 12:31 PM
To: DNV Input
Subject: 2009 CLOROX Announces Nationwide Switch from Chlorine Gas to High Strength Bleach

EXTERNAL: Do not click links or open attachments unless you trust the sender and content.

Dear Council Members,

I am sharing a few items ahead of tonight's hearing to give you more time to read in advance of my oral remarks. Below is an excerpt from the attached news release. I also worked closely with Clorox' CEO on this including the announcement date just before a successful vote in the US House of Representatives requiring the highest hazard facilities to use "methods to reduce the consequences" (MRC) where feasible. This is another example of safety, security and sustainability also being good for business. All US Clorox plants converted by 2012. A total of thirteen million people live in what were the vulnerability zones surrounding all five of their facilities. Before the conversions I visited the building Clorox used to unload rail cars of chlorine near Sacramento, CA. Frankly it was unnerving being in what felt like a confined space with 90 tons of chlorine.

Rick Hind
[REDACTED]

... "This decision was driven by our commitment to strengthen our operations and add another layer of security," said Chairman and CEO Don Knauss. Clorox will start with its Fairfield, Calif., plant. The company expects to complete the transition there within six months, followed by a phased, multiyear transition for six additional plants.

"This process requires significant expertise, training, and changes in infrastructure and equipment," Knauss said. "Our plant-by-plant approach will also enable us to apply what we learn along the way, ensure supply availability, minimize business disruptions and help make sure the transition is undertaken in the most effective manner possible."

"Clorox leads our industry in safety and security," Knauss said. "Our bleach plant employees are experts at handling chlorine, and we're proud of the fact that we've used it responsibly for our entire 96-year history. Even so, we're pleased to begin implementing this process change to make our products using high-strength bleach."



From: Peter Teevan [REDACTED]
Sent: February 24, 2026 12:33 PM
To: Mike Little, Mayor; Lisa Muri; Betty Forbes; Herman Mah; Jordan Back; Catherine Pope; James Hanson
Cc: DNV Input
Subject: Questions for tonight's Public Hearing

EXTERNAL: Do not click links or open attachments unless you trust the sender and content.

Good morning Mayor and Council,

I have submitted my request to address you at tonight's public hearing. But I am reminded of the time when I asked questions before Council at a public hearing, and then the vote to close the Public Hearing took place - staff replied with answers to Council's questions and then the question was asked "What about Mr. Teevan's Question?".

And the reply from staff was (in effect) "we answered COUNCIL's questions - not from the public". It's a reminder that this Public Hearing exists not for my benefit, nor the benefit of my neighbours - its sole purpose to inform YOU of everything you need to know to make an informed and wise decision.

So I ask that any of the questions I ask here - that you please forward them to staff and the proponent for reply:

- 1) What would the ramifications of a rail car accident with Chlorine be anywhere within the DNV but outside of the Chemtrade loading facility? I will be presenting credible graphics of what would happen at the uncontrolled railway crossings where the spur line crosses Riverside and Mountain Highway - two high volume heavy commercial vehicle routes.
- 2) What are the laws regarding what Council may or may not consider in their deliberations about a safety-impacting application? To me, it would follow that you can consider anything within your jurisdiction? How can Council ignore the inherent risks of having liquid Chlorine (CL) stored in rail cars immediately adjacent to the recently approved Hydrogen (H2) production facility next door? (note: H2 (hydrogen) + CL (Chlorine) = Hydrochloric acid or HCL. What does the prospect of an earthquake bring to that evaluation?
- 3) How many people have been injured or deceased as a result of Chlorine spills or leaks in North America in the last 50 years? How many people have been injured or deceased as a result of Bleach (Sodium Hypochlorite) in the same area and timeframe?
- 4) Why does Metro Vancouver mis-label the Seymour Water Filtration site as using Chlorine when they use Bleach? Their information brochure says "Sodium Hypochlorite (Chlorine)", when sodium hypochlorite is the safer product, Bleach? Does Metro Vancouver have any water filtration facilities that use pure Chlorine and not bleach?
- 5) Who are the clients who buy the pure Chlorine in British Columbia? And which ones buy Chlorine but do not then turn it into bleach? I can understand not making a client list public - but it should be disclosed to Council and redacted from public view. What are the volumes of each British Columbian clients' purchases relative to their total production output of the Chemtrade facility?
- 6) What is the assessed value of the Chemtrade combined DNV and Port Properties and if they had been purchased, even at a premium, how much could we have saved using that site for the debacle-stricken North Shore Wastewater Treatment Plant? What if we had paid a billion dollars for the site? How much would the taxpayers have saved?
- 7) What are David Eby and Suzie Chants interests in this Chemtrade application? Mr. Eby has been no "friend" of the DNV during his tenure, and Ms. Chant has "checked out" of virtually every issue under her tenure except Health Care. So why now the attempted intervention? Who, in BC, uses pure Chlorine in municipal or provincial government service?
- 8) How many times, in the last twenty years, when members of the public presented questions about risks from Chlorine production and transportation in our urban area, did DNV Staff and Council tell people "do not worry - Chlorine production will cease by 2030"? And, even more important than how many times that was used to silence people - how many times did Council make decisions about other projects based on that understanding? How many decisions might not have been made if Chlorine production was scheduled to continue into the long term?

Thank you, those are the questions that occur to me so far. Please also do your best to echo the questions of other members of the public to staff.

See you tonight,

Peter Teevan



Sent from my iPad

From: Rick Hind [REDACTED]
Sent: February 24, 2026 12:53 PM
To: DNV Input
Subject: 2009 Greenpeace Ltr to Dow Chemical Re: Their Potential Catastrophic Liability
Attachments: Ltr to Dow on Catastrophic Liability3-27-2009 2.pdf

EXTERNAL: Do not click links or open attachments unless you trust the sender and content.

Dear Council Members,

I am sharing a few items ahead of tonight's hearing to give you more time to read in advance of my oral remarks. This letter resulted in a meeting with their global head of security on Earth Day. I urged them to share reasonable legislative language for the chemical security legislation moving in Congress. That draft helped allies in Congress to negotiate with the rest of the industry and the bill passed the House that November without much of their draft. Dow Chemical sold its entire chlorine business to Olin in 2015.

Rick Hind
[REDACTED]



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March 27, 2009

Mr. Andrew N. Liveris, Chairman & Chief Executive Officer
The Dow Chemical Company
2030 Dow Center
Midland, Michigan 48674

Dear Mr. Liveris;

We would like to meet with you to discuss Dow Chemical's use of inherently hazardous substances and their resulting potential liabilities and regulatory obligations. To make sure that Dow is fully aware of these liabilities, we have enclosed a comprehensive list of citations from more than 50 reports and over 40 authoritative sources -- including excerpts on the hazards inherent to the bulk storage and use of toxic by inhalation (TIH) substances and other acute hazards. These sources include the Association of American Railroads, Brookings Institute, Center for American Progress, Chlorine Institute, Congressional Research Service, Federal Bureau of Investigation, National Research Council, U.S. Government Accountability Office and the U.S. Homeland Security Council. In addition, please note the hundreds of examples of chemical facilities that have secured their plants by converting to safer technologies, which eliminated the risk of a catastrophic release. Knowing about these foreseeable risks and failing to act to eliminate them could result in even greater liability for Dow in the future.

As Dow reported on page 11 of its December 31, 2008 10K Report to the Securities Exchange Commission (SEC), **"Terrorist attacks and natural disasters have increased concern regarding the security of chemical production and distribution."** This may be a vast understatement given Dow's Risk Management Reports (RMP) to the Environmental Protection Agency (EPA) which as of 2008 show that at least 32 Dow owned or operated plants reported a potential "off site consequence" to neighboring communities. At least 8 of these plants (see enclosed list) each put 100,000 or more people at risk of a catastrophic chemical release. Together these 8 Dow plants put more than 3.1 million people at risk who live and work in the "vulnerability zones" reported to the EPA. Four of these facilities put people at risk up to 25 miles from the plant. In addition to the potential for human tragedy, the financial liability resulting from such a disaster could exceed the Bhopal liability that Dow inherited from Union Carbide and could potentially rival the financial cost of the 9/11 attacks as well. According to the New York City Comptroller, economic impacts of the 9/11 attack were \$94.8 billion: www.comptroller.nyc.gov/bureaus/bud/reports/impact-9-11-year-later.pdf

Dow facilities are also subject to the new Chemical Facility Anti-Terrorism Standards (CFATS) issued by the Department of Homeland Security (DHS) which developed interim regulations for "high risk" chemical facilities. In defining the consequences of an attack compared to the accident scenarios reported to the EPA above, the DHS warns that, **"The key difference is that they may involve effects that are more severe than expected with accidental risk."** As a result, the DHS recommends that facilities use a conservative model in calculating the consequences (fatalities, injuries, property & economic damage) of a successful attack. Government sources have estimated a range of potential casualties from 100,000 (U.S. Naval Research Laboratory) to over 2.4 million people (U.S. Army Surgeon General).

As you know, these catastrophic hazards are unnecessary and preventable. Ideally, Dow could switch to safer products and processes. Such a conversion would not only eliminate Dow's enormous potential liability (discussed above) but would also reduce or eliminate regulatory compliance and insurance costs associated with inherently hazardous substances.

If, however, Dow chooses to continue to use processes that use inherently hazardous substances, there are safer ways to use them that do not involve the storage and transport of bulk quantities of these materials. For example, on December 17, 2008 Dow announced one such program in the San Francisco Bay area. According to Dow's news release the process "will utilize Inherently Safer salt-to-bleach technology, an emerging, sustainable process..." This is not our most preferred option, but it will result in a dramatic reduction in both risk and liability compared to the bulk use and storage of 90-ton rail cars of chlorine gas.

Since 9/11, at least 220 chemical facilities have converted to safer technologies, thus eliminating these risks to millions of people. More than 87 percent of those interviewed said their conversion costs ranged from less than \$100,000 to \$1 million or less. A third of those surveyed said they expected to save money. The Center for American Progress has produced several reports documenting the success stories of plants that have converted to safer technologies and the outstanding risks posed by facilities still using inherently hazardous substances. These include the April 2006 report on the hundreds of facilities which have recently converted to inherently safer technologies (ISTs): http://www.americanprogress.org/issues/2006/04/b681085_ct2556757.html/chem_survey.pdf

Given these risks, their potential liability, and widely available safer alternatives, it would make good business sense to learn that Dow has additional plans to replace inherently hazardous substances and processes through the use of ISTs.

As you also know, the current DHS regulations are very limited and will expire on October 4, 2009. Congress is now considering permanent legislation that could provide more certainty for Dow and other businesses using inherently hazardous substances. The current interim law actually bars the DHS from requiring any specific security measures including the most effective security measures: inherently safer technologies. New legislation could correct this. Last year the House Homeland Security Committee adopted H.R. 5577. This bill conditionally required the highest risk (Tier 1) facilities to "reduce the consequences of an attack." H.R. 5577 allowed each facility to choose the most appropriate technology to achieve that goal and also allowed exceptions for any facility that could demonstrate that ISTs were not feasible or too costly.

Regarding legislation, we would also like to discuss Dow's current position regarding chemical security legislation. Dow is a member of the American Chemistry Council (ACC) and the National Association of Manufacturers (NAM), which have vigorously lobbied against requiring the use of safer technologies and for making the weak temporary statute permanent. In 2008 Dow reported spending \$4.6 million on lobbying with at least two lobbyists available to lobby on chemical security. **In addition to any plans to use ISTs at more Dow facilities, we would like to discuss shifting Dow's lobbying resources to support for legislation similar to H.R. 5577.**

Other NAM members have broken ranks with the NAM on this legislation. For example, in February 2008, the **Association of American Railroads (AAR) issued a statement saying, "It's time for the big chemical companies to do their part to help protect America. They should stop manufacturing dangerous chemicals when safer substitutes are available. And if they won't do it, Congress should do it for them."**

A growing number of political leaders agree with the AAR. In a March 2006 floor statement, Senator Obama said, **"...there are other ways to reduce risk that need to be part of the equation. Specifically, by employing safer technologies [IST], we can reduce the attractiveness of chemical plants as a target...Each one of these methods reduces the danger that chemical plants pose to our communities and makes them less appealing targets for terrorists."**

As you know, the September 11th terrorist attacks used our own infrastructure against us with tragic results. The attacks also demonstrated that tight perimeter security, such as in the case of the Pentagon, is incapable of preventing such attacks. Should a chemical plant be targeted, a truck bomb, a small plane, helicopter or a high powered rifle would easily render any "target hardening" or fence-line security useless. In fact, DuPont CEO Charles O. Holliday, Jr., told the media in June 2007, ***"I feel very comfortable that we've taken all the reasonable steps, but obviously if someone wants to fly an airplane into a plant, it's very hard to guard against it."***

The vulnerability of U.S. chemical plants to terrorism and serious accidents such as the 1984 disaster in Bhopal India, which killed 20,000 people, is widely recognized. The magnitude of these risks surpass the 9/11 attacks. Once released, large quantities of these gases can remain dangerous for up to 14 miles in an urban area (20 miles in a rural area) and put the lives of millions of people at risk. U.S. chemical facilities were never designed to defend against terrorist attacks, and predicting where an attack will take place is a fool's errand. No one predicted that Timothy McVeigh would attack the Federal Building in Oklahoma City in 1995, killing 168 innocent people.

The manner in which people would be killed and injured is terrifying. Poison gases such as chlorine will literally melt the lungs of its victims causing them to drown in their own lung fluid (pulmonary edema). Survivors would be left with life-long disorders.

Following the 9/11 attacks, The Washington Post reported that 9/11 ring leader, Mohamed Atta visited a Tennessee chemical plant asking lots of questions (December 16, 2001). In 2007, at least five successful terrorist attacks in Iraq used relatively small (150 to 250 pound) cylinders of chlorine gas to kill dozens of people. In 2007, thefts of 150 pound cylinders of chlorine gas occurred in California and Texas, prompting the DHS to brief local bomb squads and chemical plants across the country (April 24, 2007 USA Today.) The time for fundamental preventive action, to safeguard American communities, is long overdue.

We look forward to meeting with you, at your earliest convenience, to discuss any plans Dow may have for converting more of its facilities and supporting legislation that will ensure the use of the safest technologies wherever feasible. In the meantime, please review the enclosed list of authoritative sources on the inherent hazards of these substances, as well as the hundreds of examples of facilities that have secured their plants by converting to safer technologies that eliminate the risk of a catastrophic release.

Sincerely,

Rick Hind
Legislative Director, Greenpeace
(202) 319-2445
rick.hind@wdc.greenpeace.org



Community Mapping Tool

North Vancouver, BC

Goal of Rail Watch

The primary objective of Rail Watch is to enhance rail safety in communities. This is an outline created with and for the **North Vancouver, BC** community and meant to improve community understanding of industrial rail activity, and empower community members to take action to improve community rail safety.

What are the North Vancouver, BC community concerns?

Train derailments in Canada are regular and predictable.

- Train derailments happen everyday in Canada.
- In 2024, Canada had 1 high-risk train derailment every 4 days involving dangerous goods that run through North Vancouver.

Chlorine gas exposure is instantly lethal.

- Liquid chlorine is being shipped by rail on 1000s of rail cars through communities.
 - A single chlorine railcar can carry 90 tons of liquid chlorine. Within 500 meters of a 90-ton rupture, the mortality rate is near 90% for those without specialized respirators.
 - Chlorine is 2.5 times heavier than air, meaning it does not dissipate; it pours into basements, ravines, and ground-floor apartments.
 - Chlorine gas reacts violently with moisture. In the humid, rainy climate of North Vancouver, the gas would turn into hydrochloric acid mist.

Chlorine is generally shipped on known-to-crack DOT 105 rail cars.

- In 2016, a [DOT 105 rail car cracked and leaked chlorine](#). The entire 178,400-pound load was released in just 2.5 hours, forming a toxic vapor cloud that migrated south along the Ohio River Valley, USA. Perimeter gas sensors recorded chlorine levels at which life-threatening health effects or death can occur in the general population. The NTSB investigation into the 2016 chlorine release found that the DOT-105 railcar failed not because of a collision, but because of a material failure known as brittle fracture.

What is the risk for North Vancouver, BC?

- Economic devastation
 - Shut down of Port of Vancouver
 - The rail lines serve the Port. A chlorine leak would require work to stop at the North Shore terminals. The estimated cost of a Port shutdown is \$100M–\$200M per day in lost trade and supply chain penalties.
 - Following the East Palestine, Ohio USA model, Norfolk Southern has already paid out over \$1.1 billion USD for the clean up. With a higher population in North Vancouver, Chemtrade and CN Rail could face *liabilities exceeding \$5 billion CAD*.
 - Real Estate Devaluation: North Vancouver has some of the highest property values in Canada. A toxic plume making neighborhoods like Maplewood or Seymour uninhabitable for any period would trigger massive insurance claims.
- A 1-mile (1.6 km) buffer (the standard evacuation circumference for chemical spills) around the rail route from the Maplewood industrial area through North Vancouver encompasses:
 - Infrastructure
 - Chlorine gas is highly corrosive to metal. A major release would cause millions in damage to local infrastructure, including power lines, bridges (Ironworkers Memorial), and emergency vehicles.
 - Human & Educational Assets
 - Schools: Many schools are within or near the potential plume zone, including, but not limited to, *Kenneth Gordon Maplewood School* and *Seycove Secondary*.
 - Homes: Over 5,000–8,000 residents live within the immediate impact zone, with population density increasing as the city plans for 20,000+ new units by 2041.
 - Hospitals/Care: Proximity to senior care homes and the North Shore Hospice means the most vulnerable would be unable to evacuate in the minutes following a leak.
 - Environment and Cultural Preservation Impacts
 - Waterways: The rail line parallels the Burrard Inlet and crosses McCartney Creek and Seymour River. Chlorine gas is heavier than air and would settle into these low-lying water corridors, devastating local salmon habitats. If the gas enters the storm drains or the Seymour River, it will sterilize the water, killing all fish and microorganisms instantly. A spill near the shoreline at the Burrard Inlet would cause an immediate fish kill and devastate the Maplewood Flats, a critical bird sanctuary.
 - Historic Sites: The Maplewood Flats conservation area and indigenous cultural sites of the Tsleil-Waututh Nation sit directly in the shadow of the rail yard.

What resources are available if there is a train derailment?

- Local Capacity: While North Shore Emergency Management (NSEM) has protocols, a mass-casualty chlorine leak (TIH – Toxic Inhalation Hazard) requires specialized equipment (Level A suits) that local volunteer or municipal crews do not possess in quantities sufficient for a 100,000+ person event.
- The Training Gap: Most hazmat training focuses on containment of liquids. **There is no effective response to a massive release of chlorine gas** other than "shelter in place," which is often NOT effective in older residential buildings.

What you should know.

Prevention is possible, and the risk to human life urgently calls for this decision to be mandatory. The 2023 derailment in East Palestine, Ohio, was preventable. The vinyl chloride release and burn was deemed unnecessary, and it provides a grim blueprint for North Vancouver.

- East Palestine, Ohio train derailment primarily involved vinyl chloride. Chlorine is the primary ingredient in vinyl chloride.
- Like North Vancouver, East Palestine was considered low risk until a mechanical failure led to a derailment. Much like the DOT 105 cars in West Virginia, USA that led to the chlorine catastrophe.
- The District of North Vancouver is currently reviewing a rezoning bylaw for the Chemtrade chlor-alkali plant on 100 Amherst Avenue.
 - The facility has operated as a "non-conforming use" since 1984 and is slated for transition away from this practice in 2030.
 - Rezoning would grant permanent status until 2044, effectively removing the municipality's leverage to demand a transition away from hazardous rail transport.
 - A vote against rezoning or defer of the vote could literally save the community from a chlorine railroad disaster. Conduction of an independent feasibility study is recommended on the installation of a Powell Unit (~ \$5M investment) to convert chlorine to bleach on-site, eliminating the need for liquid chlorine rail transport.

What you can do

- **YOU CAN PREVENT A CHLORINE DERAILMENT DISASTER.**
- **This is possible now by deferring rezoning or denying a 2044 extension without a Mandatory Transition Clause requiring on-site conversion to bleach.**
- **The "Powell Unit" alternative provides the viability of converting to bleach production, which would remove thousands of chlorine railcars from North Vancouver tracks annually.**
- **Audit the company's model: Chemtrade claims the "produce and ship" model is safer because it reduces on-site storage; however, it increases the frequency and volume of hazardous cars on a rickety rail line that is prone to derailment in cars that are prone to crack.**
- **Create an asset map, showing exactly how many children and seniors sit in the one mile radius for a chemical that no longer needs to be shipped by rail.**

Conclusion

Rail safety is a collective responsibility. This includes, but is not limited to, the railroad, railroad customers, shippers, labor unions, first responders, community members, and all levels of government and government agencies, e.g. environmental agencies, security, labor, legislative, executive and judicial branches. This project plan aims to ensure your community's infrastructure, prevention and response capabilities are aligned with current

realities, providing our first responders with the necessary training and your community with essential rail safety education and information.



Thank you for participating in Rail Watch, a non-profit, community rail safety service. Please contact Rail Watch if you have any questions. For more information or if you are interested in signing up for a Rail Watch service, please visit www.railwatch.net to sign up.



contact@railwatch.net www.railwatch.net instagram [@rail.watch](https://www.instagram.com/rail.watch)

From: Rick Hind [REDACTED]
Sent: February 24, 2026 1:10 PM
To: DNV Input
Subject: Joint statement on malicious cyber activity targeting Canadian critical infrastructure - Canada.ca

EXTERNAL: Do not click links or open attachments unless you trust the sender and content.

Dear Council Members,

I am sharing a few items ahead of tonight's hearing to give you more time to read in advance of my oral remarks.

Rick Hind
[REDACTED]

<https://www.canada.ca/en/communications-security/news/2025/11/joint-statement-on-malicious-cyber-activity-targeting-canadian-critical-infrastructure.html>

Joint statement on malicious cyber activity targeting Canadian critical infrastructure

[Communications Security Establishment Canada](#)

November 26, 2025 – Ottawa, Ontario

Today, the Honourable David McGuinty, Minister of National Defence, and the Honourable Gary Anandasangaree, Minister of Public Safety, issued the following statement:

“Malicious cyber activity targeting Canada’s critical infrastructure—like power, water, health, finance and transportation—are on the rise and are a real and urgent threat. These malicious activities are conducted by both cyber threat actors with ties to nation states and non-state actors and can disrupt essential services Canadians rely on every day. Any disruption to critical infrastructure is not only a threat to public health and safety, but also a threat to public confidence, the environment and the economy.

“State-sponsored cyber actors have the capability to target Canada’s critical infrastructure, positioning themselves to disrupt or destroy critical services in times of crisis or conflict. Cyber criminals and other non-state cyber actors continue to target critical infrastructure for financial gain, in support of geopolitical or ideological interests, or for personal reasons, such as acts of revenge by disgruntled former employees or customers.

“This is a call to be ready. Too often, hostile actors gain access to critical infrastructure through weaknesses that are preventable. We urge all critical infrastructure operators in Canada, particularly municipalities and private enterprises, to be vigilant and [take immediate action to strengthen their defences](#). Adopt best practices in cyber security, like the Cyber Centre’s Cyber Security Readiness Goals and secure-by-design principles. Report incidents promptly and work closely with government agencies to prevent and respond to threats.

“The Government of Canada is working tirelessly to detect, respond to, and mitigate threats. We are committed to transparency and collaboration, ensuring that Canadians and our critical infrastructure

sectors have the information and support they need to stay secure. We will continue to work with domestic partners and industry on countering and mitigating cyber threats to Canada's most essential systems.

“Protecting our critical infrastructure is essential for keeping Canadians safe and our economy strong. We call on all sectors and citizens to remain alert and take action—together, we can defend against cyber threats and safeguard our nation's future.”

Associated links

- [Backgrounder: Malicious cyber activity targeting Canadian critical infrastructure](#)
- [The cyber threat to Canada's water systems](#)
- [Security considerations for critical infrastructure \(ITSAP.10.100\)](#)
- [Cross-Sector Cyber Security Readiness Goals Toolkit](#)

From: Colin D Armstrong <CArmstrong@acutech-consulting.com>
Sent: February 24, 2026 2:06 PM
To: DNV Input
Subject: Input for Feb 24 - 100 Amherst Ave
Attachments: AcuTech Rail Risk Assessment Presentation.pdf

EXTERNAL: Do not click links or open attachments unless you trust the sender and content.

