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# The Facts about Kinder Morgan



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# The Facts about Kinder Morgan

By Eric de Place

Energy giant Kinder Morgan has big ambitions. Best known for its empire of oil and natural gas pipelines, the firm aspires to enlarge its role in coal transport too. Expanding its export terminals in Louisiana and Texas would increase Kinder Morgan's coal export capacity in the Gulf Coast region from roughly 5 million tons annually in recent years to nearly 29 million tons.<sup>1</sup>

These coal terminal expansions could boost Kinder Morgan's profits, but they also raise questions about what the projects might cost neighboring communities.

In public, Kinder Morgan points out that it is already operating coal export facilities in Virginia, South Carolina, Louisiana and Texas. Or, as the company's spokesperson said when the firm was pushing a failed coal export plan in Oregon, "What we're proposing is not something we don't already do."<sup>2</sup>

## And that's exactly the problem.

The truth is that Kinder Morgan's existing coal export operations are well known for blighting neighborhoods and fouling rivers. In fact, the company's track record is one of pollution, law-breaking, and cover-ups.

- In Louisiana, Kinder Morgan's terminal spills coal directly into the Mississippi River and nearby wetlands. The pollution is so heavy that satellite photos show coal-polluted water spreading from the facility in black plumes. The same site generates so much wind-blown coal dust that nearby residents won a settlement from Kinder Morgan because their homes and belongings were so often covered in coal dust.<sup>3</sup>
- In Houston, Kinder Morgan's terminal operators leave coal and petcoke, a highly toxic byproduct of oil refining, in uncovered piles several stories high. The company's petcoke operations are so dirty that even the firm's promotional literature shows plumes of black dust blowing off its equipment.<sup>4</sup>
- In South Carolina, coal dust from Kinder Morgan's terminal contaminates the bay's oysters, pilings, and boats. Locals have videotaped the company washing coal directly into sensitive waterways.
- In Virginia, Kinder Morgan's coal export terminal is an open sore on the neighborhood, coating nearby homes in dust so frequently that the mayor has spoken out about the problem.
- In Oregon, Kinder Morgan officials bribed a ship captain to illegally dump contaminated material at sea, and the firm's operations have repeatedly polluted the Willamette River.
- Kinder Morgan has been fined numerous times by the US government for stealing coal from customers' stockpiles, lying to air pollution regulators, illegally mixing hazardous waste into gasoline, and many other crimes.
- Kinder Morgan's pipelines are plagued by leaks and explosions, including two large and dangerous spills in residential neighborhoods in Canada. One hedge fund analyst has accused the firm of "starving" its pipelines of maintenance spending.

In "The Facts about Kinder Morgan," Sightline Institute explores the company's misbehavior so that local residents can decide for themselves whether they should welcome Kinder Morgan's coal export plans.

## What is Kinder Morgan?

Headquartered in Houston, Texas, Kinder Morgan is an energy transport company that describes itself as operating like a giant toll road for energy products. Kinder Morgan was formed in 1997 when a pair of former high-level Enron executives, Richard Kinder and William Morgan, bought pipelines and other assets from Enron.

The firm's core business is moving oil, natural gas, and coal from wellheads and mines to utilities, refineries, and manufacturers. Through partnerships and acquisitions, Kinder Morgan has grown into one of the largest pipeline and bulk port operators in the country. The enterprise consists of four major arms—Kinder Morgan, Inc. (KMI), the parent company; Kinder Morgan Energy Partners, L.P. (KMP), the owner and operator of almost all the assets; Kinder Morgan Management (KMR); and El Paso Pipeline Partners (EPB)—as well as an array of subsidiary and partner companies.<sup>5</sup> Kinder Morgan's parts are arranged in a complex, interlocking financial structure called a “master limited partnership.” But in August 2014 the firm announced major restructuring plans that will eliminate the partnership structure, combining all of these subsidiaries into a single entity that would be worth about \$92 billion.<sup>6</sup>

Founder and CEO Richard Kinder is known not only as a skilled energy executive but as a brilliant marketer. He famously claims only \$1 a year in salary and no bonus, and he likes to say that the company is run by shareholders, for shareholders.<sup>7</sup> Yet Kinder himself is the company's biggest shareholder, with a 24 percent ownership stake that nets him nearly \$400 million in dividends each year.<sup>8</sup> As of May 2014, Forbes estimated his net worth at \$9.4 billion, making him the 137<sup>th</sup> richest person in the world and the richest in his home town of Houston.<sup>9</sup>