Please see attached my presentation materials developed for today's meeting. I will bring the slides on a USB drive for presentation at the meeting as well.

Thanks you,

--

Colin D Armstrong, CCPSC
Group Lead & Principal Engineer, Quantitative Risk Services
carmstrong@acutech-consulting.com | +1 (571) 733-0245
www.acutech-consulting.com | [Follow us on LinkedIn](#)





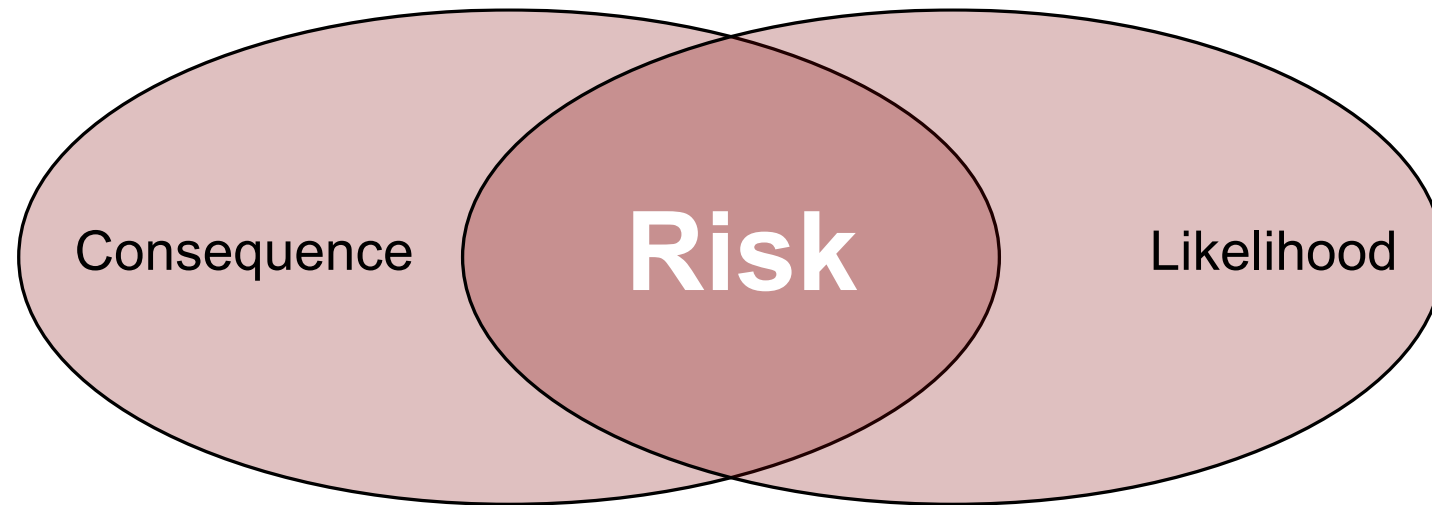
**A global leader in process risk
management services**

District of North Vancouver
Chlorine Railcar Risk Assessment

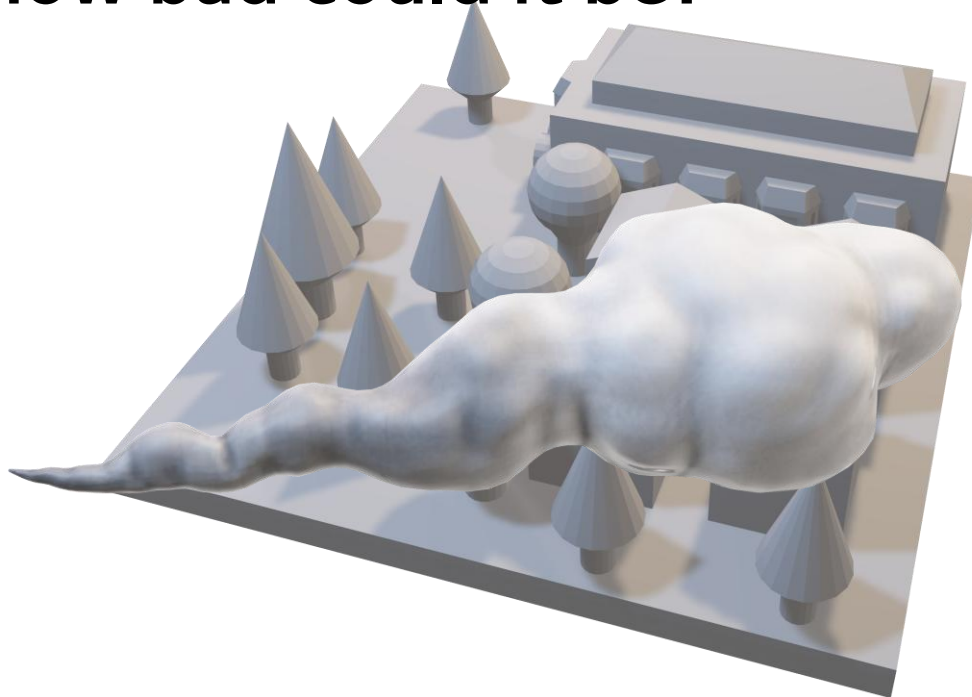


Background

- **AcuTech is a global leader in risk management for hazardous chemical processes since 1994**
 - **Lead author of the Center for Chemical Process Safety's Guidelines for Chemical Transportation Safety, Security and Risk Management (2nd Edition)**
- **Colin D Armstrong, Principal Engineer**
 - **Certified Chemical Process Safety Professional**
 - **Lead AcuTech's Quantitative Risk Services Group**
 - **Conducted hundreds of risk assessments across the globe**
 - **Recognized expert in consequence modeling, risk assessment, and risk management**



How bad could it be?



When will it happen?

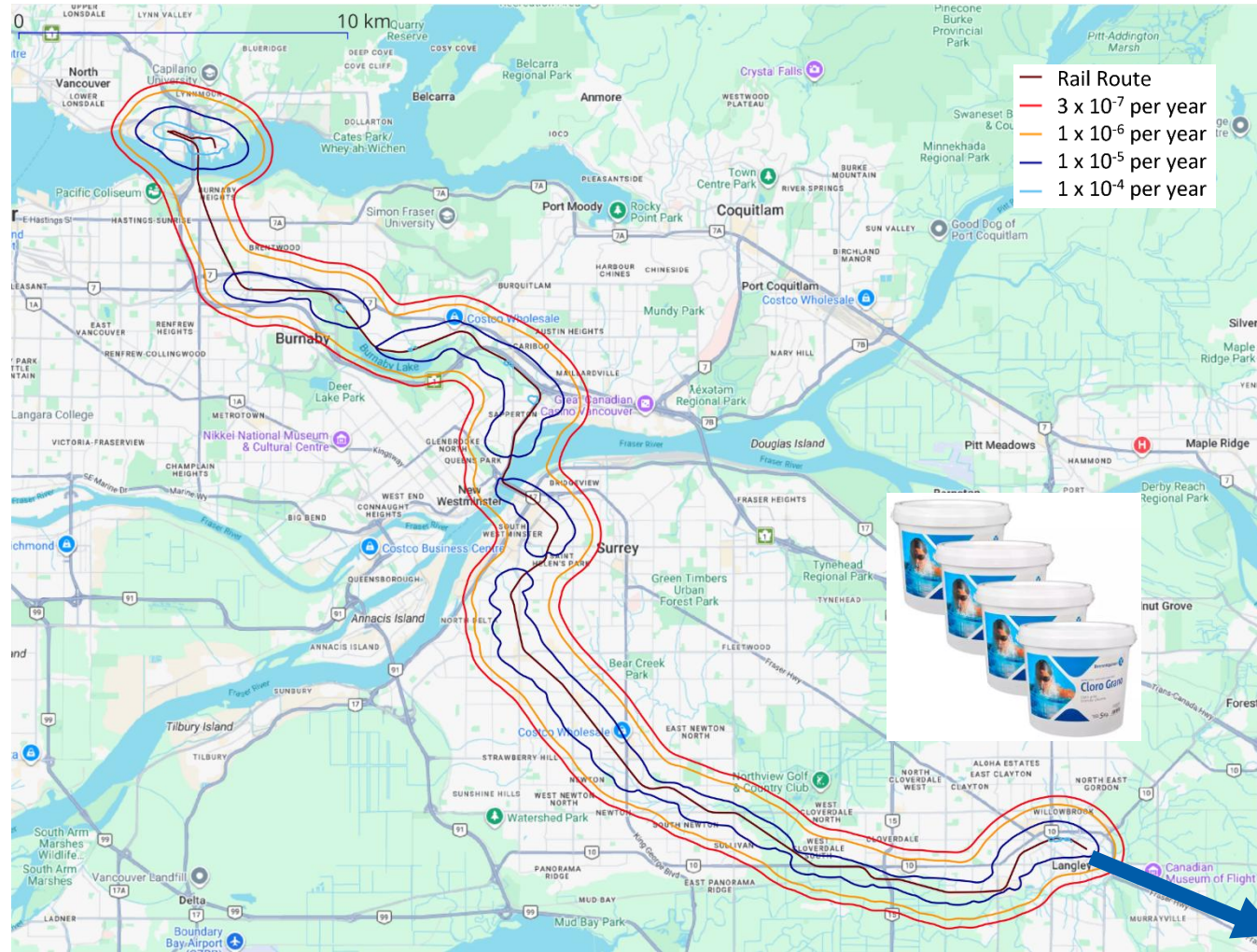


Risk Analysis Scope

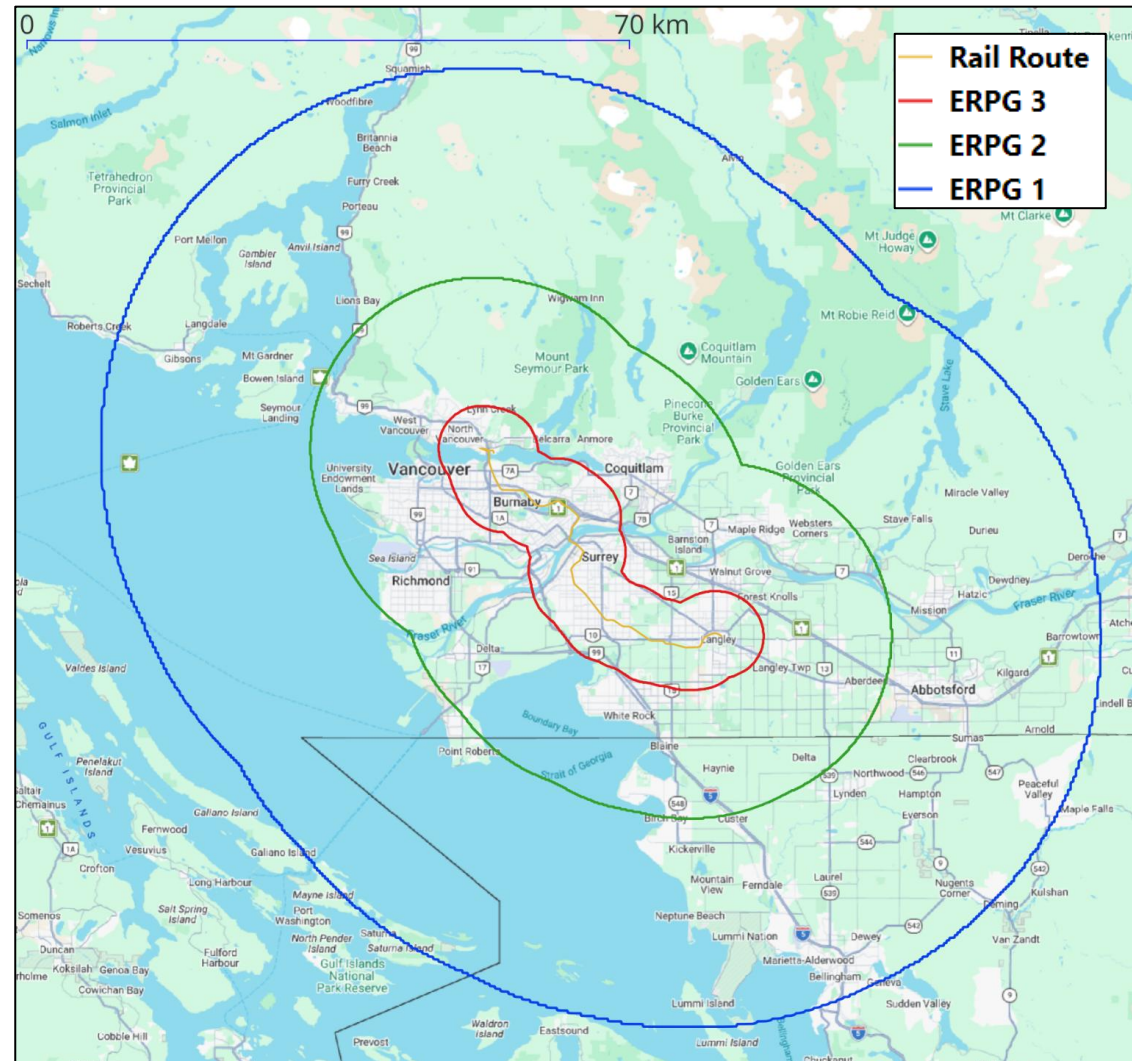


Figure 2. LSIR Contours for Current Facility with Proposed Design Changes

Risk Analysis Scope



Potential Consequence

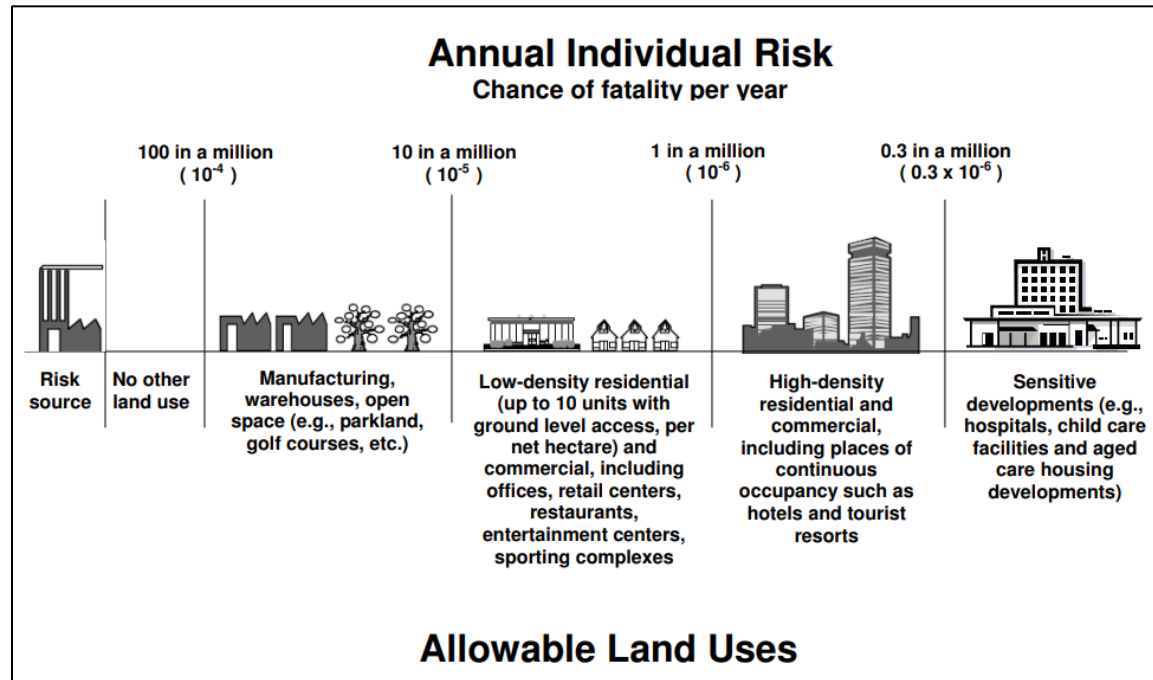


Previous Incidents

- Derailments happen regularly- leading cause of HAZMAT releases
 - Since 1995, at least four **chlorine rail accidents** have caused **13 fatalities and 300+ hospitalizations**.
 - Accident rates tend to be higher on low-speed urban rail lines, similar to those in Vancouver.

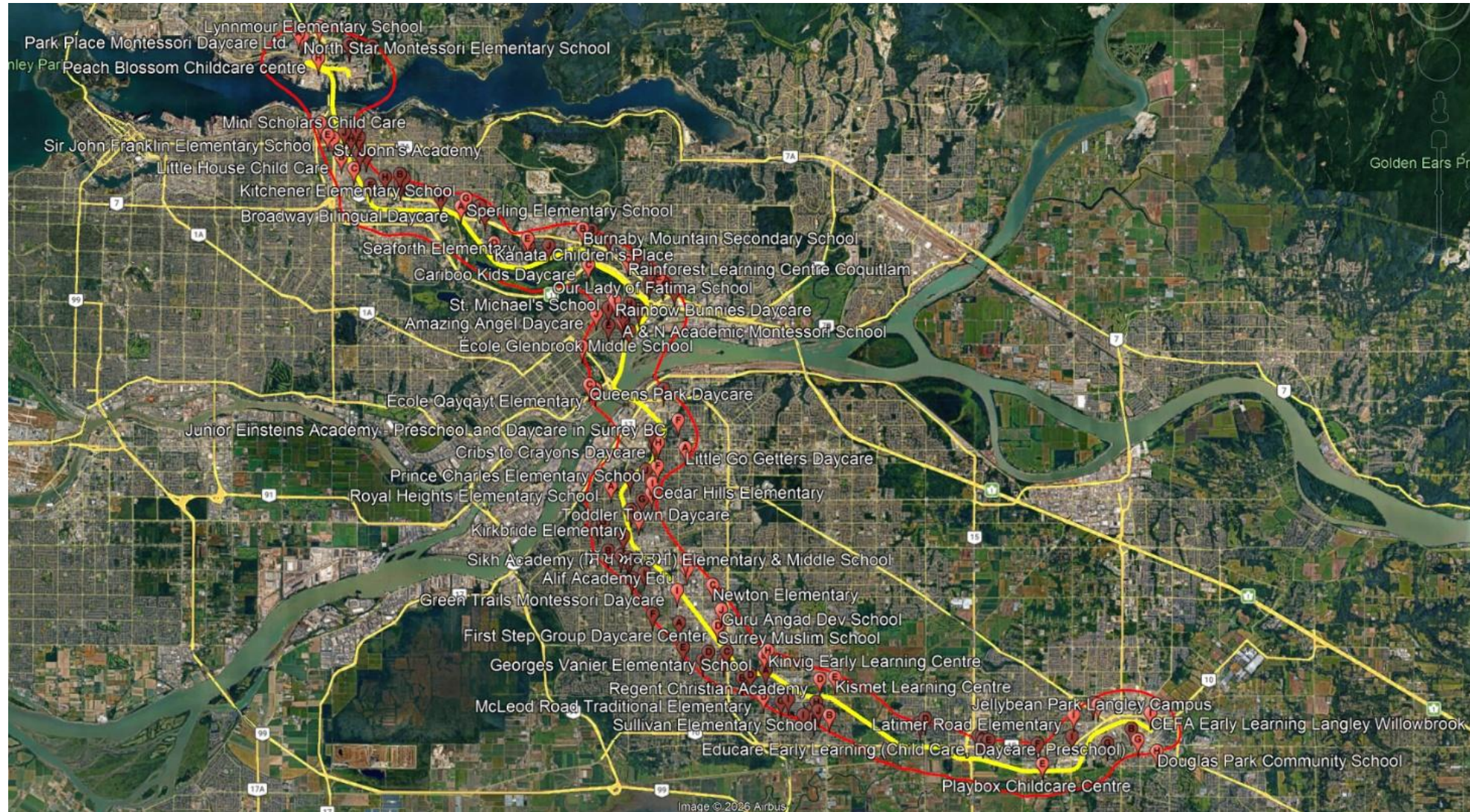


Risk Criteria



- Major Industrial Accidents Council of Canada
 - Risk Assessment – Recommended Practices for Municipalities and Industry
- Same criteria used in Chemtrade's study of production and loading risks

Schools and Daycares in High Risk Zone



Overall Determination

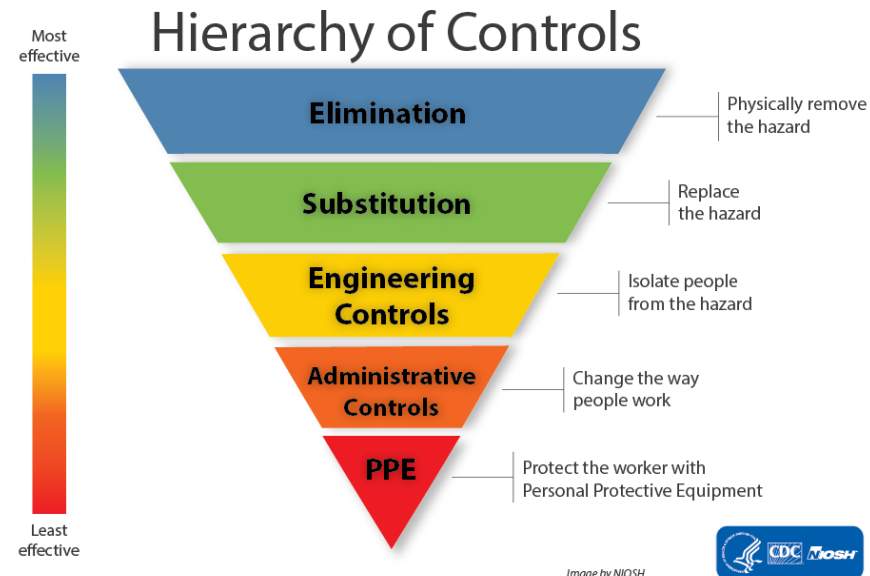
The **consequences and risks of chlorine** being stored in railcars and transported from the Chemtrade site are **catastrophic and intolerable** based on risk criteria defined by MIACC.