Kinder Morgan is best known for its aggressive expansion of its network of oil and gas pipelines. In 2012 the company spent \$21.1 billion to buy the El Paso Corporation, which made Kinder Morgan the third largest energy company in the US, and the largest “midstream” company.<sup>10</sup> In Canada, Kinder Morgan plans to nearly triple the capacity of its Trans Mountain pipeline, which connects the Alberta oil sands to a port near Vancouver, British Columbia and to US refineries in Washington State.<sup>11</sup>

Kinder Morgan is now expanding its coal transport and handling business.<sup>12</sup> The firm exported roughly 40 million tons of coal annually in recent years.<sup>13</sup> Yet because US domestic demand for coal is declining, Kinder Morgan is looking to expand its coal export capacity.

At present, Kinder Morgan's main coal export growth opportunities appear to be at the Gulf Coast, where it has put nearly \$400 million into expanding or building new export capacity at its two Houston terminals and its IMT terminal in Louisiana.<sup>14</sup> Once all of the expansions are completed, Kinder Morgan will be able to export 28 million tons of coal annually from the trio of terminals – more than five times as much as its capacity there in 2011.<sup>15</sup>

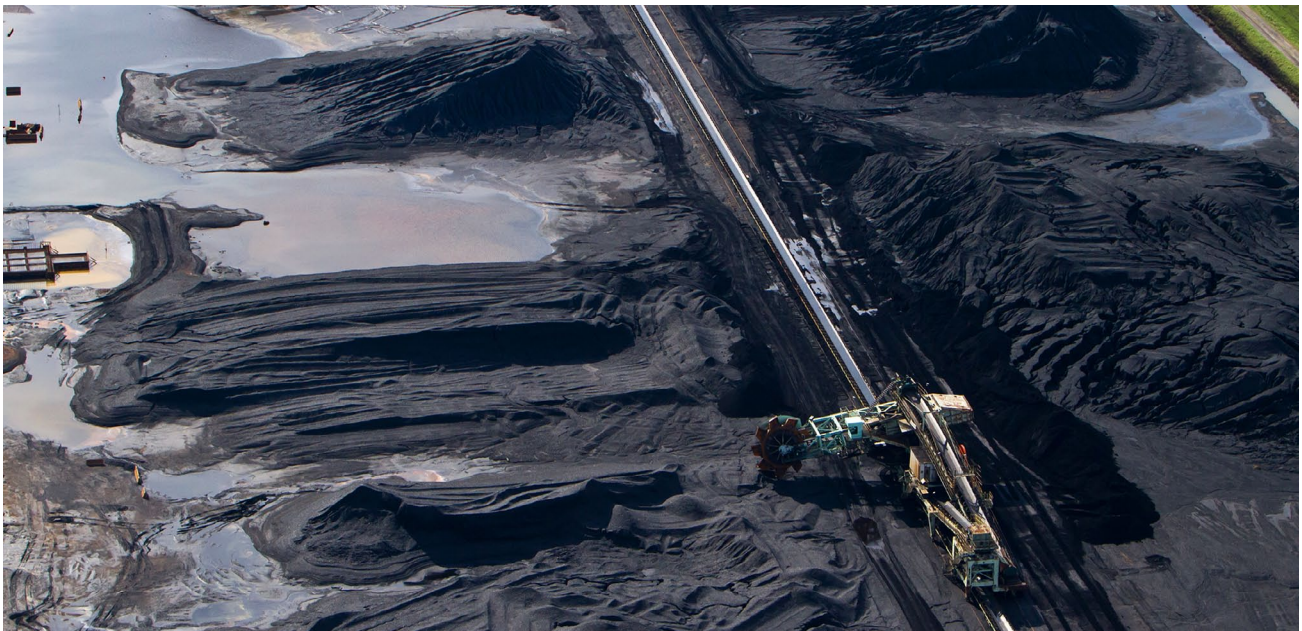
Yet even a cursory examination of Kinder Morgan's operations raises serious questions about the company's commitment to health, safety, and environmental protection. Many of Kinder Morgan's coal-handling sites are rife with pollution and coal dust.