Risk mitigation must be implemented. The proposed risk mitigations, which stop at the containment building, are inadequate

The risk of chlorine rail transport cannot be ignored

Alternatives – Substitution/Elimination

- **Producing bleach onsite could eliminate liquid chlorine in railcars, and would eliminate the risk of catastrophic toxic hazards.**
- **Eliminating the hazard is the most effective safety measure**



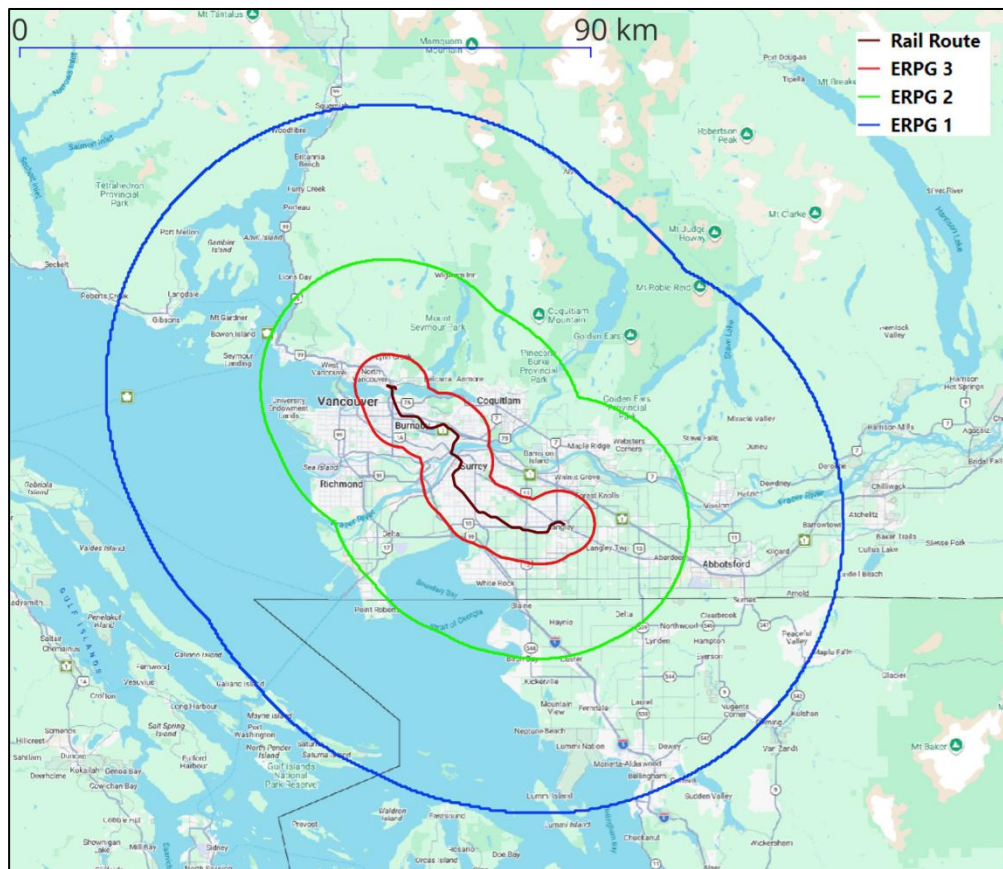
Emergency Response Planning Guidelines (ERPG) Contour

ERPG for Chlorine

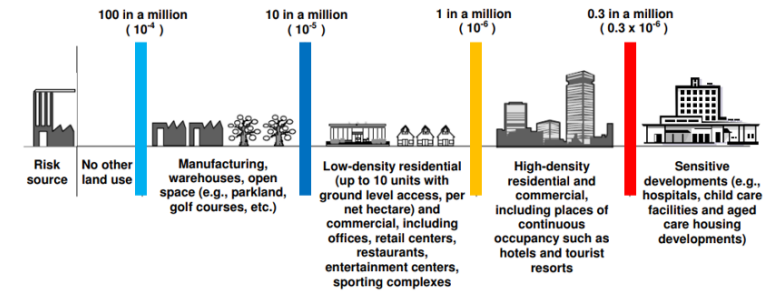
20 ppm - ERPG-3 - life-threatening health effects

3 ppm - ERPG-2 - serious, irreversible health effects or symptoms which could impair an individual's ability to take protective action

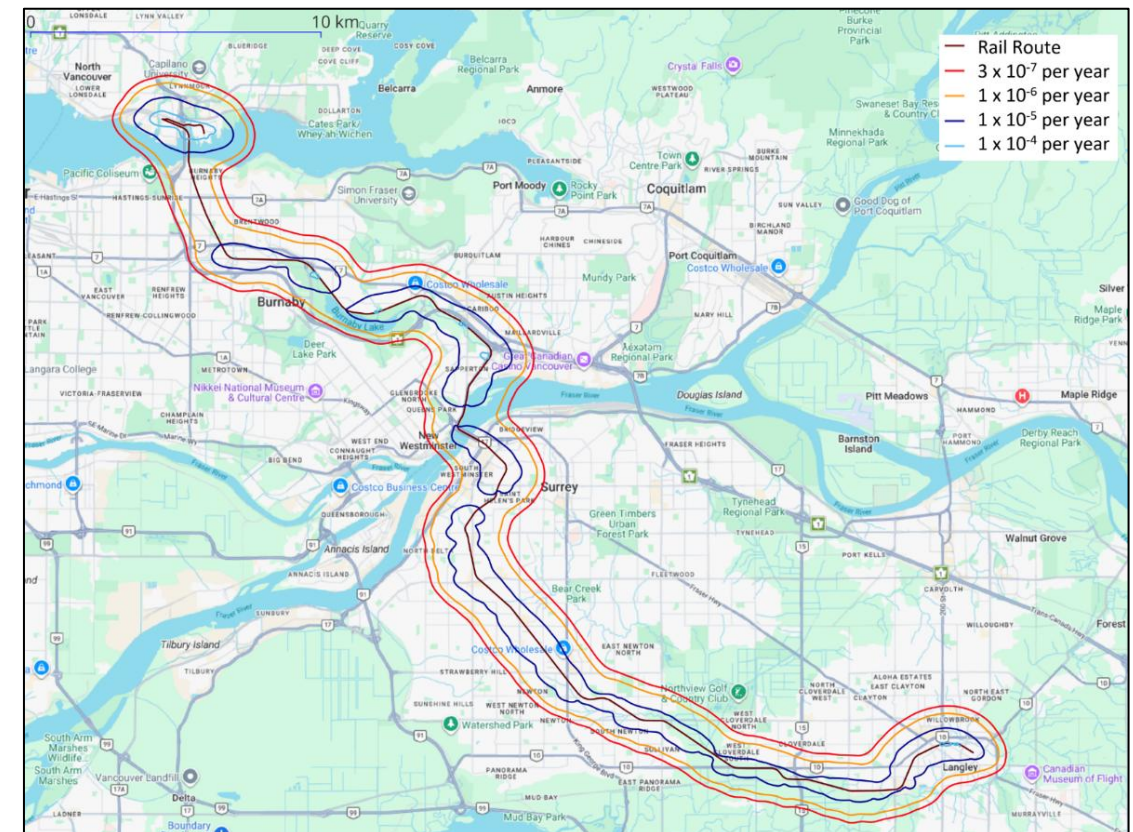
1 ppm - ERPG-1 mild, transient health effects, a clearly defined objectionable odor



Annual Individual Risk Chance of fatality per year



Allowable Land Uses



From: Michael Graveson <OMG.Consulting@outlook.com>
Sent: February 24, 2026 2:10 PM
To: DNV Input
Cc: Michael Graveson
Subject: Input for Feb 24 for Public Meeting 100 Amherst Ave
Attachments: Michael Graveson DNV meeting presentation (02.24.2026).pdf

EXTERNAL: Do not click links or open attachments unless you trust the sender and content.

Please find attached a copy of the presentation I will submit at the meeting.

Michael C. Graveson

M: 702-232-9918

E: OMG.Consulting@outlook.com



Michael C. Graveson
BSc. Chemistry, MBA

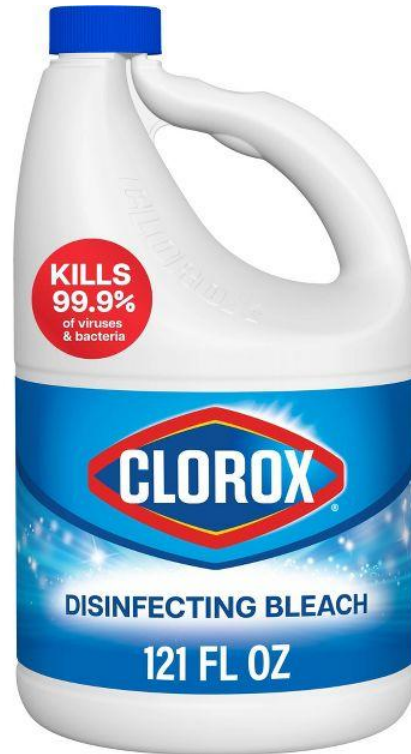


CONSULTING LLC

EXECUTIVE SUMMARY

1. You **don't need railcars** of liquid chlorine to treat the water.
2. Canadian water is **NOT** treated directly with chlorine, it's treated with **bleach**
3. **Less than 5%** of Chemtrade's chlorine goes to water treatment in western Canada
4. The safety improvements proposed by Chemtrade are **insufficient** to protect the DNV. You need to focus on the **railcars**, that's the **biggest risk!**

CHLORINE IS NOT THE SAME AS BLEACH



Bleach is also called
sodium hypochlorite

- This is not chlorine

CHEMTRADE MAKES AND SHIPS CHLORINE

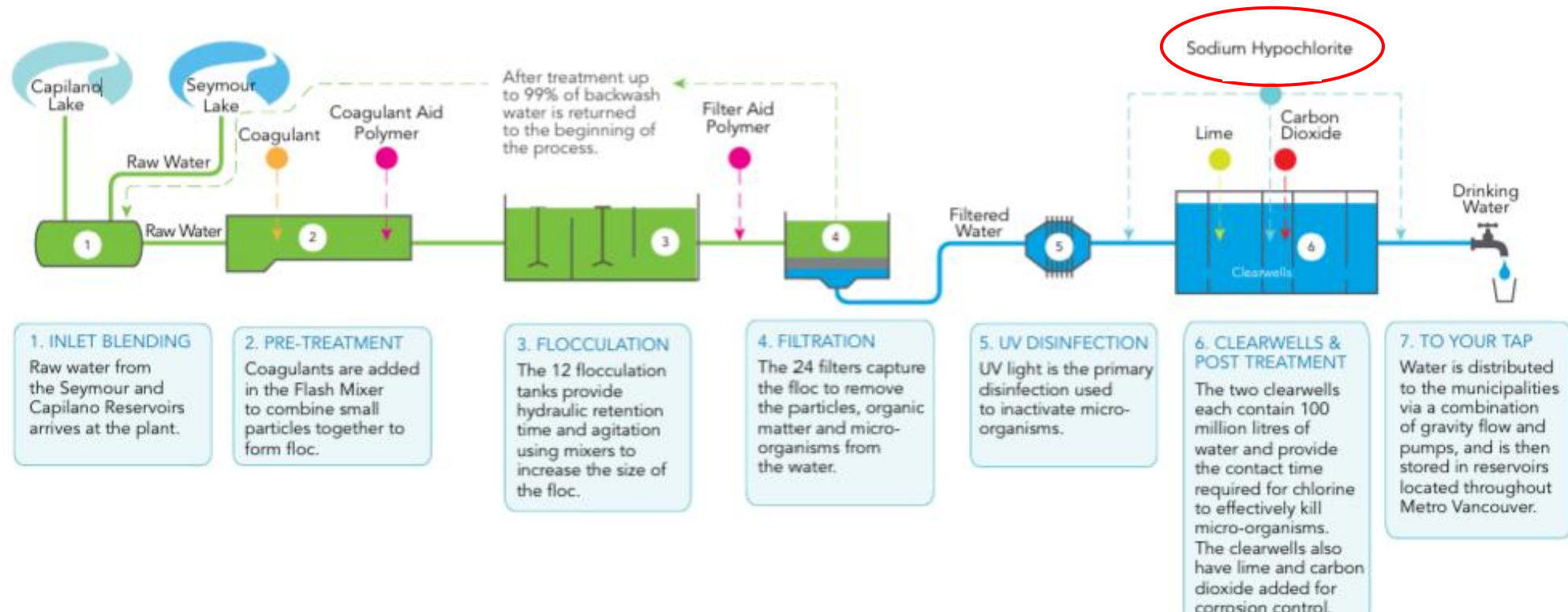
CHLORINE IS NOT THE SAME AS BLEACH

- Chlorine is a deadly gas. It was used in WWI as a weapon.



WATER IS TREATED WITH BLEACH, NOT CHLORINE

Metro Vancouver's water is treated at either the Seymour Capilano Filtration Plant (SCFP) or the Coquitlam Water Treatment Plant (CWTP).



For Metro Vancouver, call Melody Sato (Quality Coordinator) or Andrew (Division Director) at 604-451-6592. For Rose Valley WTP, call Kyle Arseneault at 250-863-3581. For South Fork WTP, Trevor Cook (Plant Operator) at trevorc@sfbwr.gov

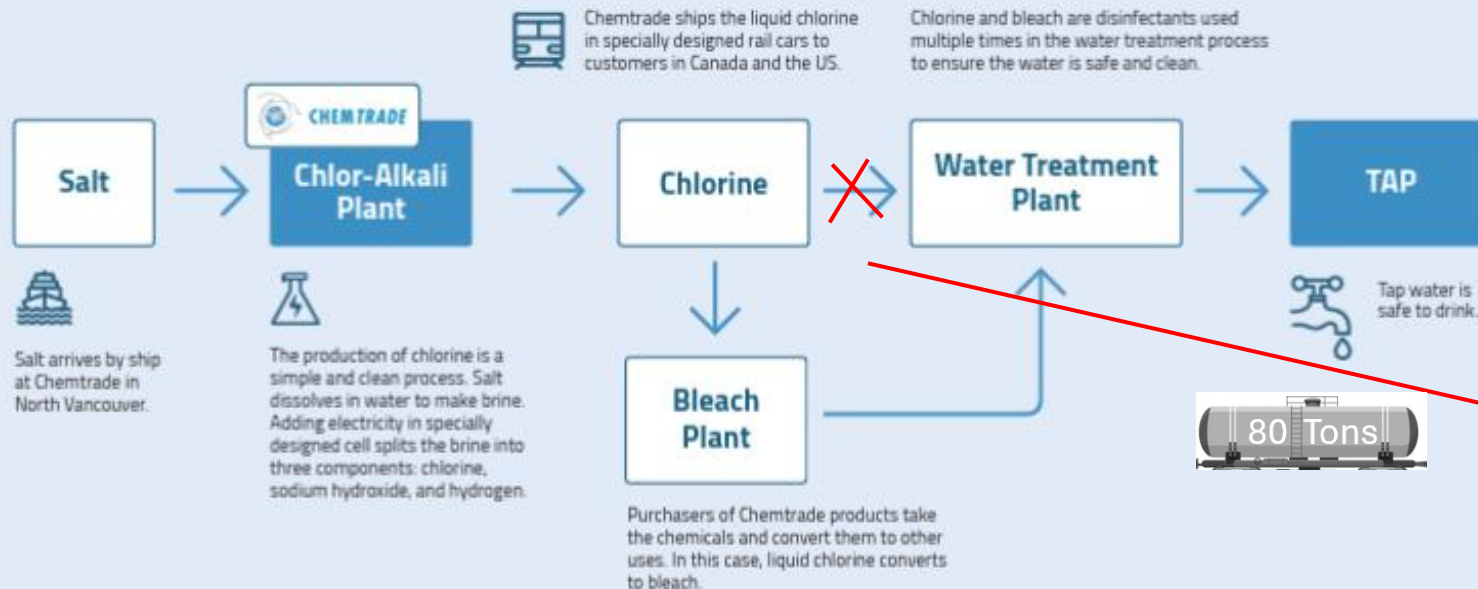
THE CHEMTRADE QUOTE IS MISLEADING

- Here is the actual quote from Stats Can:
“Chlorination remained the most common disinfection process and was applied to 96% of all drinking water produced in 2015”.
- Here is the Chemtrade quote:
“96 per cent of Canadian municipalities use chlorine to treat their drinking water supply (Source: StatsCan)”

OVER 90% OF CHLORINATION IS BLEACH, NOT CHLORINE!

LESS THAN 5% OF CHEMTRADE'S CHLORINE IS USED FOR WATER TREATMENT IN WESTERN CANADA

Safe drinking water starts at Chemtrade



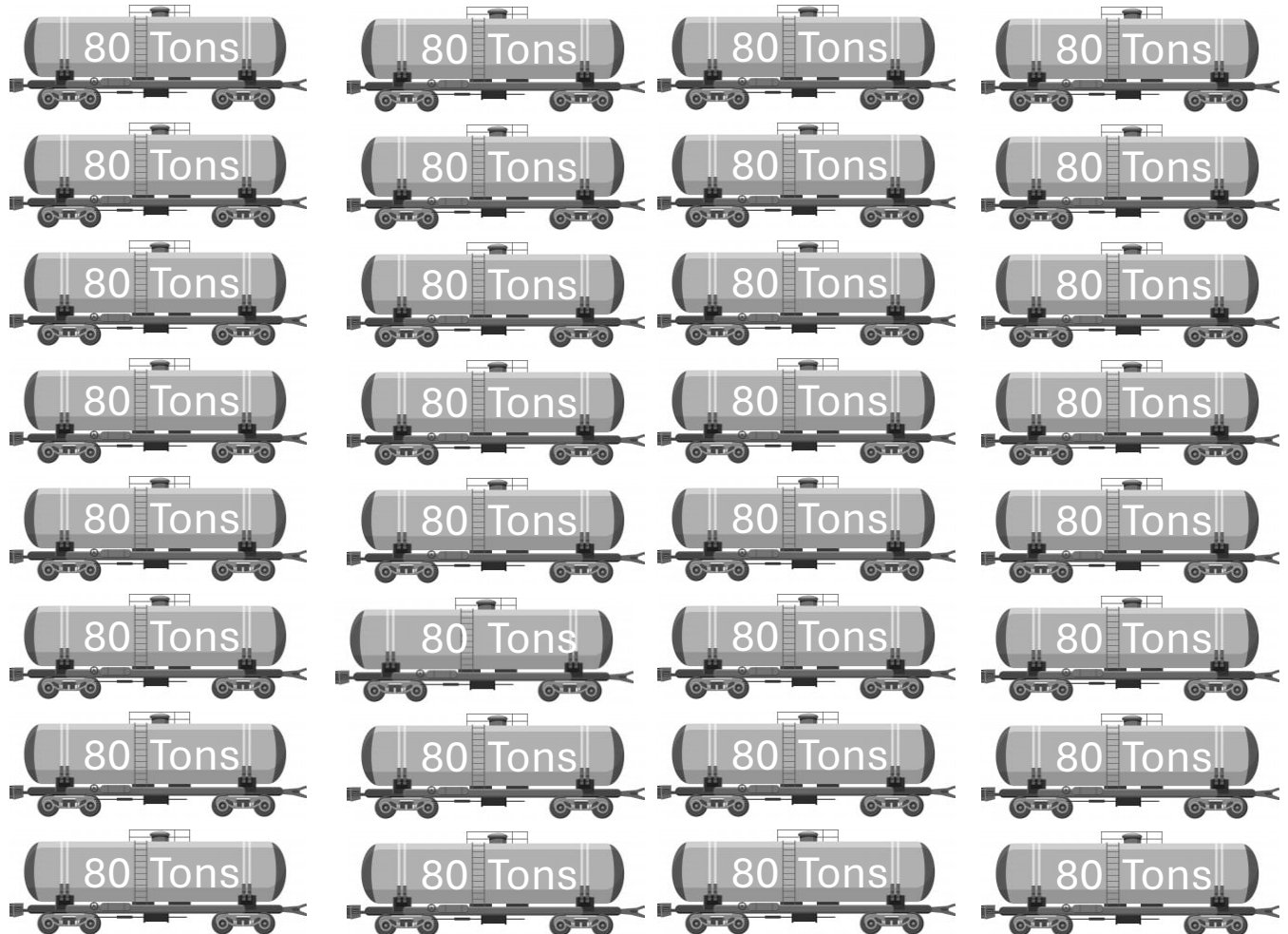
THE SOLUTION: MAKE BLEACH ONSITE

- Make the bleach onsite
- Eliminate the middleman
- Eliminate the risk
- Water gets treated
- No lost jobs

THE PROPOSED STORED CHLORINE REDUCTION IS INSIGNIFICANT



Less than 3%
Reduction in Onsite
Chlorine Storage
Inventory



LIQUID CHLORINE LOADING IN A SEALED BUILDING ADDS LITTLE VALUE

- After loading, the chlorine railcars inevitably **EXIT THE BUILDING**
 - There is no containment outside the building
- 2-4 railcars will be inside the building while 191 chlorine railcars are stored onsite (3000 tons)...outside the building without containment.
 - Axiall 2016
- But besides what's onsite, the **biggest threat to the DNV** remains the **over 1000 full railcars** of **hazardous liquid chlorine** are shipped from Chemtrade through the DNV and greater Vancouver **every year**.

A QUESTION COUNCIL SHOULD ASK?

Since liquid chlorine is **not used directly to treat water**, why continue to ship **toxic chlorine railcars** through the DNV and greater Vancouver, when a **safer alternative** exists?

THE SOLUTION: MAKE BLEACH ONSITE

- Make the bleach onsite
- Eliminate the risk
- Water gets treated
- No lost jobs

From: Corrie Kost [REDACTED]
Sent: February 24, 2026 2:53 PM
To: DNV Input; Mayor and Council - DNV
Subject: Some of the material I will present in person tonight
Attachments: Key Issues about the Chlorine plant future plans.pdf; A Short Summary of Risk Assessments Related to Maplewood.pdf

EXTERNAL: Do not click links or open attachments unless you trust the sender and content.

Your Worship & Members of Council,

I hope you find the attachment useful in the deliberation of Bylaw 8778

Yours truly,
Corrie Kost

[REDACTED]

A Short Summary of Risk Assessments Related to Maplewood

by Corrie Kost [REDACTED] – version date Nov 22, 2017

A universal minimum industry requirement is that the 10^{-4} risk contour not go outside the property line (ref 1) of the creator of the risk. As indicated on page 39 of the Aug 8th 2012 Maplewood Chemical Hazard DPA Final Report by DOUG MCCUTCHEON and Associated (hereafter called the “Final Report”) this is clearly not the case. See Figure 18 below. In fact, the 10^{-4} risk contour crosses over the area accessible by the general public – for example the North Shore Recycling and Drop-off Depot on Riverside Drive. In Canada the MIACC guidelines do not permit any other land uses inside the 10^{-4} annual individual risk contour. In other places (eg. slide 78 of reference 11) the Individual Fatality Risk contour of 5×10^{-5} per year is required to remain on site, while the 5×10^{-6} per year can extend into industrial developments only.

It should also be noted that on page 17 of the “Final Report” - low-density residential of up to **10 units with ground level access per net hectare** should be allowed in the region bounded by 10^{-5} to 10^{-6} contours (see Figure 3 attached). This **corresponds to 4 units per net acre**. Council **changed this to 8 units per net acre** on the basis that the units would be so small as to likely have an occupancy of about 1 person per unit. Since the occupancy numbers per unit are not controlled by law, or is even regulated, **this relaxation should not be implemented**. It should also be noted, that to best of my knowledge the “Final Report” did not take account of the 2015 report (ref 7) of the Earthquake Risk Study for the District of North Vancouver.

In addition, I find that “voluntary” risk should be distinguished from “involuntary” risks. On page 8 of the “Final Report” it states “Globally the acceptable level of risk for an industrial operation is similar to that risk that we as individuals are willing to accept when we travel by commercial air, rail or bus” ie. 10^{-6} . This misses the point on voluntary vs. involuntary (see some definitions in the references section). The acceptable risk that others impose upon use should be no more than, say, being hit by lightning ie. 10^{-7} .

To date only Individual Risks have been calculated. That is, the risk contours in the “Final Report” only calculated the probability of a fatality to an individual who occupies a specific location 24hrs/day. **Societal Risks**, which produce f/N graphs, although requested as a condition by council in 2007 for the continued operation of the chlorine plant, were, to my knowledge, **never done**. When calculating the consequences (expected number of fatalities) of any unique accident, the answer will depend on the local population density and distribution. Therefore, unlike individual risk contours, an f/N curve will change if the local population density or distribution changes. For a simple explanation of the three basic calculations – Hazard Footprints, Individual Risk, and Societal Risk, please see reference 10.

Since the population distribution in the area is proposed to dramatically change it behooves council to have a consultant perform the Societal Risk. For example, the Dutch have adopted a standard which has as an acceptable guideline 10 fatalities at a frequency not more than $1.E-05/yr$, 100 fatalities at no more than $1.E-07/yr$, and 1000 fatalities at no more than $1.E-09/yr$ (ref 13)

For a chlorine plant in Melbourne (ref 2) *“the nearest resident is 1.5 km away and the surrounding land areas are either vacant or are filled with warehouses and general manufacturing activities. The plant occupies approximately 8 ha of a total land area of 20 ha, with the vacant area providing a buffer zone for risk contours from the plant. The criteria set by the state government is that the **10^{-6} individual fatality risk contour must not lie outside the site boundary** and the buffer zone ensures that this is the case”.*

Distance as a guide:

In Australia, a guideline of 300 to 1500 meters from the plant boundary is used as a rule of thumb for non-major industrial developments. The DNV existing chlorine plant falls into the “major” category. In the 2014 OCP of Lloydminster Planning District, Saskatchewan, the minimum separation distance from any Hazardous Industrial Site (see attachment 1) is 1.6Km from any single family home and 2.4Km from multilot residential building sites . (ref 3) The municipality of Lumsden,

Saskatchewan uses an almost identical table (page 63 of reference 5) – that is, 1.6Km from any single family home and 2.4Km from multilot residential building sites for the separation from Hazardous Industrial sites.

Note that buildings in the DNV within the 10^{-6} risk contours will require HVAC systems (ref 4 page 36) that maintain a slight positive pressure inside the building to prevent chlorine from entering. However, if a large earthquake (see reference 7 – note particularly pages 32(attached as figure 32),33 and 35 as it relates to Maplewood) triggers a chlorine release (a much more likely time than at other times) the structure of most buildings are likely to be compromised and allow chlorine to enter. Access by emergency services would also be constrained since even a low ppm (parts per million) of chlorine will make normal engines inoperable. Recovery, not rescue, would be the likely scenario.