## Air and water pollution in Louisiana

Kinder Morgan's International Marine Terminal, known as IMT, sits about 45 miles southeast of New Orleans on the Mississippi River, and it is a key part of the firm's coal export strategy.<sup>16</sup>

In 2010, the facility could handle 5 million tons of coal exports annually.<sup>17</sup> Anticipating growth in overseas markets, particularly in China and Europe, Kinder Morgan spent \$162 million to expand the site's capacity to a hoped-for 16 million tons by 2014.<sup>18</sup> At the same time, Kinder Morgan cut new deals with coal mining companies, including a 2012 agreement with Peabody Energy to use Kinder Morgan's Gulf Coast terminals to export five to seven millions tons of Powder River Basin and Illinois Basin coal annually through 2021.<sup>19</sup>

Kinder Morgan's IMT terminal is a serious ongoing source of pollution. Aerial photographs show plumes of coal- or petcoke-polluted water spreading from IMT's barges and docks into the Mississippi River.<sup>20</sup>



**After Hurricane Isaac, stormwater collected around piles of open coal at Kinder Morgan's International Marine Terminal in Louisiana.**

Photo by Jeffrey Dubinsky / Louisiana Environmental Action Network, all rights reserved, used with permission.

Despite being located in an area prone to floods and hurricanes, IMT is unable to weather serious storms. Extensive photographic documentation made available by Gulf Restoration Network and Louisiana Environmental Action Network shows the flooding at IMT after Hurricane Isaac in 2012. Photos also show extensive coal pollution in the aftermath of the hurricane, including piles of coal standing in blackened waterways and along the riverside, as well as wetland plants stained black from coal.<sup>21</sup>



In drier weather, Kinder Morgan's site is an active source of coal dust. In 2008, the residents of Myrtle Grove, a community roughly two miles from IMT, filed a suit against Kinder Morgan because of the heavy accumulation of coal dust on, in, and near their homes. Under a subsequent settlement, Kinder Morgan was supposed to install equipment that would cut down on the coal dust pollution, but until last year, locals were reporting that the firm failed to live up to the agreement and was opting instead to simply send checks to cover the cost of washing coal dust off homes and cars.<sup>22</sup>

By early 2014, the air in Myrtle Grove was still dirty enough so that monitoring equipment registered potentially hazardous levels of fine particulate matter, a pollutant considered particularly dangerous because its particles are small enough to embed in lung tissue. Initial results from a year-long project to measure air quality around the coal terminals are troubling; according to public interest groups in the region, one air sample taken from an area about 500 yards from IMT showed concentrations of fine particles that the World Health Organization deems unhealthy when the levels are sustained over long periods of time.<sup>23</sup>

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**A containment system breached by Hurricane Isaac allows coal to spill into a drainage canal.**

Photo by Jonathan Henderson / Gulf Restoration Network, all rights reserved, used with permission.



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**Coal dust generated by Kinder Morgan's coal terminal clouds the air along Highway 23 in Myrtle Grove, Louisiana.**

Photo by Bryan Ernst, all rights reserved, used with permission.

“What’s particularly worrisome is that high levels of PM-10 are usually found in urban areas with a lot of freeways,” said Denny Larson, executive director of Global Community Monitor, a group that helped measure the air samples. “So our results, since they came from a relatively rural area, raise a very red flag. And they point a finger directly at the coal facilities, with their large piles of uncovered and uncontrolled coal.”

Residents and activists have also photographed coal dust clouds near the site.<sup>24</sup>

## Towering piles of petcoke in Houston, Texas

Kinder Morgan also has port expansion plans in the Houston Ship Channel, where the company operates a pair of coal and petcoke terminals, the Houston Bulk Terminal (sometimes referred to as Penn City) and the Houston Deepwater Terminal. These facilities handle both coal and petroleum coke (petcoke), a highly toxic byproduct of oil refining. The firm recently invested \$225.5 million to add a combined 12.7 million net tons of capacity at the two terminals.<sup>25</sup>

Kinder Morgan’s terminals in Houston have a track record of pollution that worries local residents. The company’s petcoke operations there are so dirty that even the firm’s promotional literature shows plumes of black dust blowing off its railcar loading equipment.<sup>26</sup>

Residents of nearby Marwood, a low-income community, worry about the health implications of Kinder Morgan’s pollution. Some residents complain about the presence of dust in their homes.<sup>27</sup> Air Alliance Houston, a public health advocacy organization, reports that its preliminary monitoring in the area shows the presence of elevated levels of nickel, a metal found in petcoke.

Although the source of pollution cannot be definitively proven, there are reasons to think that it may have originated at the coal and petcoke piles at Kinder Morgan’s facilities, which sometimes reach as high as the nearby freeway and reportedly coat passing vehicles with black dust on a regular basis.<sup>28</sup> In fact, a range of public interest organizations have raised concerns about both terminals, arguing that their draft permits allow them to emit 32 tons of hazardous particulate matter at Penn City and 16 tons at the Deepwater Terminal.<sup>29</sup>



**Kinder Morgan’s coal piles rise above Houston’s Beltway 8 Bridge.**

Photo by Scott Eustis, Gulf Restoration Network, all rights reserved, used with permission.

## Coal dust problems for Charleston, South Carolina

Kinder Morgan's Shipyard River Terminal covers 60 acres in Charleston, South Carolina. Although the terminal handles only about 3 million tons of coal per year, the site plagues surrounding communities with numerous well-documented incidents of escaping coal dust.<sup>30</sup>

A typical account from Charleston's *Post and Courier* newspaper reads:

*As nearby residents and city officials hack about gritty air and clogged roads, Kinder Morgan says it is just filling a need... Residents say that coal dust from the facility already is polluting the air in nearby neighborhoods and at the Cooper River Marina.*<sup>31</sup>

Residents are particularly concerned about pollution on the Cooper River, which flows into the Atlantic Ocean near Kinder Morgan's coal terminal. Again, according to the *Post and Courier*:

*...sailboat owners say that one side of their masts are white and [the] other side dirty gray. The cleaner half faces north, toward the old Navy base. The dirtier side faces south, toward the Kinder Morgan Energy Partners' shipping terminal...*

*"[Coal dust] is so excessive that it grinds into the top layer of the fiberglass," said George Heinemann, a Summerville resident who keeps his boat in the marina. "The docks are filthy. Even if your boat is clean and your shoe is wet when you step on the boat, you can see a shoe imprint."*<sup>32</sup>

A local marine mechanic, Ken Bonerigo, has documented Kinder Morgan's violations in detail. According to the *Charleston City Paper*:

*Bonerigo's videos... clearly show coal spilling into the water and plumes of dust escaping into the air as the piles are transferred from ship to shore. In perhaps the most shocking footage, the video "Midnight Clean Up" shows a crane scooping up water and sloshing it onto the dock to wash the coal debris into the water rather than sweeping it up.*<sup>33</sup>

And:

*Under Kinder Morgan's watch, violations of the Pollution Control Act and Water Classifications and Standards have persisted, covering everything from spillage of petroleum coke into the water to fugitive emissions from ships. A 2001 investigation uncovered seven violations, resulting in total fines of just \$32,400... Despite subsequent agreements to improve facilities, 2005 investigations found the company responsible for airborne particulate matter settling on neighboring properties...*<sup>34</sup>

Bonerigo's videos depict coal dust on boats, oysters, pilings, and in the water.<sup>35</sup>



**Coal dust from Kinder Morgan's coal terminal contaminates a piling at the Cooper River Marina in Charleston, South Carolina.**

Video by YouTube user [svosprey](#).



Problems persist. In 2008, for example, South Carolina regulators fined Kinder Morgan \$19,000 for failing to contain coal dust at its facilities, and the state ordered the firm to upgrade its operations.<sup>36</sup>

Until recently, Kinder Morgan used the Shipyard River Terminal to import coal, but with new export potential and rail shipping agreements, the company is expanding the terminal enough to more than double its coal-handling capacity, raising serious concerns for area residents.<sup>37</sup>

## Coal dust problems at Newport News, Virginia

Pier IX, in Newport News, Virginia, is one of Kinder Morgan's largest coal export facilities. The terminal has the capacity to ship 12 million metric tons of coal per year and store 1.3 million tons on site. Located on the James River, it can accommodate enormous "capesize" vessels capable of handling 150,000 tons of coal.<sup>38</sup> (A second coal terminal in Newport News is operated by Dominion Terminal Associates.)