Notwithstanding the MIACC guidelines I find it unacceptable to move the 10^{-6} risk contour (of Figure 18) some 50 metres closer to the chlorine plant in order to align it with Front Street “for land use planning purposes”

City of Edmonton

Edmonton used a more pragmatic approach. In the review “Risk Based Land-Use Planning in the Edmonton Area – by Doug McCutcheon”(ref 6) it is recommended that the maximum amount of chlorine that should be stored within a 3 Km radius of the plant is 1,825Kg. Currently there is **far** more than that stored both inside (60,000Kg) and outside of the North Vancouver Chlorine plant!

Concerns expressed by the local community

I would like to note some of concerns that have been expressed by others in the subject area. From two 2011 articles (references 8 and 9) I take particular note of *"If Canexus has a terrible release and it kills 10,000 people, Canexus will go bankrupt and they'll just walk away. The people in North Vancouver or Vancouver won't even have someone they can sue."*

Why Canexus did not cease chlorine production in 2007

In 2007 the existing lease (Ref No. V1381(06)) at that time was valid until

June 30, 2018. Despite the desires of the Maplewood community (and council) to terminate this hazard in their neighbourhood the Vancouver Port Authority, who appears to have ultimate jurisdiction of the subject land, agreed to extend the lease to 2032.

What is the worst case scenario for the release of the full 60Tons of chlorine?

However unlikely it may be I believe our residents deserve to know the worst case potential impact of the complete release, say during a cloudless night and low winds, of the on-site storage tank (60Tons) of chlorine.

For the less technically minded...

You may wish to read the Oct 20/2011 Scientific American article “Chlorine Accidents Take a Big Human Toll” (ref 12)

RECOMMENDATION

Whereas, contrary to the MIACC guidelines, the chlorine plant imposes a substantial risk to the community well outside their property line, and

Whereas simple calculations indicate that the chlorine plant stores 300/74/33 times more chlorine than is prudent even if it were respectively 1/2/3Km from any residential areas, and

Whereas the Societal Risk calculations, as requested by council in 2007, have yet to be performed:

I urge council not to proceed with any further densification in the Maplewood area.

There is some evidence to support not proceeding with any new residential developments within at least 3 kilometers of the chlorine plant. This unfortunately includes all of Lower Lynn.

The safety of our residents should override any other considerations.

References

- (1) <http://www.planning.nsw.gov.au/~media/Files/DPE/Reports/quantitative-risk-assessment-summary-report-botany-industrial-park-2012-09-25.ashx>
- (2) <https://books.google.ca/books?isbn=0470999462>
- (3) <http://crosbyhanna.ca/assets/LPD-OCP-FINAL.pdf>
- (4) <http://www.dnv.org/sites/default/files/edocs/Maplewood-Implementatoin-Plan-Final.pdf>
- (5) http://lumsden.ca/wp-content/uploads/rm189/pdfs/bylaws/2014/OCP_Bylaw%2006-12%20R%20M_Lumsden.pdf
- (6) <http://www.cheminst.ca/sites/default/files/pdfs/Connect/PMS/CSCHE%202007%20-%20McCutcheon%202.pdf>
- (7) http://ftp.maps.canada.ca/pub/nrcan_rncan/publications/ess_sst/296/296439/of_7816.pdf
- (8) <https://www.vancouverobserver.com/public%20safety/2011/03/28/after-japanese-earthquake-north-vancouver-residents-raise-questions-about>
- (9) <https://www.vancouverobserver.com/chlorine/2011/03/31/north-vancouver-ready-chlorine-leak-during-earthquake>
- (10) <http://www.questconsult.com/papers/risk-acceptance-criteria/>
- (11) <https://www.researchgate.net/file.PostFileLoader.html?id=579aff8148954cd06f60c964&assetKey=AS%3A389081830838272%401469775745231>
- (12) <https://www.scientificamerican.com/article/chlorine-accidents-take-big-human-toll/>
- (13) http://sache.org/workshop/2013Faculty/files/QRA%20Presentation%20for%20%20AlCHEME%20in%20Richmond_1486_1.pdf -page8

- **Voluntary risk** is associated with activities in which a person participates by choice. Examples of voluntary activities include driving a car, flying in an airplane, rock climbing, and scuba diving. Generally, the individual uses his own value system and experience to determine if the risk of a voluntary activity is acceptable to him.
- **Involuntary risks** are associated with activities, conditions, or events to which a person might be exposed without his consent. Examples of involuntary risks include the risk of premature death from illness, natural disasters (earthquakes, floods, etc.), or the **production and transportation of hazardous materials**. For certain industrial activities, the “allowable” or “acceptable” levels of involuntary risk might be set by some government agency, rather than by each individual.

lexus TCP Project Risk Contours:



Maplewood Chemical Hazard DPA Preliminary Study For The District of North
Vancouver FINAL REPORT AUGUST 8th, 2012

Final Report

FIGURE 18

Table 8.1 Lloydminster Planning District Required Separation Distance Between Uses (in Metres)		Municipal Walls	Residential			City of Lloydminster	Intensive Agriculture	Airport / Airstrip	Commercial	Gravel Pit	Waste Management		Anhydrous		Industrial	Hazard Industrial
			Single	MCR	Tourist Accommodation						Solid	Liquid	Non-Refrigerate	Refrigerated		
Residential	Single ⁽¹⁾	--	--	--	--	--	--	--	200	150	457	600	305	600	300	1,600
	Multi-lot Country Residential ⁽²⁾	--	--	--	--	--	--	800	200	300	457	600	305	600	800	2,400
	Tourist Accommodation ⁽³⁾	--	--	--	--	--	--	--	200	300	457	600	305	600	800	1,600
Intensive Agriculture ⁽⁴⁾		--	--	--	--	--	--	--	--	--	--	--	--	--	800	1,600
Airport / Airstrip ⁽⁵⁾		--	--	800	--	800	--	--	--	--	--	--	--	--	--	--
Commercial (Agriculture) ⁽⁶⁾		--	300	800	800	--	800	--	--	--	457	300	--	--	--	--
Waste Management ⁽⁷⁾	Solid	1,600	457	457	457	457	457	--	457	--	--	--	--	--	457	--
	Liquid	1,600	600	600	600	600	300	--	300	--	--	--	--	--	300	--
Anhydrous ⁽⁸⁾	Non-Refrigerated	--	300	300	300	300	--	--	--	--	--	--	--	--	--	--
	Refrigerated	--	600	600	600	600	--	--	--	--	--	--	--	--	--	--
Industrial ⁽⁹⁾		800	300	800	800	⁽¹¹⁾	800	--	--	--	457	300	--	--	--	--
Hazardous Industrial ⁽¹⁰⁾		1,600	1,600	2,400	1,600	⁽¹¹⁾	1,600	--	--	--	--	--	--	--	--	--

Distances are measured as follows - Between closest point of nearest:

- (1) Single Residential Building...
- (2) Multilot Residential Building Site...
- (3) Tourist Accommodation Facility...
- (4) Intensive Agricultural Site...
- (5) Airport / Airstrip Facility...
- (6) Commercial Site...
- (7) Waste Management Facility or Lagoon...
- (8) Anhydrous Ammonia Storage Facility...
- (9) Industrial Site...
- (10) Hazardous Industrial Site...

... to the nearest residential building, corporate limit, airport or airstrip, gravel pit, anhydrous ammonia storage, or waste management facility and the site lines for other uses.

- (11) The location of Industrial and Hazardous Industrial development in the Planning District is managed by the Future Land Use Concept contained in this Official Community Plan.
- (12) Refer to Section 5.1.2.4 for separation distances from land uses in an adjacent Rural Municipality.

Hazardous industries minimal distance
from Single Family Residential: 1.6Km

Hazardous Industries distance from Multilot
Residential Building Site: 2.4Km

City of Edmonton

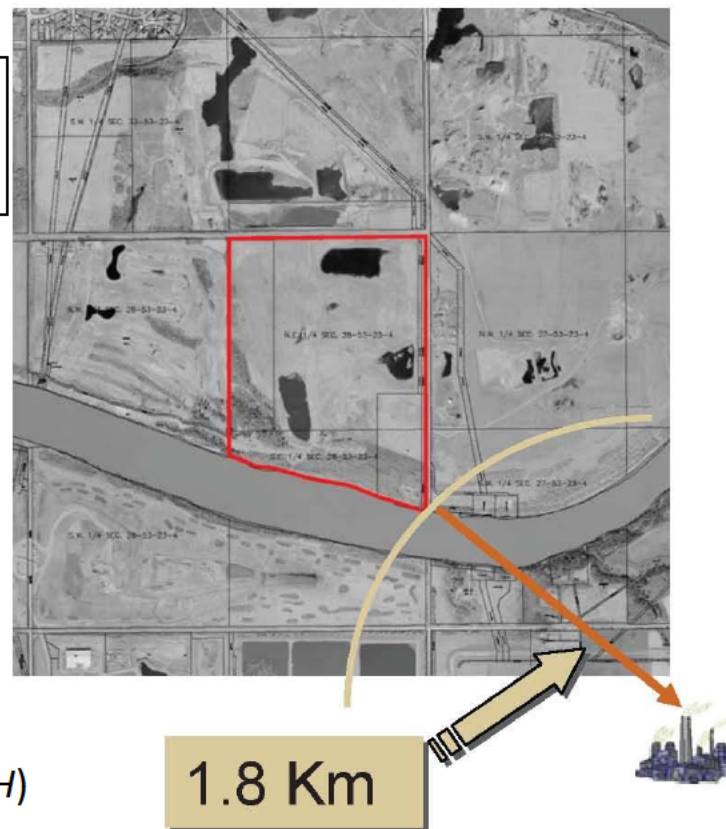
A camp for underprivileged children almost run year round. At most 1,000 people there at one time.

One approach used for a risk assessment for the City was to determine the maximum amount of hazardous chemicals could be located in a heavy industry zone to the south. The table below shows some of the quantities.

Not a lot.

IDLH for Cl_2 is 10ppm

Hazard Distance to the IDLH Concentration	H_2S Kg	SO_2 Kg	Cl_2 Kg
1 Km	979	1,748	203
2 Km	3,915	6,991	811
3 Km	8,808	15,729	1,825
Resulting Probability (high end) = 4.15×10^{-5}			



Immediately Dangerous to Life or Health *Concentrations (IDLH)*

Note that for a chlorine cloud only a portion of the area within the circular vulnerability zone can be affected by a unique accident—see Fig 2 of ref 10 (cjk)

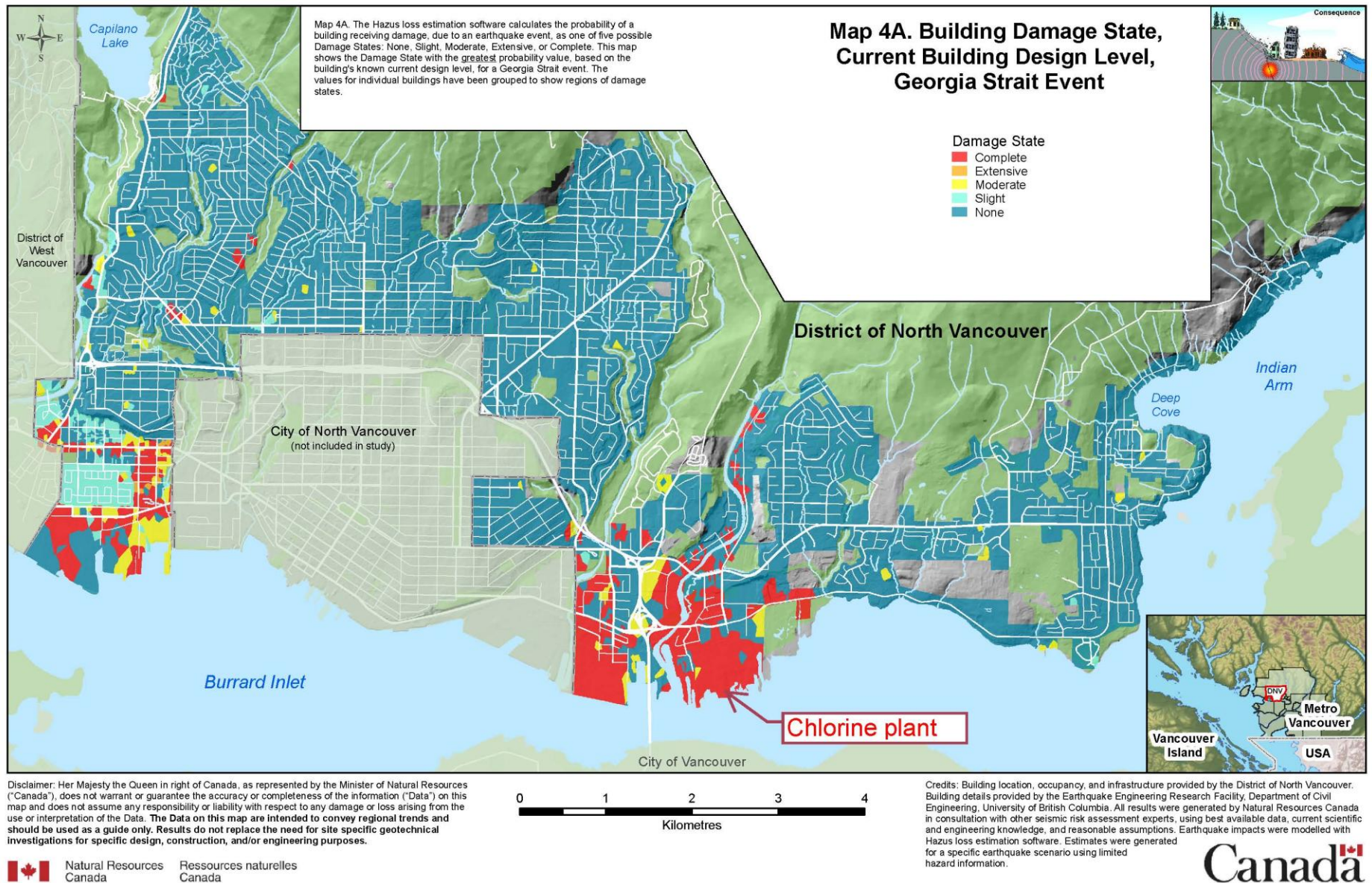
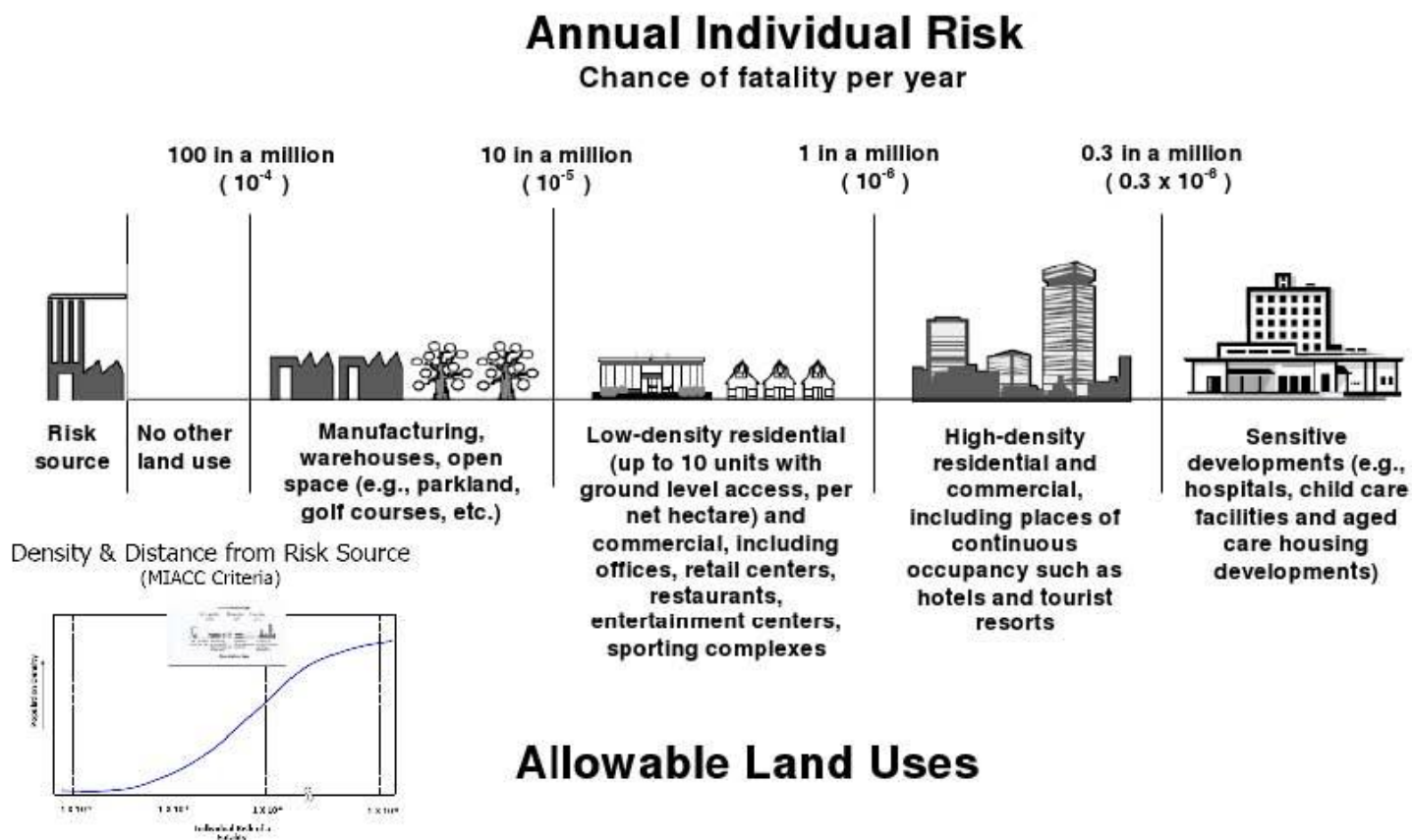


Figure 32

Figure 3

Figure 3: MIACC Land Use Planning Criteria



Additional Reading Material

- a) http://www.epd.gov.hk/eia/register/report/eiareport/eia_2242014/EIA/text_html/S12_Hazard.htm
- b) <http://www.praxair.com/-/media/documents/sds/chlorine-cl-2safety-data-sheet-sds-p4580.pdf> see page 4 for IDLH of 10ppm
- c) <http://onlinelibrary.wiley.com/doi/10.1002/9780470552940.app2/pdf>
- d) <https://www.worksafebc.com/en/resources/health-safety/books-guides/chlorine-safe-work-practices?lang%3Den%26direct>

Some useful information

If all the liquid chlorine in a 68 kg (150 lb.) container escaped, it would release so much pure chlorine gas that it would take 24 times the amount of air in BC Place stadium to dilute the gas concentration to 0.5 ppm, the maximum allowable concentration a person can be exposed to in an eight-hour period. (page 2 ref d)

Chlorine gas is not visible as a greenish-yellow cloud at concentrations below 1000 ppm. (page 3 ref d)

Key Issues about the Chlorine plant future plans

- The plant has had no serious chlorine releases since it started in 1957
- If such a Chlorine plant were proposed to be here today it would not be permitted
- IMHO the future vision for Maplewood can never be fulfilled so long as this plant exists
- The DNV taxes/fees collected by this facility should not be a factor in deciding this issue
- The plant's liability insurance of \$300million⁽¹⁾ in the 1990's should be about \$1Billion today
- If there is no such insurance currently in place then it speaks volumes about the risks!
- The proposed Bylaw 8778 does not have an expiry date for the production of chlorine
- A global survey indicated no chlorine plant in the world lies this close to housing
- The BakerRisk report that the latest 10^{-6} contour **does not lie within the site boundary**.
- No results for a "worst-case" situation (say during an extreme earthquake) was ever studied.

(1) See Aug 25 1998 Public Hearing that Canadian Occidental Petroleum carried a \$300m US funds of liability insurance.

From: Peter Teevan [REDACTED]
Sent: February 24, 2026 3:02 PM
To: DNV Input
Cc: pteevan
Subject: Input for 100 Amherst - Chemtrade
Attachments: Chemtrade Proposal Feb 2026.pdf

EXTERNAL: Do not click links or open attachments unless you trust the sender and content.

Attached please find the slide presentation I intend to present before Council tonight

Peter Teevan



Chemtrade Proposal (100 Amherst) Comments to Council

PETER TEEVAN

1900 BLOCK INDIAN RIVER CRES

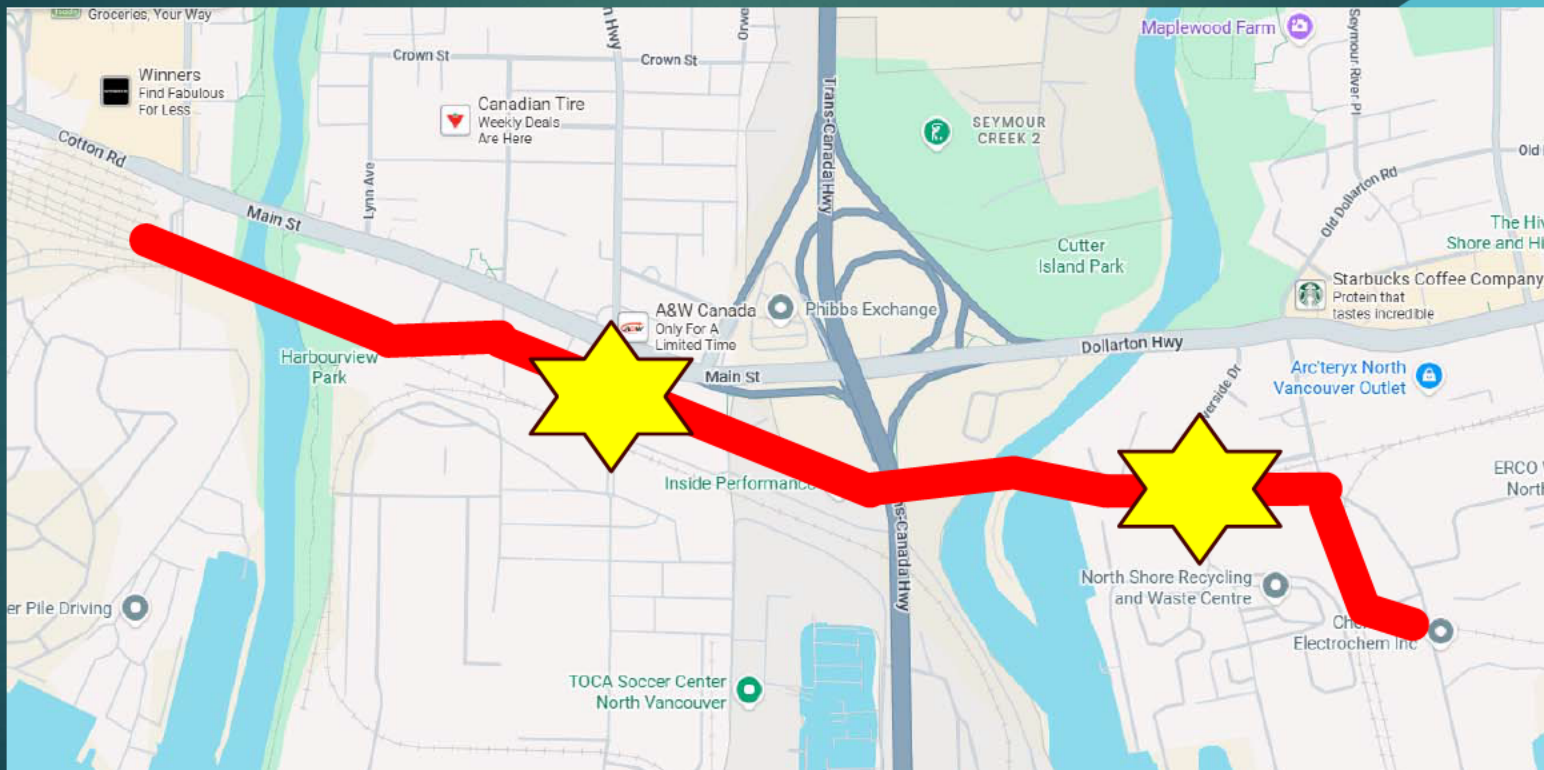
1st Concern: Chlorine in an Urban Setting. Why take such a risk?



- ▶ Chemtrade appears to be a very competent and professional company – But is producing, storing and transporting a hazardous material such as Chlorine a risk we need to take?
- ▶ I used the following software to envision what an accident would result in – ERG2024.
- ▶ DNVFRS should be familiar and expert with this software.

Transportation by rail...
I looked at Crossings at Riverside & Mountain Highway

Transportation by rail...
I looked at Crossings at Riverside & Mountain Highway



Transportation by rail...