Despite recent costly upgrades and 44 sprinklers designed to suppress coal dust on Kinder Morgan's site, the community is routinely blanketed in coal dust. In 2011, the *Daily Press* newspaper reported:

*[Mayor] Price said not only are the piles unsightly, but the coal dust blown from the piles has for decades caused problems in the Southeast Community. Wind picks up the dust in the piles off of Terminal Avenue... coating neighborhoods in the Southeast Community...*<sup>39</sup>

In fact, the *Daily Press* reported that Mayor McKinley Price, who lives about a mile from the coal piers, has complained that coal dust coats his house and outdoor furniture.<sup>40</sup>



**McKinley Price, Mayor of Newport News, Virginia.**

Photo by flickr user vademocrats, used under a creative commons license.

Kinder Morgan's poor coal handling practices may even be resulting in serious health consequences nearby. A local newspaper reported on a 2005 health study that showed Newport News residents in the Southeast Community experience asthma rates more than twice the citywide and state averages.<sup>41</sup>

Across the bay in Norfolk, Virginia, communities near the Lambert's Point coal terminal operated by Norfolk Southern also worry that coal dust is responsible for the vicinity's elevated asthma rates. Near Lambert's Point, coal dust coats cars, windowsills, and plants. Even the soil is contaminated with coal and high concentrations of arsenic.<sup>42</sup>

The coal dust problem in Newport News is so severe that it has figured prominently in local electoral debates, and city officials are considering using public money to attempt to mitigate the spread of coal dust from the terminals.<sup>43</sup>

## Kinder Morgan's failed plan to bring coal to Oregon

Kinder Morgan's coal port plans do not always succeed, as the company learned when it launched a proposal to export coal from a site on the lower Columbia River in Oregon.

Kinder Morgan wanted to build and operate a 30-million-ton-per-year coal export terminal at an industrial park about 60 miles downriver from Portland. The terminal was designed to receive coal shipped by train from the Powder River Basin in Montana and Wyoming, unload the coal into stockpiles, and then reload it onto ocean-going vessels bound for Asia. Kinder Morgan estimated that the project would cost \$150 million to \$200 million. Local port commissioners approved Kinder Morgan's proposal in January 2012.<sup>44</sup>

Yet Kinder Morgan's plans unraveled just a few months later. In May, facing coordinated community opposition as well as research documenting the company's persistent problems managing coal dust, Portland General Electric (PGE) refused to allow Kinder Morgan to sublease its property at the port. The utility, which operates coal-handling facilities of its own, concluded that Kinder Morgan could not be trusted to prevent coal dust from fouling PGE's nearby natural gas turbines.

Kinder Morgan scrambled to spin the story, saying, **"We don't have a site identified, and we have not put forth a proposal."**

Yet the company's response was an outright deception. In fact, Kinder Morgan's own publicity materials identified a specific site, one that the firm actually labeled in an aerial photograph as "proposed terminal development."<sup>45</sup>

A week later, Kinder Morgan dropped its coal export proposal in Oregon.<sup>46</sup>

## Bribery and pollution in Portland, Oregon

Kinder Morgan's operations in Portland, Oregon have been home to pollution, law-breaking, and even bribery.

In one incident, Kinder Morgan illegally dumped contaminated potassium chloride into the Pacific Ocean rather than pay landfill charges to dispose of it properly. In 2003, according to dockworkers, company officials bribed a ship captain \$1,100 to haul 159 tons of the fertilizer component out to sea and dump it.<sup>47</sup> Nearly five years later, Kinder Morgan finally pled guilty to violating the Ocean Dumping Act and settled with the US Attorney's Office, agreeing to pay \$240,000.<sup>48</sup>

Previously, in response to a lawsuit against the company for its poor handling of soda ash in Portland, Kinder Morgan agreed in 2004 to pay \$75,000 for spills and to prevent its soda ash from continuing to pollute the Willamette River.<sup>49</sup> But problems continued. In July 2011, state officials levied a \$10,400 fine for a spill at Kinder Morgan's port site, in which a fueling vessel spilled 125 gallons of marine fuel into the Willamette River. Then in October 2011, the US Coast Guard investigated a mysterious oil spill and fish die-off at Kinder Morgan's soda ash facility; state officials say it was the deadliest fish kill on the lower Willamette in nearly a decade.<sup>50</sup>

## Fraud, scams, and thefts

The bribery case in Oregon is part of a pattern of illegal behavior. An FBI investigation determined that between 1997 and 2001, Kinder Morgan systematically defrauded its own customers, including the Tennessee Valley Authority (TVA), a publicly owned provider of electricity in the mid-South.

At Kinder Morgan's Cora Terminal in Illinois, company officials used two different methods to weigh coal for the TVA and other power producers.<sup>51</sup> Operators used certified scales to take delivery of coal from rail cars, but then weighed outgoing coal by "barge draft," typically yielding weights two to three percent heavier than the certified scales. Kinder Morgan claimed that it was shipping out the same amount of coal that it had received, but in reality the company was keeping the excess coal yielded by the weight differential and selling it as its own coal, marketed under the "Red Lightning" brand, an apparent nod to the company's logo, which features a red lightning bolt.

The same federal investigation found that at its Grand River Terminal in Kentucky, Kinder Morgan officials simply took coal from its customer stockpiles. Altogether, investigators established that Kinder Morgan took and resold nearly 259,000 tons of coal. In 2007, the US Attorney's Office reached a \$25 million civil settlement with Kinder Morgan.<sup>52</sup>

In another case settled in 2007, the US Environmental Protection Agency (EPA) fined Kinder Morgan \$613,000 for violations of the US Clean Air Act after regulators discovered that the company had been illegally mixing an industrial solvent—a dangerous hazardous waste described as a "cyclohexane mixture"—into unleaded gasoline and diesel. The company distributed 8 million gallons of the contaminated fuel, which clogged fuel filters and caused vehicles to break down.<sup>53</sup>

In 2010, the federal government fined Kinder Morgan \$1 million for repeatedly violating the Clean Air Act at its Port Manatee Terminal in Florida. The US Department of Justice found that, among other crimes, Kinder Morgan managers lied in permit applications, stating that the company would control its pollution when they knew the control equipment was not being used or even properly maintained.<sup>54</sup>

The US Environmental Protection Agency has also investigated Kinder Morgan for violating the federal Renewable Fuels Standard. Officials alleged that Kinder Morgan used invalid documents to fulfill its requirements for the use of renewable energy. The company signed a settlement agreement in April 2012, agreeing to resolve 30,000 violations and pay a monetary penalty.<sup>55</sup>

## Wall Street worries

Long a darling of investors, Kinder Morgan has recently been faced with stern questions by bearish financial analysts who question both the accounting arrangements between the companies as well as the wisdom of drastically reduced maintenance spending.

In September 2013 Kevin Kaiser, a senior analyst with the hedge fund investment firm Hedgeye, published a damning critique of the company, aptly titled, “Is Kinder Morgan Maintaining its Stock Prices Instead of its Assets?” Although the report was largely devoted to Kinder Morgan’s curious accounting practices under its master limited partnership arrangement—practices that Hedgeye believes may be misleading to investors—the report also raises a number of issues that may concern communities near Kinder Morgan’s facilities.

For example, Hedgeye claimed that, “Kinder Morgan’s high-level business strategy is to starve its pipelines and related infrastructure of routine maintenance spending.” The report enumerates a variety of instances in which the company has slashed maintenance spending on some of its pipelines by as much as 90 percent.

Then in February 2014, a shareholder filed a lawsuit arguing that Kinder Morgan was playing games by making clever use of the arrangement of its companies. Plaintiff John Slotoroff alleges that Kinder Morgan (KMI) has taken \$3.2 billion out of Kinder Morgan Energy Partners (KMP), money that is then not available for maintenance of pipelines and other energy infrastructure.<sup>56</sup> The company says that it plans to defend itself “vigorously.”<sup>57</sup>

That same month, financial magazine *Barron’s* published a gimlet-eyed look at Kinder Morgan, highlighting similar questions about the company’s financial practices.<sup>58</sup> *Barron’s* also drew more attention to Kinder Morgan’s apparent under-spending on maintenance, quoting an analyst at investment banking firm Jefferies: “We struggle to understand how KMP can safely operate the largest portfolio of transmission and storage assets in the industry for just a fraction of its peers’ expenditures.”

Jefferies points out that Kinder Morgan spends just half as much on the maintenance per mile of pipeline as Spectra Energy, another major pipeline operator.<sup>59</sup>

In response to the *Barron’s* article, Kinder Morgan issued a rebuttal similar to other statements it has made:<sup>60</sup>

*“We have consistently outperformed industry averages for health, environmental and safety measures. The suggestion that we would knowingly compromise safety is simply uninformed, irresponsible and is not supported by our safety record.”*

Kinder Morgan’s pipeline operations have had their share of problems though.