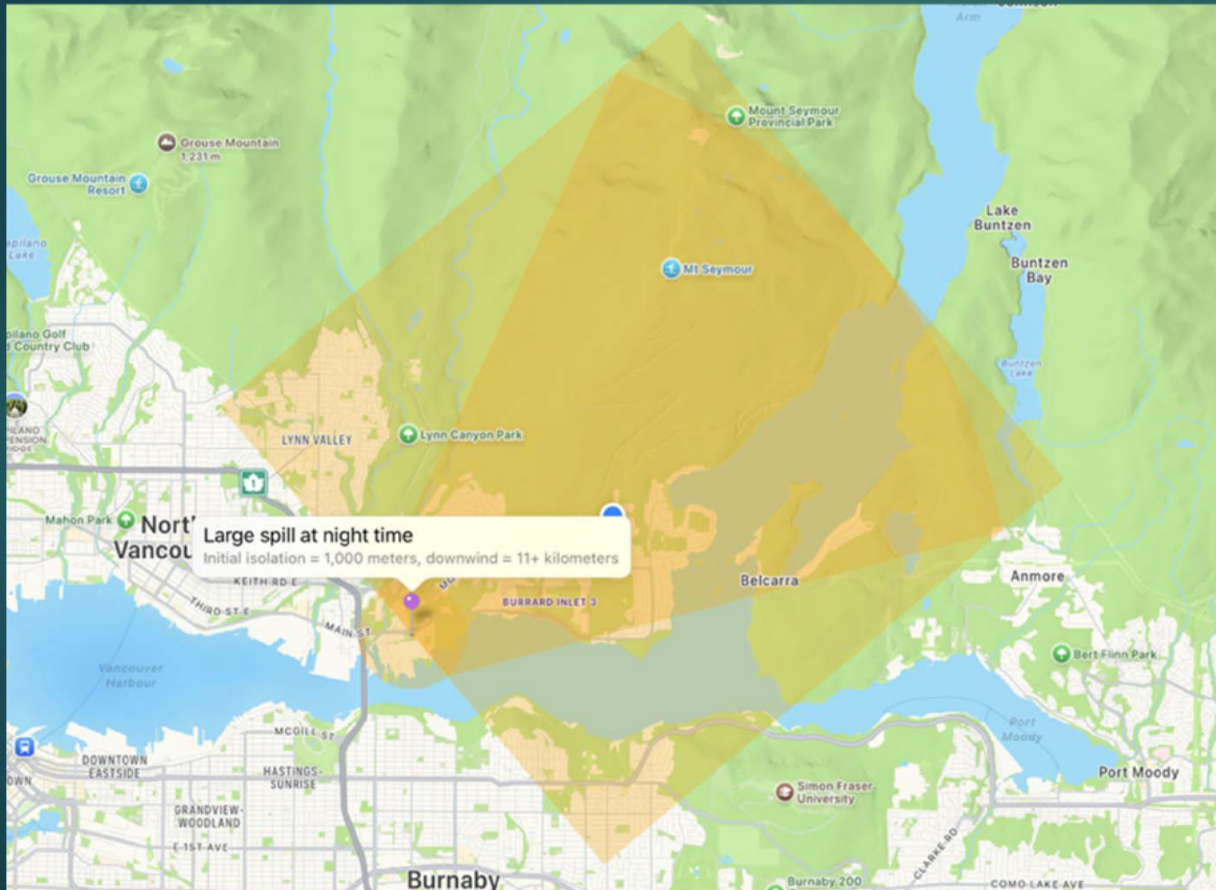
History – CN is in all of these except 3

Worst railway accidents [\[edit \]](#)

Accident ♦	Date ▾	Location ♦	Killed ♦	Injured ♦	Description ♦	Ref. ♦
Lac-Mégantic rail disaster	6 July 2013	Lac-Mégantic, Quebec	47	?	An unattended 73-car Montreal, Maine and Atlantic Railway freight train carrying crude oil rolled down the grade. On derailling in the town centre, multiple tank cars burned and exploded, destroying buildings. The locomotive engineer, rail traffic controller , and operations manager were acquitted of criminal negligence.	
Hinton train collision	8 February 1986	west of Dalehurst, Alberta	23	71	A westbound CN freight train, which ran a red signal before leaving a portion of double track , collided head on with an eastbound Via Rail Super Continental . The estimated cost of the accident was \$35 million. The three freight crew members may have been asleep or otherwise incapacitated.	[36]
Dorion level crossing accident	7 October 1966	Dorion, Quebec	19	26	An eastbound CN freight train struck a school bus on a railway crossing. The coroner's report concluded that two students on the bus, who were not expecting another train, had raised the crossing barrier after a westbound train had passed.	
Lamont bus/train crash	29 Nov 1960	Lamont, Alberta	17	25	A westbound CN freight train shattered a school bus negotiating an unguarded railway crossing. The bus driver appeared to have been blinded by the rising sun in that direction.	[34] [35]
Cane River train crash	21 November 1950	north of Valemount, British Columbia	21	58	Faulty train orders provided to a westbound CN troop train led to a head-on collision with an eastbound CN Continental Ltd . Both trains tumbled down an embankment. Most casualties occurred in the wooden cars of the troop train. A telegraph	[33]

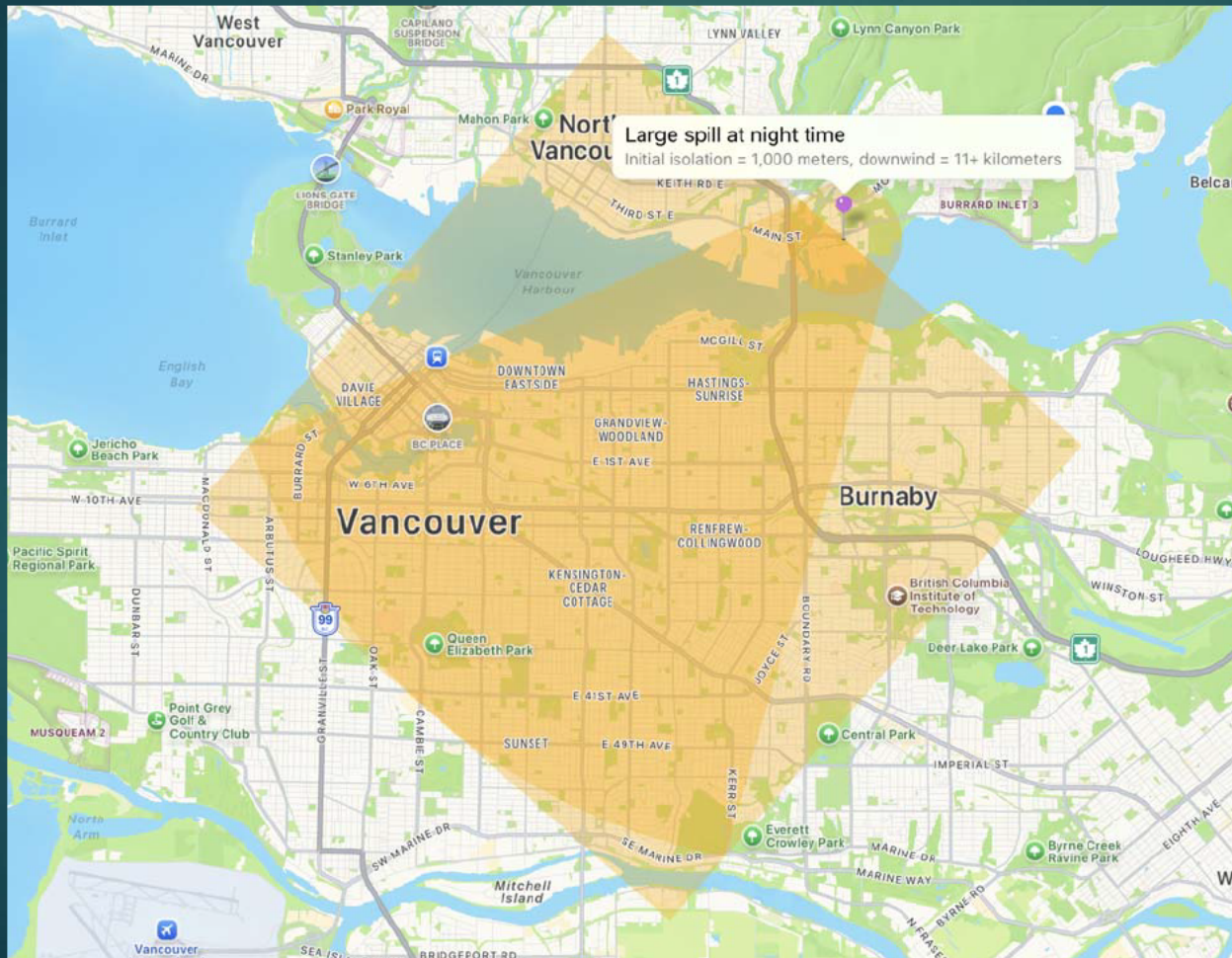
Dugald rail accident	1 September 1947	Dugald, Manitoba	31	85	A westbound CN excursion train, which failed to stop at the east switch and enter the passing track, collided head on with a stationary eastbound Continental Ltd on the main line. Gas-lit wooden cars burst into flames. Primary blame was on the westbound crew for disobeying train orders and excessive speed.	[32]
Aldershot bus/train crash	10 September 1943	Aldershot, Burlington, Ontario	12	2	When a fast eastbound CN passenger train struck a Canada Coach Lines bus stalled on the Waterdown Rd railway crossing , the bus was sliced and dragged several hundred metres. The deceased driver was found negligent.	[31]
Almonte rear-end collision	27 December 1942	Almonte, Ontario	36	155	A southeast-bound CP troop train ran into the rear of a CP local passenger train stopped at the station. The troop train conductor drowned himself before the inquest, which focussed on the absence of adequate warning devices to indicate the presence of the first train.	[30]
Louiseville truck/train crash	15 August 1936	near Louiseville, Quebec	22	12	A CP freight train sliced a truck attempting to cross the tracks, which was carrying a group returning from a political rally.	[29]
Downie snow clearing accident	2 March 1936	east of Albert Canyon, British Columbia	16	?	When a snowslide engulfed a freight train 6.8 km (4.2 mi) east of Albert Canyon, a work gang began snow removal, but the rescued tender under tow broke loose and ran back down the track. Two occupants jumped safely, but a third jumped to his death. The speeding tender plowed into the work gang causing devastation.	[28]
					operator was acquitted of manslaughter.	
					While his eastbound CN passenger train parked on a siding, a brakeman headed to Dundas to arrange	

Transportation by rail...



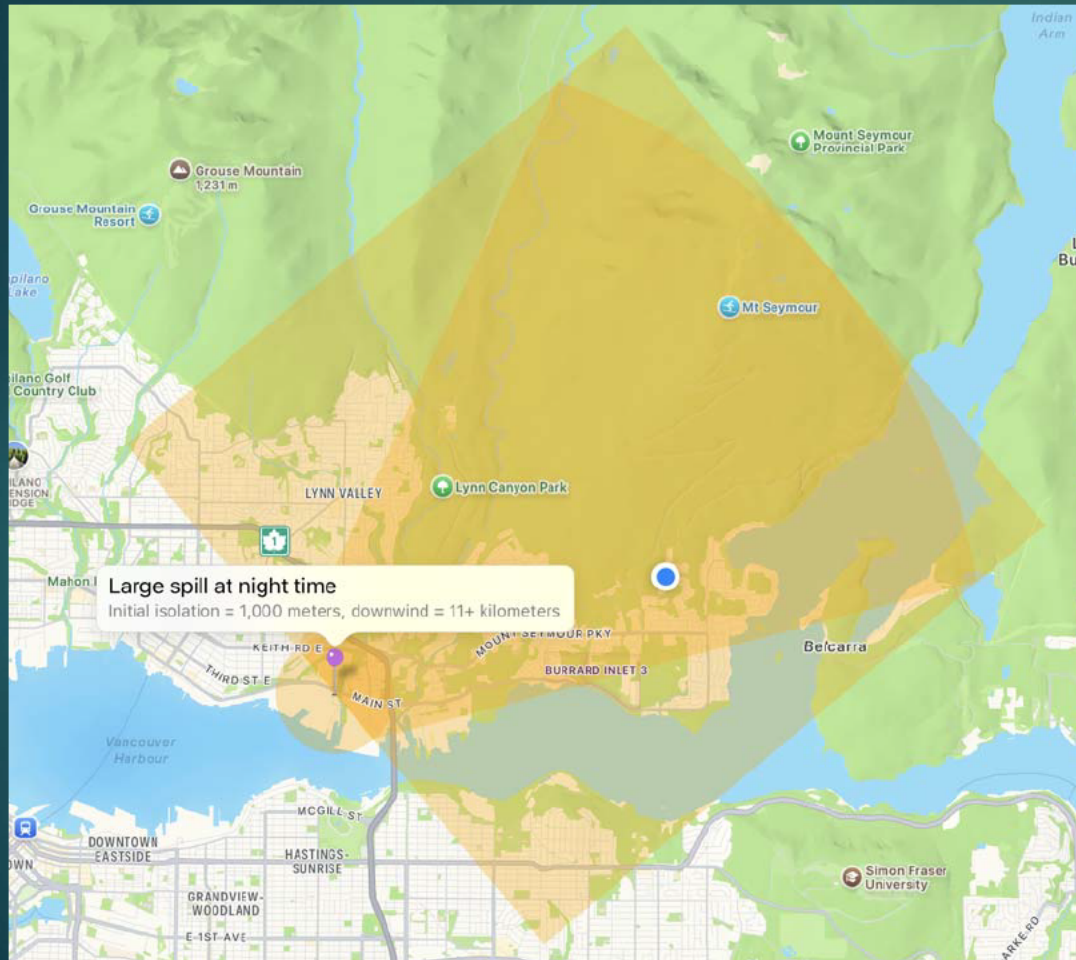
- ▶ Rail Spur and Riverside – Prevailing Summer Winds

Transportation by rail...



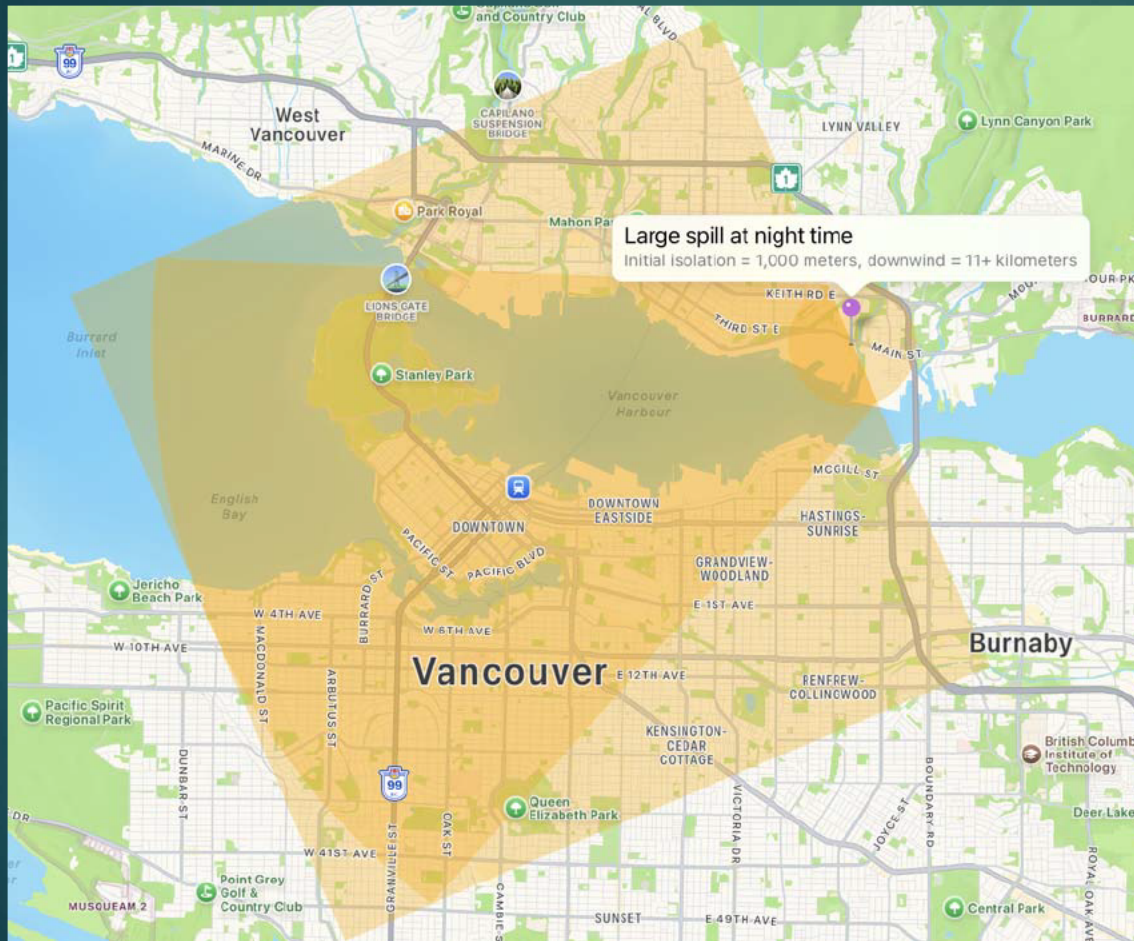
- ▶ Rail Spur and Riverside – Prevailing Winter Winds

Transportation by rail...



- ▶ Rail Spur and Mountain Highway – Prevailing Summer Winds

Transportation by rail...



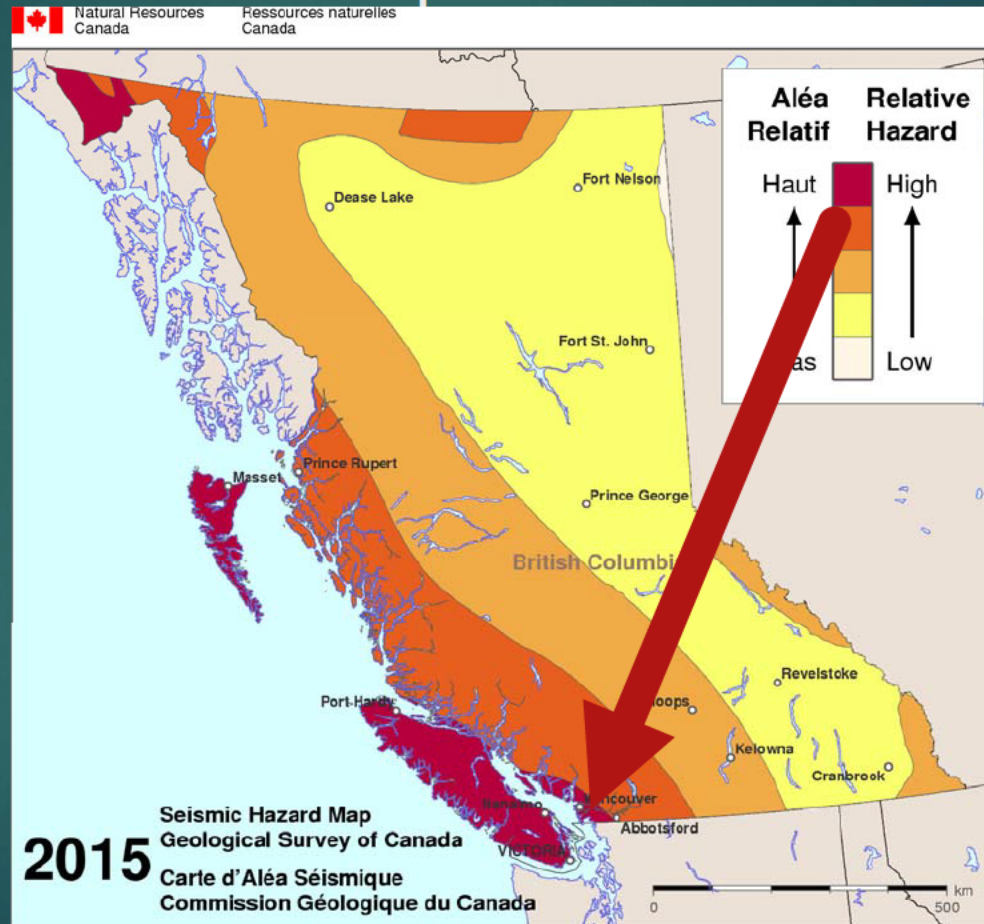
- ▶ Rail Spur and Mountain Highway – Prevailing Winter Winds

Chlorine and Hydrogen



- ▶ Chlorine – Chemical Formula = Cl (Cl_2)
- ▶ Hydrogen – Chemical Formula = H_2
- ▶ Combined: HCl (HCl) = Hydrochloric Acid

What about Earthquakes?



Wise words...

- ▶ “A prudent person foresees danger and takes precautions. The simpleton goes blindly on and suffers the consequences.”
- ▶ Written in approximately the 10th century BC.
- ▶ Proverbs 22:3

My questions:

- ▶ What would the ramifications of a rail car accident be anywhere in the DNV but outside the loading facility at Chemtrade?
- ▶ What are the laws regarding what Council may and may not consider in an application such as this?
- ▶ How many people have been injured or deceased in Chlorine Accidents in North America in the last 50 years?
- ▶ How many people have been injured or deceased in Bleach (Sodium Hypochlorite) Accidents in North America in the last 50 years?

2nd Concern: Why are we focussing on Chlorine when the Seymour Water Filtration Plant uses BLEACH?



Oxidizing gases - Category 1



Acute toxicity - inhalation - Category 2



Skin corrosion/irritation - Category 1



Serious eye damage/eye irritation - Category 1

The signal word is danger.

The hazard statements are:

- May cause or intensify fire; oxidizer
- Corrosive to the respiratory tract; Fatal if inhaled
- Causes severe skin burns and eye damage

2nd Concern: Why are we focussing on Chlorine when the Seymour Water Filtration Plant uses BLEACH?



[Home](#) → [OSH Answers Fact Sheets](#) → [Chemicals and Materials](#) → Bleach (Household chlorine) - Working Safely

Chemicals and Materials

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Bleach (Household chlorine) - Working Safely

On this page

[What is household/chlorine bleach?](#)

[Why should I be careful when working with bleach?](#)

[Why is bleach useful?](#)

[What are some steps to take to work safely with bleach?](#)

[What do I do if I splash bleach in my eyes or on my skin?](#)

What is household/chlorine bleach?

[Back to top](#)

Bleach is a chemical that is diluted and sold for household use. It is a mixture of water and the chemical sodium hypochlorite. For uses in the home and many workplaces, it is usually sold with concentrations of sodium hypochlorite present at a range from about 3 to 9 percent.

Note that industrial uses can use concentrations of sodium hypochlorite at 30% or higher. This document does not cover the safe use and handling of bleach at high concentrations.

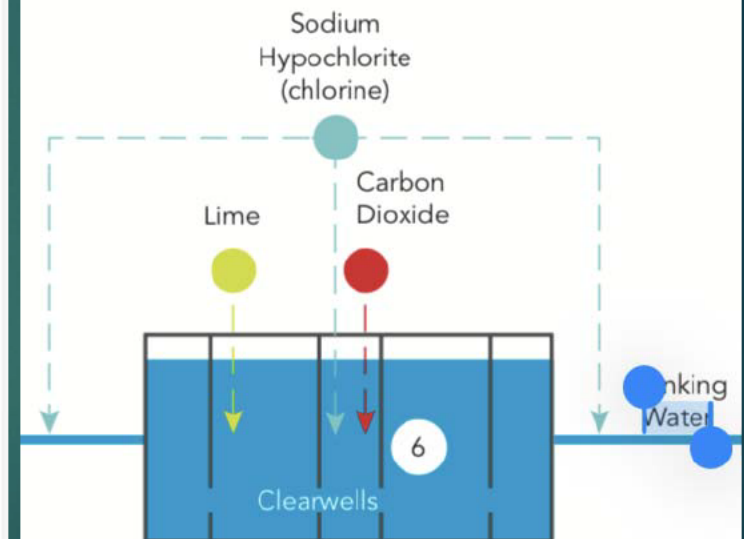
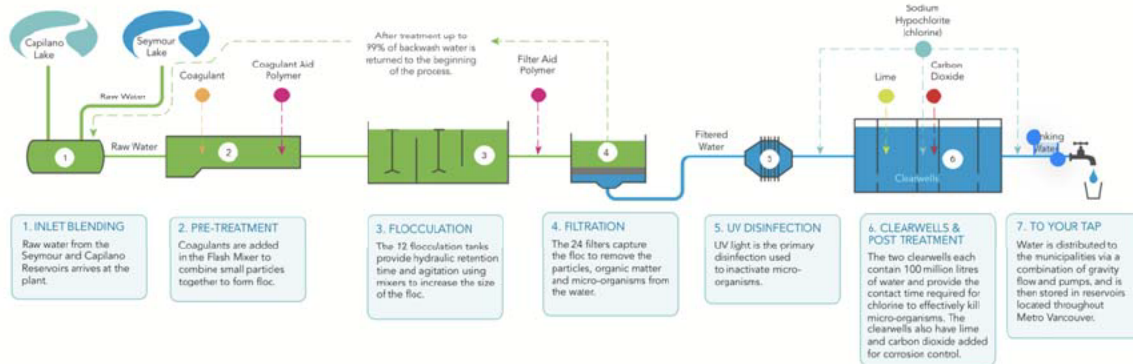
Why should I be careful when working with bleach?