## Pipelines failures result in deaths, felonies, and environmental damages

In 2005, for \$3.1 billion, Kinder Morgan acquired Canadian pipeline company Terasen, including its Trans Mountain Pipeline, which the company now proposes to nearly triple in capacity.<sup>61</sup> In 2007, the pipeline ruptured in Burnaby, a suburb of Vancouver, British Columbia. Fifty families were forced to evacuate their homes as oil rained down on a residential neighborhood.<sup>62</sup>

CBC News reported:

*Some witnesses said oil shot 30 metres into the air like a geyser for 25 minutes. The black liquid rained down on houses, spewed across two lanes of traffic and ran downhill into [Burrard Inlet].*

*“We smelled oil and the smell of gas in [our] home,” said one resident, Natalie Marson. “Next thing I know, we heard a frantic knock and it was police officers telling us to get out.”<sup>63</sup>*



**In 2007, a Kinder Morgan pipeline ruptured in Burnaby, British Columbia. Fifty families were forced to evacuate their homes as nearly 60,000 gallons of crude oil rained down on their residential neighborhood.**

Video from YouTube user Ben West.

Then in January 2012, a Kinder Morgan storage facility in Abbotsford, another Vancouver suburb, spilled roughly 29,000 gallons of crude oil.<sup>64</sup>

The most tragic Kinder Morgan mishap occurred in November 2004 when an excavator ruptured a pipeline carrying gasoline in the town of Walnut Creek, California. When a welding torch ignited the fuel, the pipeline erupted in a fiery explosion, killing five workers.<sup>65</sup> The courts convicted the Kinder Morgan subsidiary that operated the pipeline on six felony counts related to the explosion and ordered the firm to pay \$15 million in fines.<sup>66</sup>

Kinder Morgan has had numerous other problems in California.

In April 2004, a long stretch of corroded pipeline ruptured, spilling more than 123,000 gallons of diesel fuel into the Suisun Marsh, a sensitive saltwater wetland on San Francisco Bay.<sup>67</sup> Local environmental groups allege that the company waited more than a day before notifying authorities that the spill had occurred.<sup>68</sup> Kinder Morgan pled guilty on four counts related to the Suisun Marsh spill and an unrelated small spill in Los Angeles Harbor.<sup>69</sup>

In November 2004, an oil pipeline owned by a Kinder Morgan subsidiary burst in the Mojave Desert, sending a jet of fuel 80 feet into the air. The break closed the nearby interstate highway and contaminated more than 10,000 tons of soil in the habitat for federally-designated endangered species.<sup>70</sup>



**A ruptured Kinder Morgan pipeline in Walnut Creek, California, killed five people when it exploded.**

Photo by wikimedia user Leonard G., used under a creative commons license.



**A Kinder Morgan oil pipeline ruptures in endangered species habitat in California's Mojave Desert.**

Photo by US EPA (p. 3 of report).

In 2005, Kinder Morgan spilled 70,000 gallons of fuel into Oakland's inner harbor, and then 300 gallons into the Donner Lake watershed in the Sierra Nevada.<sup>71</sup> And in 2007, the city of San Diego sued Kinder Morgan for failing to clean up a fuel leak that contaminated an aquifer.<sup>72</sup>

Problems plague Kinder Morgan's pipeline operations elsewhere too. In one high profile case, a ruptured pipeline in Arizona spilled 19,000 gallons of gasoline into a housing development under construction.<sup>73</sup>

In May 2011, the US Pipeline and Hazardous Materials Safety Administration fined Kinder Morgan \$425,000 for safety violations, following a federal investigation into the company spilling 8,600 gallons of "hazardous liquid" in New Jersey.<sup>74</sup>

Then in December 2011, a two-year-old natural gas pipeline called REX, owned mostly by Kinder Morgan, leaked in Ohio, spewing 127,000 cubic feet of natural gas and forcing nearby residents to evacuate their homes. The *Philadelphia Inquirer* reported:<sup>75</sup>

*The leak in Ohio was the last in a string of problems with REX. One worker digging the line in Wyoming was incinerated when his bulldozer hit another buried line; another firm was fined for not marking it properly.*

Perhaps most troubling are allegations that a Kinder Morgan subcontractor was attempting to intimidate whistleblowers. According to the *Inquirer*, "In Kansas, three private safety inspectors attached to the project quit in protest, saying that a REX subcontractor had pressured them to keep quiet about substandard work, making threats and offering bribes."<sup>76</sup>

Kinder Morgan has had other labor problems too.