[Back to top](#)

Bleach is corrosive, which means the liquid can irritate or burn your skin or eyes. It can also corrode ("eat") metals. The vapours may also cause irritation or damage to the throat (esophagus) and lungs. When mixed with certain other chemicals or cleaners, it can produce toxic gases, which can damage your lungs or be deadly. Always use caution and care when working with this product.

2nd Concern: Why are we focussing on Chlorine when the Seymour Water Filtration Plant uses BLEACH?

THE PROCESS OF WATER FILTRATION



From Metro Vancouver's Seymour Capilano Filtration Plant Brochure - 2016

So it seems that sodium hypochlorite is a powder that you add water to that makes it bleach?...

Google

what is sodium hypochlorite

AI Overview

Sodium hypochlorite ($NaOCl$) is a strong, alkaline chemical compound primarily used as the active ingredient in household bleach, disinfectants, and water purification agents. Appearing as a pale greenish-yellow liquid, it acts as an effective germicide and whitening agent, frequently used in concentrations of 3% to 6% in homes and up to 15% for industrial applications. [Wikipedia](#) +4

Key Details and Uses

- **Composition:** It is an inorganic salt, often produced by reacting chlorine with a solution of sodium hydroxide.
- **Household Use:** Commonly known as liquid bleach, it is used for disinfecting

Show more

People also ask

Is sodium hypochlorite the same as bleach?

Sodium Hypochlorite on its own is the powder substance used to create liquid bleach, and bleach is a liquid disinfectant and whitening agent made by combining sodium hypochlorite with water. Oftentimes, sodium hypochlorite is just referred to as bleach, as liquid bleach is the most common use of sodium hypochlorite. Aug 13, 2021

Ecolink, Inc.
<https://ecolink.com/info/sodium-hypochlorite-vs-bleach/>

Sodium Hypochlorite VS Bleach - Ecolink, Inc.

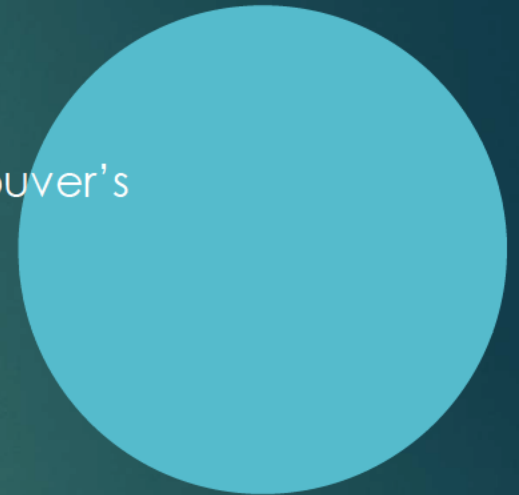
What is the common name for sodium hypochlorite?

My questions:

- ▶ Why does Metro list Chlorine beside the Chemical Name “Sodium Hypochlorite” in their brochure? It seems Bleach, Sodium Hypochlorite and Chlorine are related but not the same thing?
- ▶ Is this a lack of understanding on Metro's Part? Or an effort at propaganda?
- ▶ Which clients in BC buy the pure liquid Chlorine that Chemtrade produces? How much do they buy? What portion of Chemtrade's total production?
- ▶ Wouldn't it make more sense to produce the powder form Sodium Hypochlorite?

3rd Concern: A little history...

- ▶ The Chlorine Plant was established in DNV in 1957.
- ▶ In the 1956 Canadian Census, the District of North Vancouver's population was 26,252.
- ▶ In 2025 our population was an estimated 97,845.
- ▶ That's 372% more population than 1957!
- ▶ In 1957, DNV was mostly RURAL/Industrial.
- ▶ In 2026 DNV is mostly URBAN.



A little history - continued

- ▶ In November 2017 – DNV Presented the Maplewood Village Centre and Innovation District Plan. We, the people, asked “How does it make sense to put residential higher density development next to a Chlorine Plant?”. We were told “don’t worry about it – Chlorine Production will cease by 2030”.
- ▶ For each and every development proposal in Maplewood since, we, the people, asked “How does it make sense to put residential higher density development next to a Chlorine Plant?”. We were told “don’t worry about it – Chlorine Production will cease by 2030”.
- ▶ When DNV presented the new FRS HQ building in Maplewood, We, the people, asked “How does it make sense to put residential higher density development next to a Chlorine Plant?”. We were told “don’t worry about it – Chlorine Production will cease by 2030”.

A little history - continued

- ▶ When DNV first proposed the Riverside Metro Housing Project, we, the people, asked “How does it make sense to put residential higher density development next to a Chlorine Plant?”. We were told “don’t worry about it – Chlorine Production will cease by 2030”.
- ▶ At every point, at every turn, at every incident, we raised concerns about putting PEOPLE next to liquid Chlorine production. And DNV Staff and Council patted us on our little heads, sent us off to sleep and said “don’t worry your pretty little heads – Chlorine will stop by 2030”.
- ▶ If this Council approves this, in an election year, you will be admitting you lied to us all those previous times.

My questions:

- ▶ Why does Premier Eby, and MLA Chant suddenly inject themselves into our District? Eby has pretty much been against us at every turn, and Chant has “opted out” of every local issue except health care – until now.
- ▶ How many projects and how many times did DNV Staff and Council tell the public that Chlorine Production would cease by 2030?
- ▶ How many decisions were made by Council in the last 10 years that were contingent on this original promise?

My last questions:

- ▶ Given that:
- ▶ Metro uses Bleach at the Seymour Water Filtration Plant,
- ▶ Metro is mis-informing us that bleach (sodium hypochlorite) IS Chlorine,
- ▶ The Province is trying to get us to continue with this risk venture,
- ▶ And that the risks of this type of production and transportation are not ZERO...
- ▶ 1) Is this not another case of Metro and the Province sticking it to DNV residents and giving us more than our share of costs and more than our share of risks, while other people get the benefits? (another WWTP all over)
- ▶ 2) Why take on risks for which we don't get any benefit?
- ▶ 3) Does Chlorine Production make sense in an Urban Environment in 2026?



“A prudent person foresees danger
and takes precautions. The
simpleton goes blindly on and
suffers the consequences.”

Proverbs 22:3

From: DNV Input
Sent: February 24, 2026 6:16 PM
To: DNV Input
Subject: ChatGBT data re Chlorine gas Vs Bleach to purify water.

Follow Up Flag: Follow up
Flag Status: Completed

From: Catherine Pope <popec@dnv.org>
Sent: February 24, 2026 3:32 PM
To: [REDACTED] Mike Fox <foxm@dnv.org>
Cc: Dan Milburn <milburnd@dnv.org>
Subject: Re: ChatGBT data re Chlorine gas Vs Bleach to purify water.

Sorry - here's the rest of the link. And obviously, this would all need to be fact checked.
https://chatgpt.com/s/t_699e34a807b88191826b68534fe59252

Get [Outlook for iOS](#)

From: Catherine Pope <popec@dnv.org>
Sent: Tuesday, February 24, 2026 3:28:12 PM
To: [REDACTED] Mike Fox <foxm@dnv.org>
Cc: Dan Milburn <milburnd@dnv.org>
Subject: ChatGBT data re Chlorine gas Vs Bleach to purify water.

Hi all. Some very interesting data here.
Cole's notes: Most water treatment plants in Canada are now using bleach instead of chlorine gas) to purify water, because it's safer.
Significantly , Coquitlam switched to bleach for safety reasons.
AND the NSWWTP will not be using either. Instead, it will use an ultraviolet process , as it's better for the environment

Catherine

https://chatgpt.com/s/t_699e323ed9b881919f77c554f9eccc05

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From: DNV Input
Sent: February 24, 2026 6:17 PM
To: DNV Input
Subject: ChemTrade and chlorine vs bleach
Attachments: Chemtrade Rezoning Application Feb 5 26 - Bullets.pdf

From: Catherine Pope <popec@dnv.org>
Sent: February 19, 2026 2:03 PM
To: Dan Milburn <milburnd@dnv.org>
Cc: [REDACTED]
Subject: ChemTrade and chlorine vs bleach

Hi Dan. This is an aspect of the project that I don't have any background or info on.

Can you please provide and share w Council?

I'd like to know if this claim is factually correct, whether the chlorine is being shipped to another plant that turns it into bleach and whether it is then used by municipalities in B.C. for drinking water?

Is Chemtrade an outdated technology ?

I have also not seen any info on what the dangers are regarding rail transport of chlorine. Was any of this covered by the independent safety report?

And finally, could the Chemtrade plant be converted to a technology that converts chlorine to bleach? Could we suggest it, if it makes sense.

Thanks
Catherine

Thanks
Catherine

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Chemtrade Rezoning Application 100 Amherst Avenue, North Vancouver



- Chlorine is no longer necessary for water treatment.
 - From Chemtrade's very own Website: **"Chemtrade supplies Chlorine to producers and repackagers of sodium hypochlorite (bleach), who in turn supply municipalities where the product is used to ensure both safe drinking water and clean wastewater."**
www.chemtradelogistics.com/product/chlorine/
- Chemtrade **NEEDLESLY** ships over 1,000 toxic railcars full of chlorine each year - travelling through North Vancouver and the Lower Mainland, thus exposing millions of residents—and "Canada's Most Livable City" — to potentially deadly risk and ruinous generational financial liability.
- Bleach (Sodium Hypochlorite) is now regularly used for water treatment. Over 90% of water systems—including those in BC—have transitioned to safer, non-toxic Bleach (Sodium Hypochlorite).
- Bleach (Sodium Hypochlorite) represents NO toxic safety shipping hazard.
- Using common practices and readily available equipment Bleach (Sodium Hypochlorite) is being made all over North America WITHOUT shipping toxic chlorine railcars for water treatment.
- Transport Canada says: "Chlorine is a toxic gas that can present a serious risk to public safety if released... The potential for derailments, punctures, and releases of toxic gases being key risk factors in dangerous goods transport safety discussions." <https://tc.canada.ca/en/dangerousgoods/newsletter/june2017>, https://tc.canada.ca/sites/default/files/migrated/top_10_asks_oct_2017.pdf
- Chemtrade could eliminate all toxic chlorine rail shipments entirely by producing Bleach (Sodium Hypochlorite) on-site - using proven, off-the-shelf equipment that's been in market for over 50 years – Instead of shipping toxic chlorine railcars.
 - This regularly used - solution called a Powell System would cost approximately \$5 million and could easily integrate into Chemtrade's processes.
- If Chemtrade was to eliminate its toxic chlorine railcar shipments, **it would lose NO jobs**. Chlorine sales could be replaced with Bleach (Sodium Hypochlorite) sales. And Chemtrade could continue to make and sell all of its other products.
 - Jobs would be saved.
- While Chemtrade may control safety within its facility, it has no control once over 1,000 railcars full of toxic chlorine railcars leave its site.
- Chemtrade is now proposing only a reduction in its chlorine storage, not an elimination of the chlorine railcars it ships. Chemtrade is ignoring approximately 3,000+ tonnes of toxic chlorine it holds and ships in railcars = over 1,000 toxic chlorine rail cars shipped each year through North Vancouver and the Lower Mainland.

If a Safer, Proven, and Affordable alternative is already regularly used by industry and utilities, why does **Chemtrade need to continue to transport toxic chlorine** through BC's communities?

Money!!!

Chemtrade would lose a small portion of sales that came from shipping their toxic chlorine railcars for consumption in the USA. NOT locally. All major water treatment facilities in Canada already use Bleach... As do most in North America.

From: J. Peterman [REDACTED] >
Sent: February 24, 2026 6:55 PM
To: DNV Input
Subject: Chemtrade's Rezoning Application in the District of North Vancouver
Attachments: February 24 2026 -- Support of Chemtrade.pdf

EXTERNAL: Do not click links or open attachments unless you trust the sender and content.

Dear Mayor and Council:

I am writing as a District of North Vancouver resident **in support** of the rezoning application for Chemtrade's chlor-alkali facility on the waterfront in the District of North Vancouver. As a member [REDACTED], I toured the site in August 2025. I was deeply impressed by its safety culture, operational scale, economic contributions and the strategic importance it plays in safeguarding drinking water for millions of Canadians.

Chemtrade's North Vancouver facility is a critical national asset. It produces up to 70% of the chlorine used in Western Canada and roughly 40% of the liquid chlorine available nationally—an essential chemical that is relied on by 96% of Canadian municipalities to safely treat drinking water. Without this domestic production, Canada would struggle to ensure safe and reliable municipal water treatment at scale.

If Canadian supply were disrupted, our country would become heavily dependent on U.S. chlorine imports at a time when American producers face their own constraints, including plant closures and regulatory changes that may reduce output by up to 30% before 2029. In such conditions, U.S. domestic demand will take priority, leaving Canada vulnerable to supply shortages, higher costs, and trade uncertainty. The District of North Vancouver plays an outsized role in Canada's trade ecosystem by hosting critical trade-related industrial operations like Chemtrade. As a former staff member in the federal government's Minister of International Trade Office in Ottawa, I know firsthand how essential market diversification and secure domestic production are to protecting Canada's economic resilience and supply chain sovereignty.

Safety Standards and Upgrades

Chemtrade has operated safely on this site since 1957 and has invested more than \$500 million since 2010 to modernize the facility. It is highly automated, continuously monitored, and equipped with 72 chlorine sensors capable of detecting concentrations as low as 0.1 ppm. Storage volumes have been reduced by over 94%—from 1,600 tonnes historically to 93 tonnes today—with plans to transition further toward a near “manufacture-and-ship” model that could eliminate bulk storage almost entirely. Planned upgrades by the facility, including sealed rail loading systems and seismically activated shutoff valves, will further enhance community safety, with updated risk assessments indicating that any potential impact would be contained near the property line.

Rail Safety

In terms of rail safety, Chemtrade uses purpose-built chlorine railcars compliant with strict federal and provincial hazardous materials regulations. These cars feature thicker-than-standard steel walls, strategically reinforced structural zones, and advanced puncture-resistant protections designed to withstand extreme conditions. Each railcar is also outfitted with upgraded valves and fittings that reduce the likelihood of leaks and enhance overall containment integrity.

The nearly 300 dedicated chlorine railcars leased by Chemtrade undergo a rigorous four-stage inspection cycle while on site—once upon arrival, again before loading begins, immediately following loading, and a final check before the car is cleared for departure. This layered verification process ensures the cars remain in top mechanical condition throughout their time at the North Vancouver facility.

The North Vancouver facility has never experienced a transportation-related chlorine release. Railcar failures in North America are extremely rare, and significant regulatory improvements since 2005 have strengthened tank car design, routing protocols, inspections, and emergency planning. Chemtrade employees are part of the elite chlorine spill response team – CHLOREP – which respond to chlorine spills across Western Canada, regardless of the cause of the spill, or the product manufacturer.

Jobs for the North Shore

Economically, the facility employs 118 full-time workers, contributes more than \$23 million annually in payroll, pays approximately \$3.7 million in District taxes and \$2.7 million in municipal water fees, and generates roughly \$140 million in economic activity through suppliers and contractors. It is also one of BC Hydro's largest industrial customers in B.C.

For all these reasons, I respectfully urge Council to support the rezoning application. Enabling Chemtrade to proceed with its modernization plans will protect Canada's drinking water supply, strengthen national supply chain independence, preserve local jobs, and enhance public safety—outcomes that are aligned with the long-term interests of the District of North Vancouver and the country as a whole.

Thank you for your consideration. Please confirm receipt.

Sincerely,

Joshua Peters



From: Jesse Wheeler <[REDACTED]>
Sent: February 24, 2026 7:20 PM
To: DNV Input
Subject: Re 100 Amherst ave

EXTERNAL: Do not click links or open attachments unless you trust the sender and content.

Good evening. I'm writing in support of renewing the operating permit for Chemtrade.

Canada already manufactures very little. If this plant is shut down, another facility will not be built in a different location, we'll simply import chlorine and other industrial chemicals from the U.S. or China, exporting both jobs and environmental oversight.

This facility has an excellent safety record, and with a renewed permit has committed to reducing on-site chlorine storage and filling rail cars inside a new building to further contain any potential leaks.

Finally, the plant provides about 150 high paying jobs on the North Shore, and because these are shift work positions, they don't add to the already busy roads during normal rush hour.

Renewing this permit supports safety, good local jobs, and responsible Canadian manufacturing. Thank you

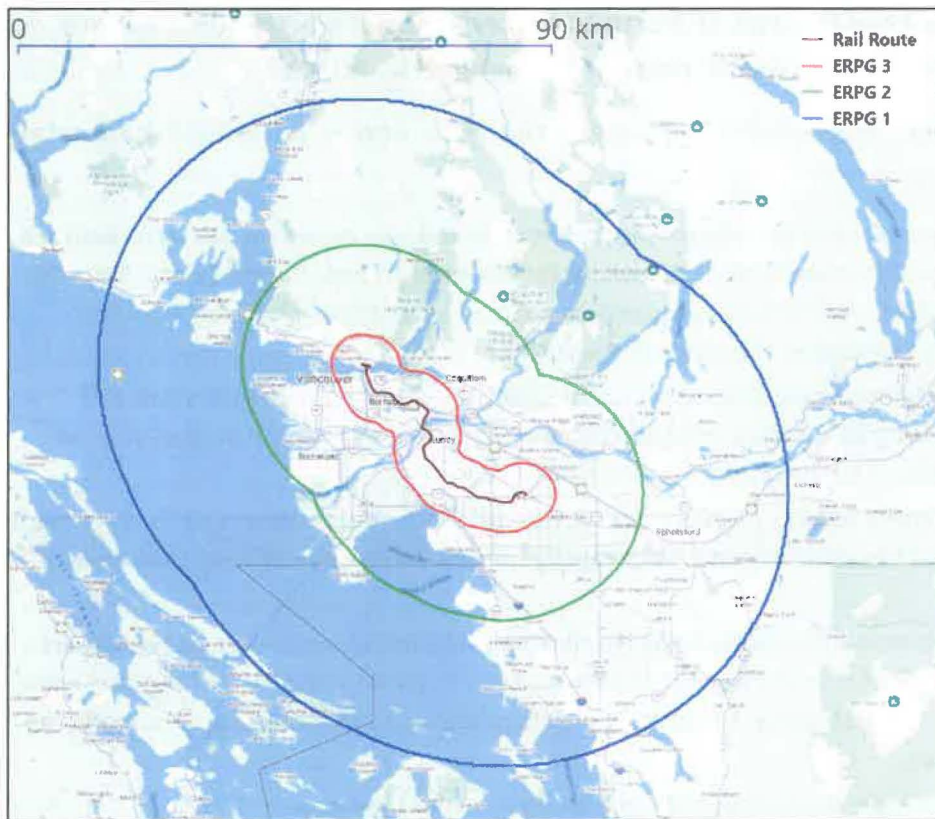
Overall Determination

Transporting chlorine through the District of North Vancouver poses a high-consequence risk to the public, which is not tolerable based on risk criteria defined by MIACC.

Converting chlorine to bleach onsite would eliminate the risks and is an established safety strategy used by the industry.

- The following summarizes an extensive Risk Assessment report written by industry experts at AcuTech. **AcuTech authored the Center for Chemical Process Safety's Guidelines for Chemical Transportation Safety, Security and Risk Management (2nd Edition).** AcuTech assesses hazards and risks of hazardous chemical production, storage, and transport- they have conducted thousands of risk studies.
- This study evaluates the public **consequences and risks** associated with the **storage and transportation of chlorine railcars** produced at Chemtrade's facility in North Vancouver. It also analyses bleach production as an alternative to pure chlorine, as bleach is most widely used for water treatment.
- Chlorine is classified as an **"extremely hazardous substance"** (EHS) due to its acute inhalation toxicity. Each railcar can carry up to 82 metric tonnes of liquefied chlorine, which **rapidly forms a dense, ground-level toxic cloud if released.**
- A **consequence-based** analysis is most informative and useful for emergency response planning, as **responders must prepare for credible catastrophic scenarios** that could overwhelm emergency response, or threaten entire neighborhoods. Likelihood-based or **probability-based assessments provide an understanding of how soon an event may be expected to occur.**
- **Derailments happen regularly**, and are the leading cause of hazardous-material releases.
 - Since 1995, at least **four chlorine rail accidents** have caused **13 fatalities and 300+ hospitalizations.**
 - Accident rates tend to be higher on **low-speed urban rail lines**, similar to those in Vancouver.
- Moving storage (railcars) is more vulnerable and offers **significantly more risk** vectors than static bulk storage
- While the proposed liquid chlorine loading building is designed to mitigate risks while loading onsite, the loaded railcars are shipped through the city without containment to mitigate the risks.
- Modeling of credible accident scenarios indicates that:
 - **A single major chlorine release could generate a toxic vapor cloud estimated to cause up to 2,000 fatalities.**
 - **Thousands of additional residents would require evacuation.**
 - The hazard zone includes **hundreds of sensitive locations such as schools, hospitals, childcare facilities, senior residences, and dense housing.**
- Current chlorine transport conditions present **intolerable risk levels** (as defined by MIACC) and a credible potential for catastrophic public harm that **warrant action to eliminate or reduce the risks.**
 - These risk results incorporate mitigating factors that reduce the risks of chlorine transport by rail, such as robust tank designs and rail speed limits, but **despite these factors, the risks levels are intolerable.**
- Producing **bleach** (sodium hypochlorite) onsite could **eliminate liquid chlorine** in railcars, and **eliminate the risk of catastrophic toxic hazards.**

Impact Zones for Single Railcar Release Events Along the Rail Line

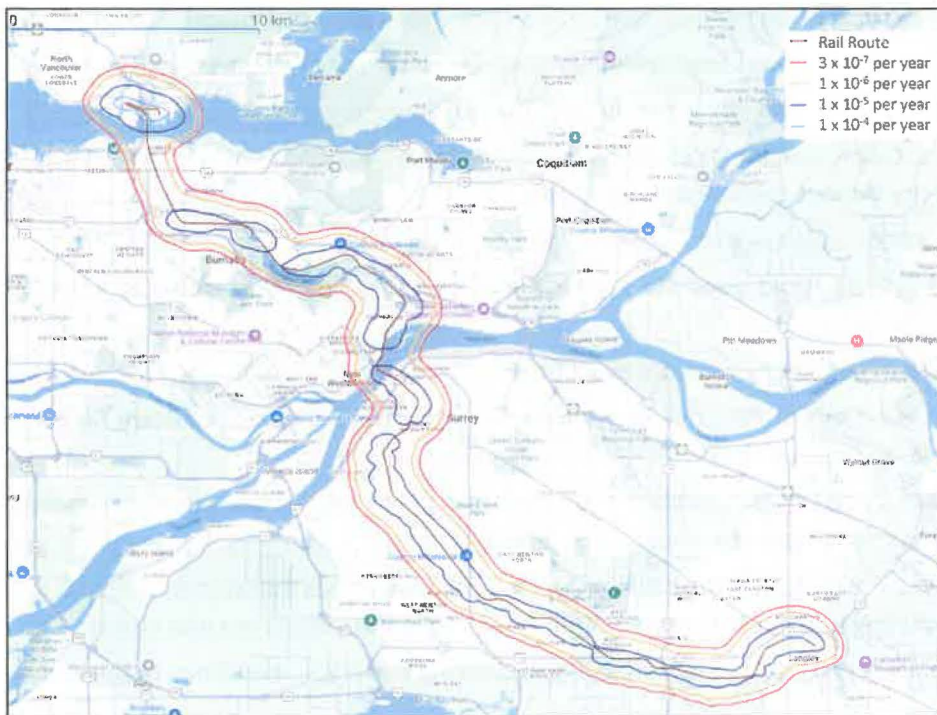


Emergency Response Planning Guidelines for Chlorine

20 ppm - ERPG-3 - life-threatening health effects

3 ppm - ERPG-2 - serious, irreversible health effects or symptoms which could impair an individual's ability to take protective action

1 ppm - ERPG-1 mild, transient health effects, a clearly defined objectionable odor



Toxic Risk Contour for Chlorine Railcars

MIACC Criteria

100 in a million (1×10^{-4}) - Tolerable limit for manufacturing, warehousing and open space

10 in a million (1×10^{-5}) - Tolerable limit for low-density residential and commercial

1 in a million (1×10^{-6}) - Tolerable limit for high-density residential and commercial

0.3 in a million (3×10^{-7}) - Tolerable limit for sensitive developments, such as childcare facilities and hospitals

Liquid Chlorine Rail Car Release



Hello

I am here to speak direct about Emergency Response to Chlorine Release from Rail Cars

My Name is Chris Bowcock

I served with the City of Burnaby Fire Department for 30 years

The last (4) of which I held the position of Fire Chief

I have been actively involved in industrial emergency management planning in the public and private sector for 25 years

On several occasions the Province of BC has utilized my Emergency Response expertise related to the Industrial Interface

As a young man of 18 years old I worked in a Chlor-Alkal Plant in Squamish BC

Liquid Chlorine Rail Cars



- Pure Chlorine Cl_2
- Inside the Rail Car at pressure: Liquid
- During Release expands 460:1 Gas
- **Poses a significant risk to Life**
- Massively Expanding Gas
- Incapacitating Victims

**The Volume of Gas from a Rail Car
Is a Gas Cloud equal to the size of a WalMart Store**

Scope of Release – Rail Car



2004/2009 report and testimony to the
US House Homeland Security Committee

Modelled - Chlorine rail car rupture
in densely populated Washington, DC area
could result in:

- 17,500 fatalities
- 10,000 severe injuries,
- 100,000 hospitalizations, and
- 40 km downwind chemical exposures

Emergency Planning

Focuses on the
Most credible worst-case scenario

The 2004/2009 report to US House Homeland Security Committee
Focused not on probability, but on consequence and impact

18,000 usgal rail cars = 8.3M usgal Chlorine gas

15 usgal release would require (Chlorine Cylinder)
x25 the air volume in BC Place Stadium to dilute to safe levels

The chlorine gas is 2 ½ times heavier than air
It will form high concentration areas low to the ground
dissipate much slower

North Shore Rail Car Release - Scope

Washington DC - Dense Urban
by Study

North Shore - Urban Population Center
by extrapolation to scale

Population Density:
4,440 per km²

Population Density:
550 per km²

- 17,500 potential fatalities

- **2,000 potential fatalities**

- 10,000 severe injuries

- **1,230 severe injuries**

- 100,000 hospitalizations

- 12,300 hospitalizations

- 40 km downwind exposures

- 40 km downwind exposures

**The DC Study has to be taken in context of differing population densities
As the North Shore is far less dense
But the population present on the North Shore in proximity to a release
Is just as vulnerable, just at a smaller total number**

1% Fatality Rate is based on a 10 minutes exposure @ 103 ppm Cl₂

DC pop 672,000 to 702,000

Density 4,440 people per square km as of 2024

DNV pop 88,168

Density 548.8 people per square kilometre

Broader Area Growth:

7,500

3,000 Residential, 4,500 Commercial

The Maplewood Village Centre is targeted for at least 300 new non-market housing units,

while the surrounding Innovation District is anticipated to add roughly 900 residential

units.

= 2,700 residential

The Maplewood Village Centre Plan overall targets the creation of 100,000 square feet of

commercial space and roughly 4,500 new jobs by 2030 to support the growing population.

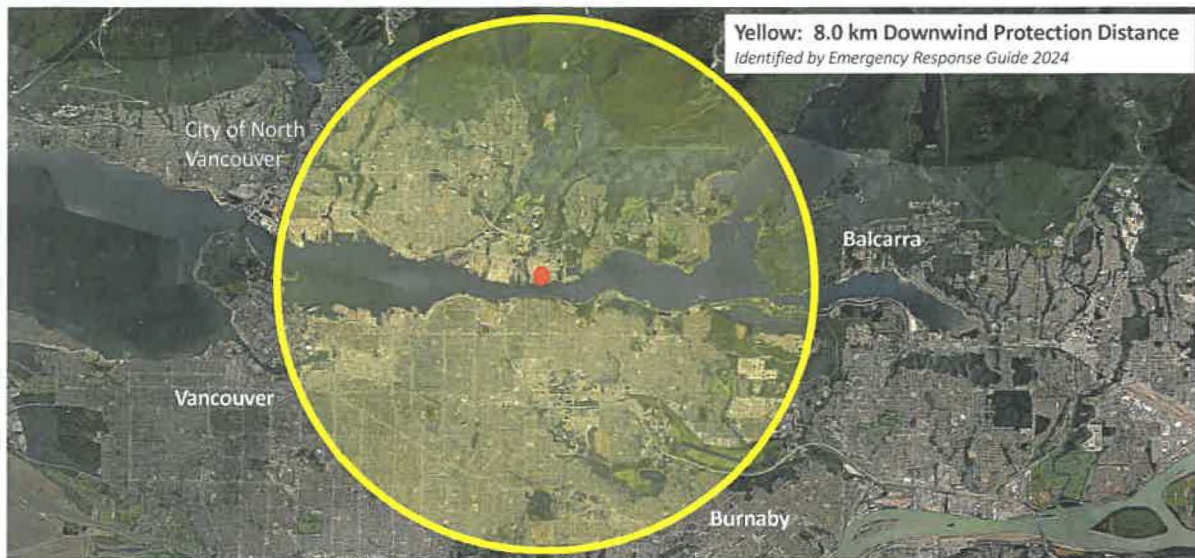
Inhalation Hazard – Day Time



**The minimum downwind protection zone
For a Chlorine Rail Car Release
3.5 km during Day Time**

**Note that depending on wind direction and strength
the downwind protection areas include
most of Eastern DNV
Lands of the TWN
2nd Narrows Bridge
Parts of East Vancouver
Most of North Burnaby**

Inhalation Hazard – Night Time



**The minimum downwind protection zone
For a Chlorine Rail Car Release
8.0 km during Night Time**

**Note that depending on wind direction and strength
the downwind protection areas include
most of DNV**

TWN

2nd Narrows Bridge

Portions of Balcarra

All of East Vancouver into Downtown

Most of Burnaby

Mass Casualty Incident



Based on:

- Hazardous Materials – Mass Casualty Event
- 3:1 minimum Work Cycle required for extended SCBA operations

Within the Urban Density of a Population Center

- Magnitude of the Emergency Response:

Firefighters	150
Paramedics	50
RCMP Officers	30

**The Emergency Response to limit fatalities and injuries to citizens
Is extremely large in scope**

The scale is significant based on the number of lives at risk

At a minimum requiring resources from:

All the North Shore	(52 On-Duty)
Vancouver	(155 On-Duty)
Burnaby	(62 On-Duty)

Fire Operations will include:

Evacuations
Search & Rescue
Perimeter Air Monitoring
Mass Scale Decontamination
Hazardous Materials Entry Teams

BCAS Operations will include:

Medical Triage
Field Medical Treatment

Rapid Medical Transport to Hospital

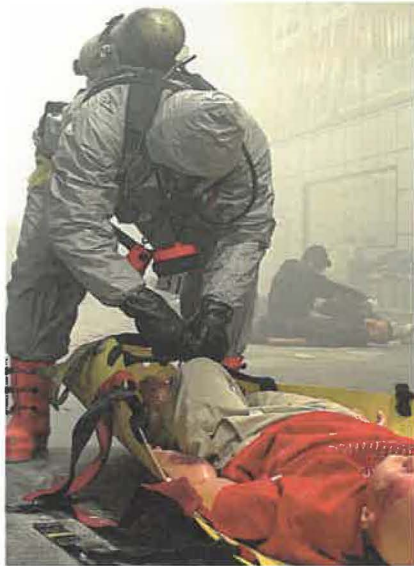
RCMP Operations will include:

Site Law Enforcement

Evacuated Area Security

Citizen Interface

Respiratory Threat of Chlorine Gas



Immediately Fatal	1,000 ppm Cl₂
Lethal in 30 minutes	450 ppm
1% Fatality in 10 minutes	100 ppm
Breathing Difficulty causing Death:	30 ppm
Immediately Dangerous to Life & Health:	10 ppm

ppm: parts per million

The human impact of Chlorine Gas
Rapid prevents breathing

The very low amounts of Chlorine in air that create a fatality risk
Are notable
And limit the victim's ability to escape the release area

The significant life risk: victims unable to self-evacuate from release area due to respiratory distress

Incapacitation of victims: difficult breathing & suffocation, impaired vision, severe vomiting & pain

Lung Damage: Can be Immediate and Irreparable

Acid-Chemical burns occur: At moist skin surfaces in lungs, throat, eyes, nose, wet skin

Requiring decontamination by flushing with water, high flow oxygen, and rapid transportation to hospital

Victims Unable to Escape without Rescue



Mass Casualty Incident with victims requiring:

- Decontamination
- High Flow Oxygen
- Rapid transportation to hospital
- Respiratory distress requiring **Rescue & removal by firefighters**
- Difficult breathing, leading to suffocation
- Impaired vision, severe vomiting & pain
- Chemical burns:
Lungs, Throat, Eyes, Nose, Moist Skin
- Lung Damage:
Can be Immediate and Irreparable

**For many exposure at early concentrations of Chlorine Gas
They may rely on Firefighters Rescue and removal
to survive the exposure**

All will require escape for the release area – immediately

Most victims will require rapid transport to Hospital for treatment

I hope this presentation helps you better understand:

- The **Incident Scope** of a Chlorine Rail Car Release
- The **Medical Threats** citizens will be exposed to
- The **Magnitude** of the Emergency Response
- The **Fatality Risks** of a Chlorine Gas Release

**A Mass Casualty Incident
involving a Chlorine Gas release
Is a Major Community Emergency incident**

One that effects many lives, and is expect to include multiple fatalities

**To prevent the loss of lives, First Responders and Public citizens themselves
will be at great risk of lasting personal injury**

**From a Risk-Benefit perspective
Liquid Chlorine Rail Car has far too much Risk
considering that Bleach is widely used in water treatment for decades
At a greater community Benefit**

SUBMITTED AT THE

FEB 24 7 32 PM

PUBLIC HEARING

Mayor and Members of Council,

My name is Colin Metcalfe and I am the [REDACTED]

[REDACTED]. But I am not here tonight in that capacity. I am here as a concerned Northshore resident. I am here tonight on behalf of those families, seniors, and children who live in our neighbourhood — and on behalf of future residents who will one day call the District of North Vancouver home.

I am speaking in **strong opposition** to the proposed rezoning that would permit, in perpetuity, the continued manufacture of **liquid chlorine** at the Chemtrade facility. I'm aware that this practice has been on-going for many years.

But this re-zoning is not an abstract planning issue.

This is not a theoretical risk.

This is a decision about whether we allow the ongoing production of a **highly lethal industrial chemical** within the middle of existing and expanding residential communities.

Liquid chlorine is not just another industrial input. It is a **deadly substance**. In sufficient concentration, it can kill within minutes. It was a deadly and efficient killer in WW1. Today, emergency planners, first responders, and federal agencies all acknowledge that a major chlorine release — whether caused by accident, equipment failure, rail incident, or natural disaster — could expose **thousands of people** to serious injury or death.

And let us be clear: the risk is not confined to one site. Liquid chlorine is transported by rail through North Vancouver, across

the Lower Mainland, and into the United States. A single incident anywhere along that corridor could have catastrophic consequences for communities far beyond this facility.

Council is being asked tonight to approve a rezoning that would **lock in this risk forever.**

That is an extraordinary decision — and an unnecessary one.

Chemtrade has manufactured liquid chlorine for many years. We acknowledge that history. But longevity alone should not justify permanence. The fact that a dangerous activity has not yet resulted in tragedy does not mean it never will occur.

What matters — and what must matter to Council — is this: **Chemtrade does not need to manufacture liquid chlorine in order to serve the public good.**

There are **safer alternative technologies** available today that perform the same essential function — including water purification — without requiring the production, storage, or transport of large volumes of liquefied chlorine gas. These alternatives are already in use across North America and around the world. They have reduced catastrophic risk. They have reduced emergency planning burdens. And most importantly, they protect human life. Why are we not implementing these alternatives here?

This is not a question of shutting down water treatment. It is a question of **how that treatment is supplied** — and at what cost to surrounding communities.

The District of North Vancouver is actively planning for increased housing density, transit-oriented development, and new residential neighbourhoods IN the immediate vicinity of Chemtrade's operations. Council is encouraging families to live, work, and raise children here.

And yet, this rezoning would entrench an industrial land use that is fundamentally incompatible with that vision.

You cannot responsibly plan for more homes, more schools, more seniors' facilities, and more density — while simultaneously approving the perpetual manufacture of a chemical that, if released, would endanger all of them.

This is not about being anti-industry.

This is about being **pro-common sense, pro-community, and pro-responsibility.**

If this rezoning is approved, Council will be making a conscious decision to prioritize corporate convenience over public safety — despite the availability of safer alternatives.

Future Councils would be bound by this decision.

Future residents would bear the risk.

And future generations would rightly ask why this Council chose permanence over precaution. And God help us all if an incident did occur. All those affected would be holding you and your officials responsible for their misfortune. Have you done the risk assessment of what the possible financial liability to the taxpayer might be?

Mayor and Council, you have a duty not only to today's residents, but to tomorrows. Land-use decisions last far longer than any one term of office. This is one of those decisions.

On behalf of the residents of the District of North Vancouver, I urge you to **reject this rezoning**.

Reject the idea that deadly risk is acceptable simply because it has existed before.

Reject the notion that safer alternatives are someone else's responsibility.

Reject a precedent that puts residential communities in harm's way — forever.

Choose public safety.

Choose common sense.

Choose a future where no family has to wonder whether a single accident could change their lives forever.

Thank you for your time and for your consideration.

A Short Summary of Risk Assessments Related to Maplewood

by Corrie Kost

– version date Nov 22, 2017

A universal minimum industry requirement is that the 10^{-4} risk contour not go outside the property line (ref 1) of the creator of the risk. As indicated on page 39 of the Aug 8th 2012 Maplewood Chemical Hazard DPA Final Report by DOUG MCCUTCHEON and Associated (hereafter called the “Final Report”) this is clearly not the case. See Figure 18 below. In fact, the 10^{-4} risk contour crosses over the area accessible by the general public – for example the North Shore Recycling and Drop-off Depot on Riverside Drive. In Canada the MIACC guidelines do not permit any other land uses inside the 10^{-4} annual individual risk contour. In other places (eg. slide 78 of reference 11) the Individual Fatality Risk contour of 5×10^{-5} per year is required to remain on site, while the 5×10^{-6} per year can extend into industrial developments only.

It should also be noted that on page 17 of the “Final Report” - low-density residential of up to **10 units with ground level access per net hectare** should be allowed in the region bounded by 10^{-5} to 10^{-6} contours (see Figure 3 attached). This **corresponds to 4 units per net acre**. Council **changed this to 8 units per net acre** on the basis that the units would be so small as to likely have an occupancy of about 1 person per unit. Since the occupancy numbers per unit are not controlled by law, or is even regulated, **this relaxation should not be implemented**. It should also be noted, that to best of my knowledge the “Final Report” did not take account of the 2015 report (ref 7) of the Earthquake Risk Study for the District of North Vancouver.

In addition, I find that “voluntary” risk should be distinguished from “involuntary” risks. On page 8 of the “Final Report” it states “Globally the acceptable level of risk for an industrial operation is similar to that risk that we as individuals are willing to accept when we travel by commercial air, rail or bus” ie. 10^{-6} . This misses the point on voluntary vs. involuntary (see some definitions in the references section). The acceptable risk that others impose upon use should be no more than, say, being hit by lightning ie. 10^{-7} .

To date only Individual Risks have been calculated. That is, the risk contours in the “Final Report” only calculated the probability of a fatality to an individual who occupies a specific location 24hrs/day. **Societal Risks**, which produce f/N graphs, although requested as a condition by council in 2007 for the continued operation of the chlorine plant, were, to my knowledge, **never done**. When calculating the consequences (expected number of fatalities) of any unique accident, the answer will depend on the local population density and distribution. Therefore, unlike individual risk contours, an f/N curve will change if the local population density or distribution changes. For a simple explanation of the three basic calculations – Hazard Footprints, Individual Risk, and Societal Risk, please see reference 10.

Since the population distribution in the area is proposed to dramatically change it behooves council to have a consultant perform the Societal Risk. For example, the Dutch have adopted a standard which has as an acceptable guideline 10 fatalities at a frequency not more than $1.E-05/\text{yr}$, 100 fatalities at no more than $1.E-07/\text{yr}$, and 1000 fatalities at no more than $1.E-09/\text{yr}$ (ref 13)

For a chlorine plant in Melbourne (ref 2) *“the nearest resident is 1.5 km away and the surrounding land areas are either vacant or are filled with warehouses and general manufacturing activities. The plant occupies approximately 8 ha of a total land area of 20 ha, with the vacant area providing a buffer zone for risk contours from the plant. The criteria set by the state government is that the **10^{-6} individual fatality risk contour must not lie outside the site boundary** and the buffer zone ensures that this is the case”.*

Distance as a guide:

In Australia, a guideline of 300 to 1500 meters from the plant boundary is used as a rule of thumb for non-major industrial developments. The DNV existing chlorine plant falls into the “major” category. In the 2014 OCP of Lloydminster Planning District, Saskatchewan, the minimum separation distance from any Hazardous Industrial Site (see attachment 1) is 1.6Km from any single family home and 2.4Km from multilot residential building sites . (ref 3) The municipality of Lumsden,

Saskatchewan uses an almost identical table (page 63 of reference 5) – that is, 1.6Km from any single family home and 2.4Km from multilot residential building sites for the separation from Hazardous Industrial sites.

Note that buildings in the DNV within the 10^{-6} risk contours will require HVAC systems (ref 4 page 36) that maintain a slight positive pressure inside the building to prevent chlorine from entering. However, if a large earthquake (see reference 7 – note particularly pages 32(attached as figure 32),33 and 35 as it relates to Maplewood) triggers a chlorine release (a much more likely time than at other times) the structure of most buildings are likely to be compromised and allow chlorine to enter. Access by emergency services would also be constrained since even a low ppm (parts per million) of chlorine will make normal engines inoperable. Recovery, not rescue, would be the likely scenario.

Notwithstanding the MIACC guidelines I find it unacceptable to move the 10^{-6} risk contour (of Figure 18) some 50 metres closer to the chlorine plant in order to align it with Front Street “for land use planning purposes”

City of Edmonton

Edmonton used a more pragmatic approach. In the review “Risk Based Land-Use Planning in the Edmonton Area – by Doug McCutcheon”(ref 6) it is recommended that the maximum amount of chlorine that should be stored within a 3 Km radius of the plant is 1,825Kg. Currently there is **far** more than that stored both inside (60,000Kg) and outside of the North Vancouver Chlorine plant!

Concerns expressed by the local community

I would like to note some of concerns that have been expressed by others in the subject area. From two 2011 articles (references 8 and 9) I take particular note of *"If Canexus has a terrible release and it kills 10,000 people, Canexus will go bankrupt and they'll just walk away. The people in North Vancouver or Vancouver won't even have someone they can sue."*

Why Canexus did not cease chlorine production in 2007

In 2007 the existing lease (Ref No. V1381(06)) at that time was valid until

June 30, 2018. Despite the desires of the Maplewood community (and council) to terminate this hazard in their neighbourhood the Vancouver Port Authority, who appears to have ultimate jurisdiction of the subject land, agreed to extend the lease to 2032.

What is the worst case scenario for the release of the full 60Tons of chlorine?

However unlikely it may be I believe our residents deserve to know the worst case potential impact of the complete release, say during a cloudless night and low winds, of the on-site storage tank (60Tons) of chlorine.

For the less technically minded...

You may wish to read the Oct 20/2011 Scientific American article "Chlorine Accidents Take a Big Human Toll" (ref 12)

RECOMMENDATION

Whereas, contrary to the MIACC guidelines, the chlorine plant imposes a substantial risk to the community well outside their property line, and

Whereas simple calculations indicate that the chlorine plant stores 300/74/33 times more chlorine than is prudent even if it were respectively 1/2/3Km from any residential areas, and

Whereas the Societal Risk calculations, as requested by council in 2007, have yet to be performed:

I urge council not to proceed with any further densification in the Maplewood area.

There is some evidence to support not proceeding with any new residential developments within at least 3 kilometers of the chlorine plant. This unfortunately includes all of Lower Lynn.

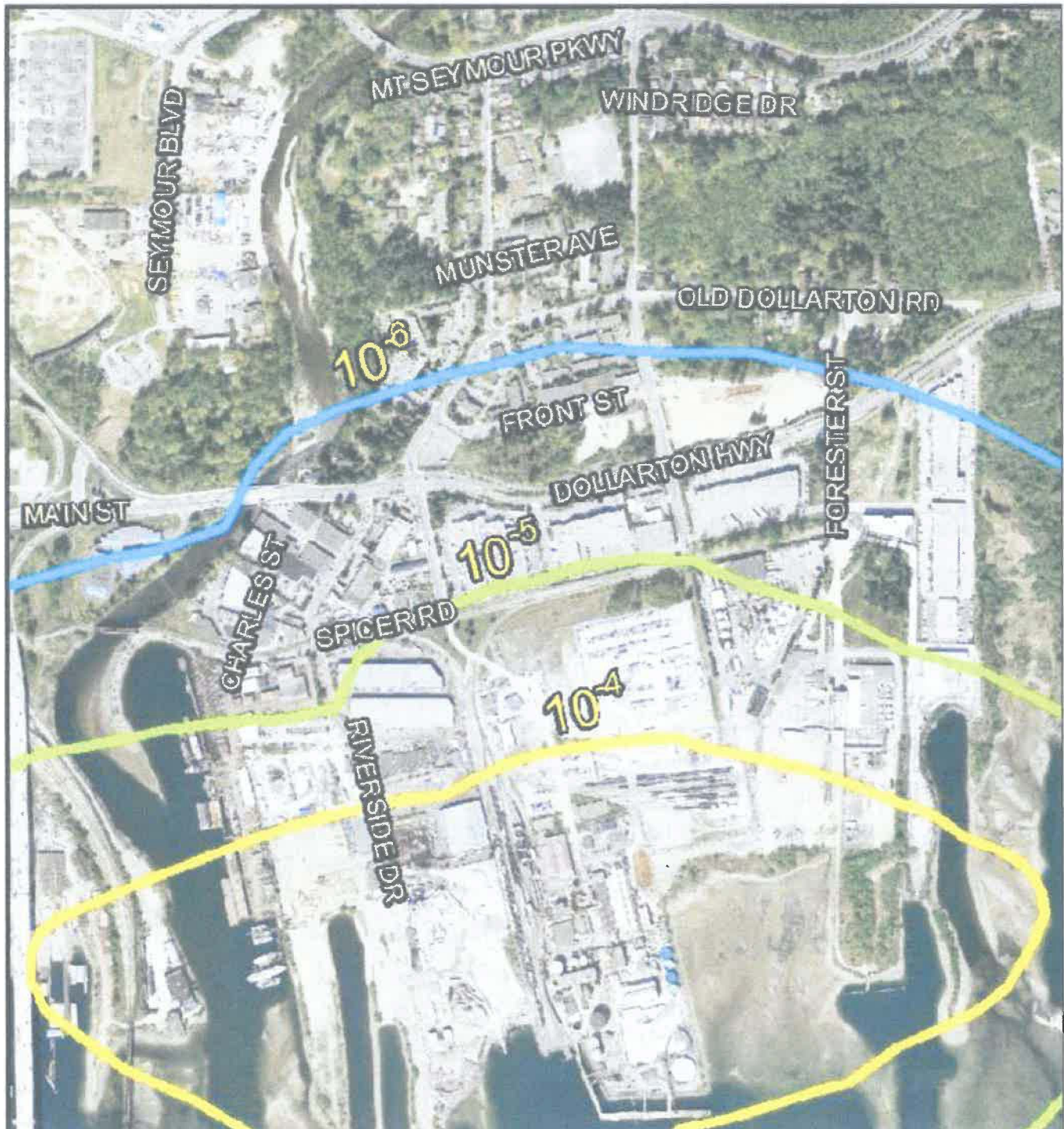
The safety of our residents should override any other considerations.

References

- (1) <http://www.planning.nsw.gov.au/~media/Files/DPE/Reports/quantitative-risk-assessment-summary-report-botany-industrial-park-2012-09-25.ashx>
- (2) <https://books.google.ca/books?isbn=0470999462>
- (3) <http://crosbyhanna.ca/assets/LPD-OCP-FINAL.pdf>
- (4) <http://www.dnv.org/sites/default/files/edocs/Maplewood-Implementatoin-Plan-Final.pdf>
- (5) http://lumsden.ca/wp-content/uploads/rm189/pdfs/bylaws/2014/OCP_Bylaw%2006-12%20R%20M_Lumsden.pdf
- (6) <http://www.cheminst.ca/sites/default/files/pdfs/Connect/PMS/CSE%202007%20-%20McCutcheon%202.pdf>
- (7) http://ftp.maps.canada.ca/pub/nrcan_rncan/publications/ess_sst/296/296439/of_7816.pdf
- (8) <https://www.vancouverobserver.com/public%20safety/2011/03/28/after-japanese-earthquake-north-vancouver-residents-raise-questions-about>
- (9) <https://www.vancouverobserver.com/chlorine/2011/03/31/north-vancouver-ready-chlorine-leak-during-earthquake>
- (10) <http://www.questconsult.com/papers/risk-acceptance-criteria/>
- (11) <https://www.researchgate.net/file.PostFileLoader.html?id=579aff8148954cd06f60c964&assetKey=AS%3A389081830838272%401469775745231>
- (12) <https://www.scientificamerican.com/article/chlorine-accidents-take-big-human-toll/>
- (13) http://sache.org/workshop/2013Faculty/files/QRA%20Presentation%20for%20%20AICHEME%20in%20Richmond_1486_1.pdf -page8

- **Voluntary risk** is associated with activities in which a person participates by choice. Examples of voluntary activities include driving a car, flying in an airplane, rock climbing, and scuba diving. Generally, the individual uses his own value system and experience to determine if the risk of a voluntary activity is acceptable to him.
- **Involuntary risks** are associated with activities, conditions, or events to which a person might be exposed without his consent. Examples of involuntary risks include the risk of premature death from illness, natural disasters (earthquakes, floods, etc.), or the **production and transportation of hazardous materials**. For certain industrial activities, the “allowable” or “acceptable” levels of involuntary risk might be set by some government agency, rather than by each individual.

exus TCP Project Risk Contours:



Maplewood Chemical Hazard DPA Preliminary Study For The District of North
Vancouver FINAL REPORT AUGUST 8th, 2012

Final Report

FIGURE 18

Table 8-1 Lloydminster Planning District Required Separation Distance Between Uses (in Metres)		Municipal Wells	Residential			City of Lloydminster	Intensive Agriculture	Airport - Airstrip	Commercial	Gravel Pit	Waste Management		Anhydrous		Industrial	Hazard Industrial
			Single	Mx2	Tourist Accommodation						Solid	Liquid	Non-Refrigerated	Refrigerated		
Residential	Single ⁽¹⁾	--	--	--	--	--	--	--	200	150	457	600	305	600	300	1,600
	Multi-lot Country Residential ⁽²⁾	--	--	--	--	--	--	800	200	300	457	600	305	600	800	2,400
	Tourist Accommodation ⁽³⁾	--	--	--	--	--	--	--	200	300	457	600	305	600	800	1,600
Intensive Agriculture ⁽⁴⁾		--	--	--	--	--	--	--	--	--	--	--	--	--	800	1,600
Airport - Airstrip ⁽⁵⁾		--	--	800	--	800	--	--	--	--	--	--	--	--	--	--
Commercial (Agriculture) ⁽⁶⁾		--	200	800	800	--	800	--	--	--	457	300	--	--	--	--
Waste Management ⁽⁷⁾	Solid	1,600	457	457	457	457	457	--	457	--	--	--	--	--	457	--
	Liquid	1,600	600	600	600	600	300	--	300	--	--	--	--	--	300	--
Anhydrous ⁽⁸⁾	Non-Refrigerated	--	300	300	300	300	--	--	--	--	--	--	--	--	--	--
	Refrigerated	--	600	600	600	600	--	--	--	--	--	--	--	--	--	--
Industrial		800	300	800	800	300	800	--	--	--	457	300	--	--	--	--
Hazardous Industrial ⁽⁹⁾		1,600	1,600	2,400	1,600	300	1,600	--	--	--	--	--	--	--	--	--

Distances are measured as follows - between closest point of nearest

- ① Single Residential Building...
- ② Multilot Residential Building Site...
- ③ Tourist Accommodation Facility...
- ④ Intensive Agricultural Site...
- ⑤ Airport / Airstrip Facility...
- ⑥ Commercial Site...
- ⑦ Waste Management Facility or Lagoon...
- ⑧ Anhydrous Ammonia Storage Facility...
- ⑨ Industrial Site...
- ⑩ Hazardous Industrial Site...

⑪ The location of industrial and hazardous industrial development in the Planning District is managed by the Future Land Use Concept contained in this Official Community Plan.
⑫ Refer to Section 5.1.2.1 for separation distances from land uses in an adjacent Rural Municipality.

to the nearest residential building, corporate land, airport or airstrip, gravel pit, anhydrous ammonia storage, or waste management facility and the site lines for other uses

Hazardous Industries distance from Multilot Residential Building Site: 2.4Km

Hazardous industries minimal distance from Single Family Residential: 1.6Km

ATTACHMENT 1

City of Edmonton

A camp for underprivileged children almost run year round. At most 1,000 people there at one time.

One approach used for a risk assessment for the City was to determine the maximum amount of hazardous chemicals could be located in a heavy industry zone to the south. The table below shows some of the quantities.

Not a lot.

IDLH for Cl_2
is 10ppm

Hazard Distance to the IDLH Concentration	H_2S Kg	SO_2 Kg	Cl_2 Kg
1 Km	979	1,748	203
2 Km	3,915	6,991	811
3 Km	8,808	15,729	1,825
Resulting Probability (high end) = 4.15×10^{-5}			



Immediately Dangerous to Life or Health *Concentrations* (IDLH)

Note that for a chlorine cloud only a portion of the area within the circular vulnerability zone can be affected by a unique accident –see Fig 2 of ref 10 (cjk)

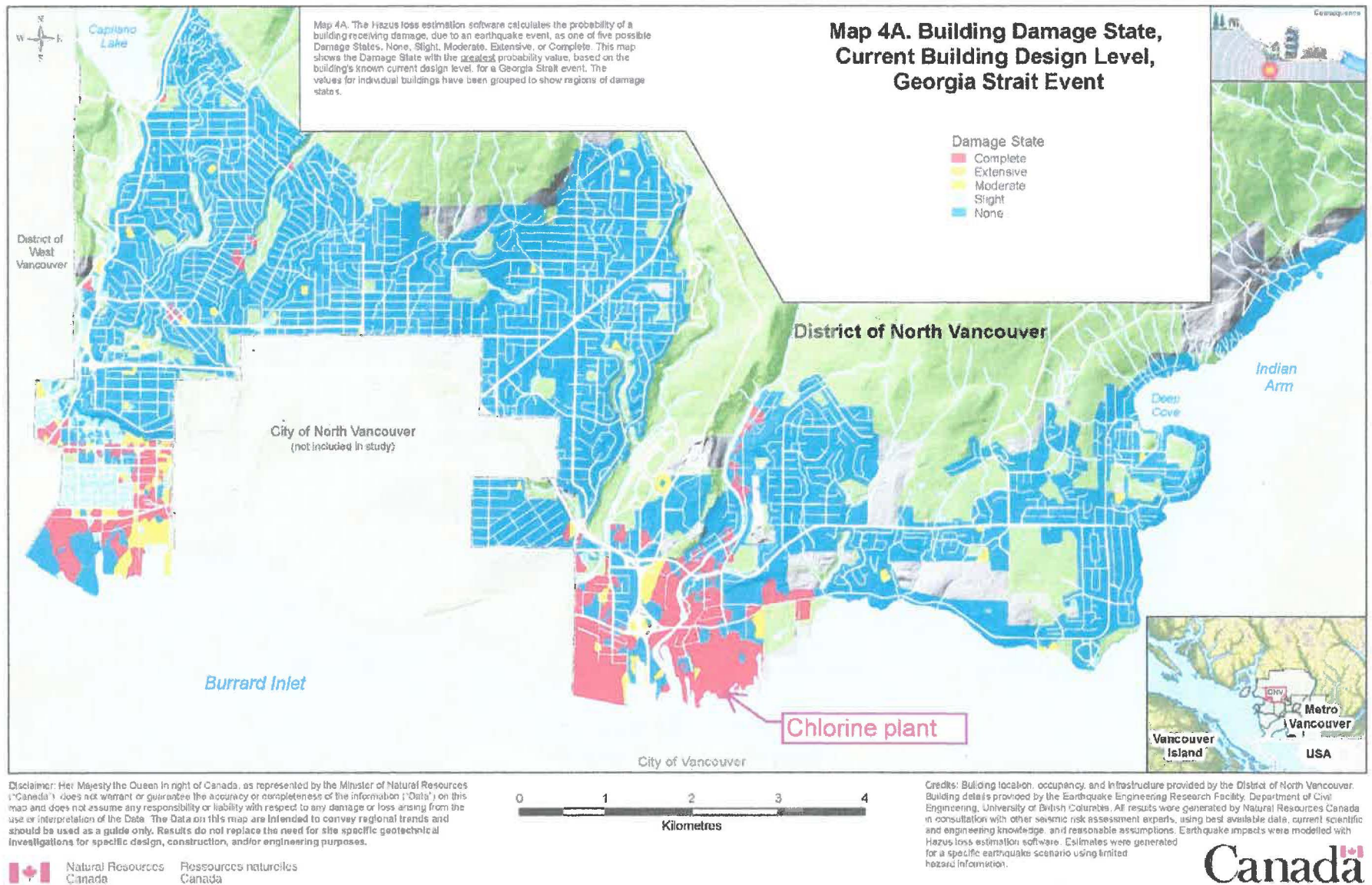
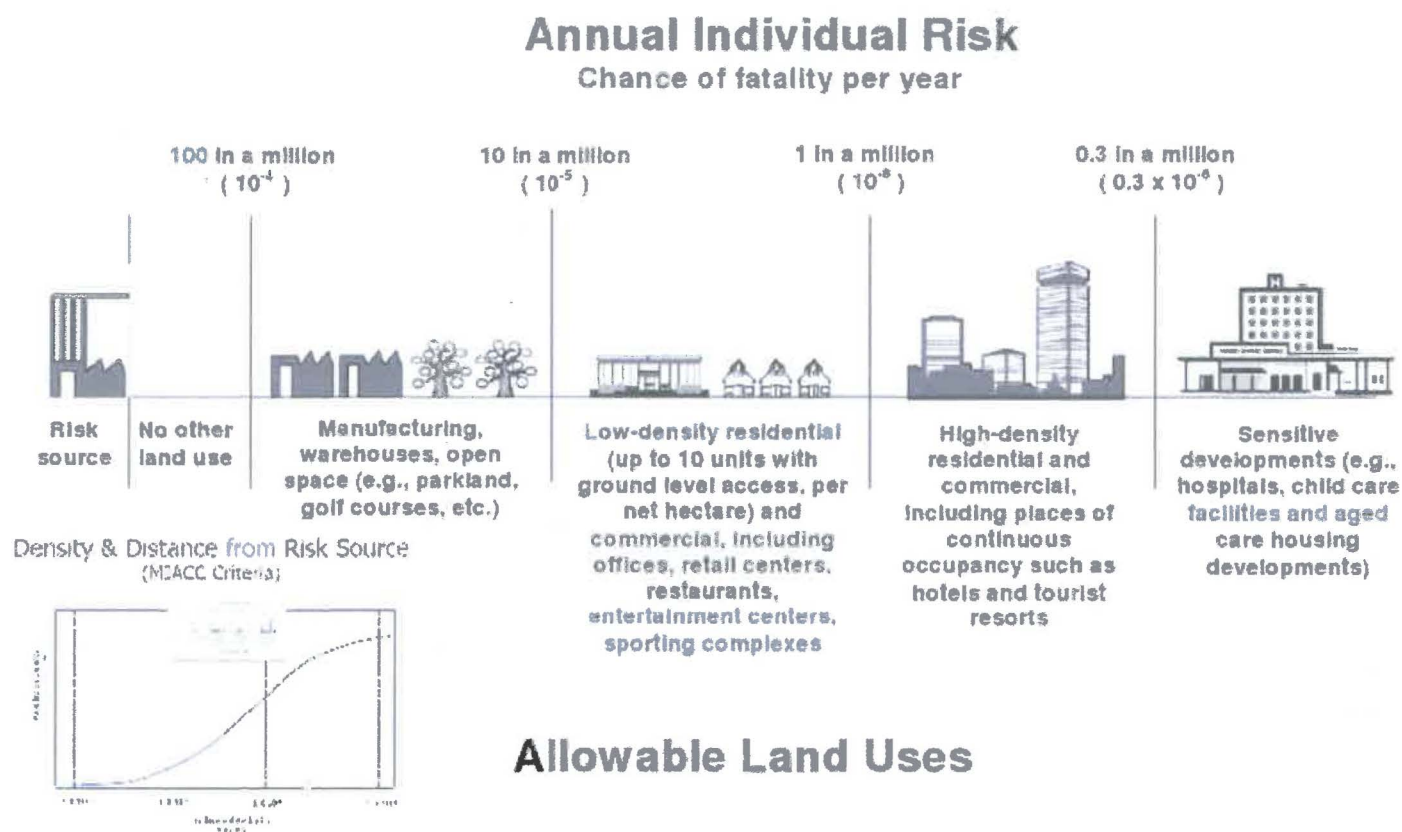


Figure 32

Figure 3

Figure 3: MIACC Land Use Planning Criteria



Additional Reading Material

- a) http://www.epd.gov.hk/eia/register/report/eiareport/eia_2242014/EIA/text_html/S12_Hazard.htm
- b) <http://www.praxair.com/-/media/documents/sds/chlorine-cl-2safety-data-sheet-sds-p4580.pdf> see page 4 for IDLH of 10ppm
- c) <http://onlinelibrary.wiley.com/doi/10.1002/9780470552940.app2/pdf>
- d) <https://www.worksafebc.com/en/resources/health-safety/books-guides/chlorine-safe-work-practices?lang%3Den%26direct>

Some useful information

If all the liquid chlorine in a 68 kg (150 lb.) container escaped, it would release so much pure chlorine gas that it would take 24 times the amount of air in BC Place stadium to dilute the gas concentration to 0.5 ppm, the maximum allowable concentration a person can be exposed to in an eight-hour period. (page 2 ref d)

Chlorine gas is not visible as a greenish-yellow cloud at concentrations below 1000 ppm. (page 3 ref d)

C

SUBMITTED AT THE

FEB 24 2025

PUBLIC HEARING

Michael C. Graveson
BSc. Chemistry, MBA

OMG

CONSULTING LLC

My name is Michael Graveson

- I am a consultant for the chemical industry
- I have worked in the chemical industry for 40 years and I've reviewed every document you have received, and I'm here to tell you that in your defense, there is no way you could make an informed decision before today.

EXECUTIVE SUMMARY

1. You **don't need railcars** of liquid chlorine to treat the water.
2. Canadian water is **NOT** treated directly with chlorine, it's treated with **bleach**
3. **Less than 5%** of Chemtrade's chlorine goes to water treatment in western Canada
4. The safety improvements proposed by Chemtrade are **insufficient** to protect the DNV. You need to focus on the **railcars**, that's the **biggest risk!**

1. You don't need railcars of liquid chlorine to treat the water
2. Canadian water is NOT treated directly with chlorine, it's treated with bleach.
3. Less than 5% of Chemtrade's chlorine actually goes to water treatment in western Canada
4. The proposed safety improvements are insufficient
5. The railcars stored onsite and traveling through the community are the biggest risk.

CHLORINE IS NOT THE SAME AS BLEACH



Bleach is also called
sodium hypochlorite

- This is not chlorine

When you think of chlorine, you probably think of what you put in your pool and your laundry. But that's not chlorine, it's bleach. People interchange those words, but for the purpose of this discussion, and your decision, you need to know they are not the same.

CHEMTRADE MAKES AND SHIPS CHLORINE CHLORINE IS NOT THE SAME AS BLEACH

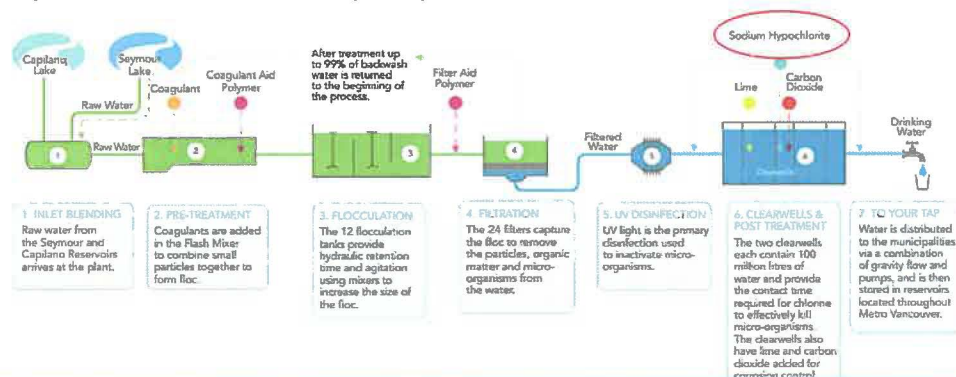
- Chlorine is a deadly gas. It was used in WWI as a weapon.



- Chemtrade makes and ships chlorine
- Chlorine is one of the most dangerous chemicals in the world.
- Dangerous chlorine gas is used to make bleach, which is safe
- I doubt anyone here is put this in their laundry at home

WATER IS TREATED WITH BLEACH, NOT CHLORINE

Metro Vancouver's water is treated at either the Seymour Capilano Filtration Plant (SCFP) or the Coquitlam Water Treatment Plant (CWTP).



For Metro Vancouver, call Melody Sato (Quality Coordinator) or Andrew (Division Director) at 604-451-8592. For Rose Valley WTP, call Kyle Arseneault at 250-863-3581. For South Fork WTP, Trevor Cook (Plant Operator) at trevorc@sfbwbor.gov

- The vast majority, well over 90% of water in Canada and the United States is treated with bleach (sodium hypochlorite), not chlorine. And that's the same for western Canada.
- Water treatment facilities don't want dangerous chlorine gas...they had this meeting years ago.
- I also spoke with at the other water treatment facilities in BC. They all use bleach. The Rose Valley WTP in Kelowna forman, Kyle Arseneault said they converted from chlorine gas in 2023 for safety reasons. You can call him at 250-863-3584. For South Fork WTP, Trevor Cook (Plant Operator trevorc@sfbwbor.gov)

THE CHEMTRADE QUOTE IS MISLEADING

- Here is the actual quote from Stats Can:

“Chlorination remained the most common disinfection process and was applied to 96% of all drinking water produced in 2015”.

- Here is the Chemtrade quote:

“96 per cent of Canadian municipalities use chlorine to treat their drinking water supply (Source: StatsCan)”

OVER 90% OF CHLORINATION IS BLEACH, NOT CHLORINE!

Chemtrade regularly quotes a Statistics Canada survey from 2015 with a “typo”:
“96 per cent of Canadian municipalities use chlorine to treat their drinking water supply (Source: StatsCan)”

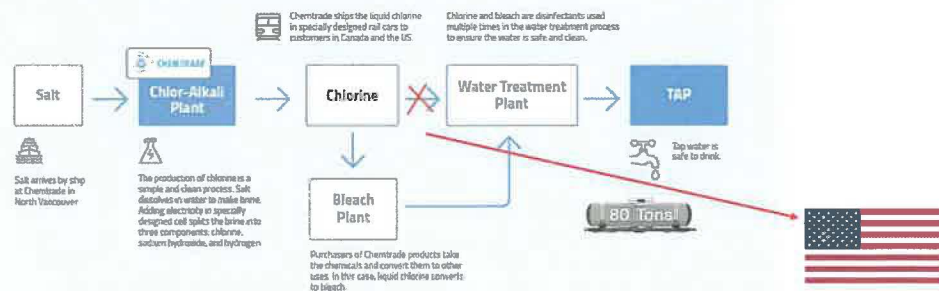
Here is the actual quote:

“Chlorination remained the most common disinfection process and was applied to 96% of all drinking water produced in 2015”.

Why did they change the quote? Because they wanted you to think that their chlorine was going directly to water treatment and without Chemtrade liquid chlorine, you can't treat the water. That is incorrect.

LESS THAN 5% OF CHEMTRADE'S CHLORINE IS USED FOR WATER TREATMENT IN WESTERN CANADA

Safe drinking water starts at Chemtrade



This is from Chemtrade's own website.

LESS THAN 5% OF CHEMTRADE'S CHLORINE IS USED FOR WATER TREATMENT IN WESTERN CANADA. None of Chemtrade's chlorine goes directly to water treatment plants. It is shipped in railcars to a plant nearby that converts it into the safer alternative, bleach, who then ships it in trucks safely to the water plants. If this bleach plant was on Chemtrade's site in North Vancouver, they wouldn't need to put the chlorine in a railcar. Eliminate the middleman, water would get treated, the risk would be eliminated, no jobs lost.

Actually, most of Chemtrade's chlorine doesn't go to either one, it actually goes to the US in railcars through greater Vancouver.

THE SOLUTION: MAKE BLEACH ONSITE

- Make the bleach onsite
- Eliminate the middleman
- Eliminate the risk
- Water gets treated
- No lost jobs

THE PROPOSED STORED CHLORINE REDUCTION IS INSIGNIFICANT



Less than 3%
Reduction in Onsite
Chlorine Storage
Inventory



- Chemtrade is proposing to “reduce liquid chlorine storage onsite to **absolute minimum** by removing all bulk storage and loading liquid chlorine directly into railcars.”
- According to Chemtrade, they store at any given time an average of 32 full cars onsite and 159 unloaded cars (not empty).
- **That is approximately 3000 metric tons of stored hazardous liquid chlorine.**
- **And Railcars are far more vulnerable to an accident.**
- And the new safer cars won’t eliminate the risk either. Graniteville, SC in 2005. Chlorine from one of 3 railcars was released. 9 people died, thousands impacted. Many experts will tell you that the new car wouldn’t have prevented the accident.
- The new railcar is like improving cigarette filters. It might help a bit, but it doesn’t eliminate the underlying danger. The real solution is not better filters, it’s removing the cigarette.

LIQUID CHLORINE LOADING IN A SEALED BUILDING ADDS LITTLE VALUE

- After loading, the chlorine railcars inevitably **EXIT THE BUILDING**
 - There is no containment outside the building
- 2-4 railcars will be inside the building while 191 chlorine railcars are stored onsite (3000 tons)...outside the building without containment.
 - Axial 2016
- But besides what's onsite, the **biggest threat to the DNV** remains the **over 1000 full railcars** of **hazardous liquid chlorine** are shipped from Chemtrade through the DNV and greater Vancouver every year.

- Liquid chlorine loading in a sealed building adds little value
- After loading, the chlorine railcars inevitably **EXIT THE BUILDING**. There is no containment outside the building
- Railcars are more vulnerable than bulk storage
- 2-4 railcars will be inside the building while 191 chlorine railcars are stored onsite...outside the building
- In 2016, a Axial chlorine railcar in WV had just left a sealed building similar to the one proposed by Chemtrade and was sitting on the plant track, and it released all of its contents as a hazardous gas, leading to mass evacuations.
- The biggest threat to the DNV is from the ongoing presence of dozens of 80 ton railcars onsite, and the over 1000 railcars shipped from Chemtrade through greater Vancouver every year

QUESTIONS COUNCIL SHOULD ASK?

Since liquid chlorine is **not used directly to treat water**, why continue to ship **toxic chlorine railcars** through the DNV and greater Vancouver, when a **safer alternative** exists?

THE SOLUTION: MAKE BLEACH ONSITE

- Make the bleach onsite
- Eliminate the risk
- Water gets treated
- No lost jobs