## Labor violations and unsafe working conditions

Kinder Morgan has numerous labor and workplace safety violations to its name. In February 2011, for example, the US Department of Labor sued Kinder Morgan, arguing that the firm had been underpaying nearly 4,600 workers for overtime for at least two years.<sup>77</sup> The company agreed to settle the suit, paying out \$830,000 in back pay.<sup>78</sup>

The company claims that it has "better than industry average" safety performance at its facilities.<sup>79</sup> Yet Kinder Morgan has been fined for workplace safety violations over and over again by the U.S. Occupational Safety & Health Administration, including "serious" violations at the company's bulk handling terminal in Portland, Oregon; its coal-handling terminals in Louisiana; Sparrows Point and Baltimore, Maryland; Rockwood, Illinois; Milwaukee, Wisconsin; Fernandina Beach, Florida; and Fairless Hills, Pennsylvania.<sup>80</sup>

In 2011, Kinder Morgan agreed to pay \$7.5 million in a wrongful death lawsuit brought by the family of a Nevada truck driver. The family accused the company of failing to monitor and warn workers about exposure to toxic chemicals like benzene.<sup>81</sup>

## Controversy over oil sands pipeline in Northwest

Kinder Morgan is proposing to spend \$5.4 billion building a second oil pipeline 608 miles from Edmonton, Alberta to a port on the Burrard Inlet at Burnaby, British Columbia along roughly the same route as the existing Trans Mountain Pipeline.<sup>82</sup> The new pipeline would be capable of moving 590,000 barrels per day (bpd) in addition to the existing line's rated capacity of 300,000 bpd.<sup>83</sup>

Staunchly opposed by environmental advocates, the Trans Mountain Pipeline has become increasing controversial. At least one investment analyst has called the expansion project “the new Keystone XL” in reference to the breadth and severity of opposition.<sup>84</sup> Even the company has had to publicly acknowledge that its plans are unpopular. According to reporting in the *Financial Post*, the president of Kinder Morgan Canada, Ian Anderson, “said the company is fielding a dizzying array of questions from regulators, municipalities and various levels of government” and that interest in the project is “overwhelming.”<sup>85</sup>

Indeed, the project's opponents include not only environmental groups, but also the Tsleil Waututh First Nation, whose traditional territory includes much of Burrard Inlet, as well as the City of Burnaby. The mayor's opposition has been described as “blistering”<sup>86</sup> and local homeowners whose property may be seized to provide a right-of-way for the expanded pipeline.<sup>87</sup>

Among the biggest worries is that the expanded pipeline would induce an unsafe increase in oil tanker traffic. The expansion is projected to add 400 tankers to the region every year, and oil spill maps show that in some cases, a spill would result in widespread shoreline contamination in a very short period of time.<sup>88</sup>

Others worry about spills from the pipeline itself, which crosses numerous water bodies and densely populated areas. Indeed, Kinder Morgan's 15,000-page permit application caused a minor public relations headache for the firm when it came to light that the report says pipeline spills can have a positive effect on regional economies because “spill response and cleanup creates business and employment opportunities.”

Though the company responded by telling the *Vancouver Sun* that “no spill is acceptable to us,” locals were not convinced.<sup>89</sup>

## Buying influence

Kinder Morgan trumpets the claim that it does not make any political contributions.<sup>90</sup> Yet public information made available by the Center for Responsive Politics shows that, in fact, Kinder Morgan has spent \$1.8 million to lobby Congress since 2003, and the firm is continuing to spend money on lobbying in 2014.<sup>91</sup> Individuals at Kinder Morgan have made more than \$1.4 million in contributions to candidates and PACs since 1998, with the vast majority going to support Republicans.<sup>92</sup>

Kinder Morgan's leadership also makes lavish political gifts. CEO Richard Kinder, who owns 24 percent of the company, seems to focus his political contributions on unregulated “soft money,” giving nearly half a million dollars to the Republican National State Elections Committee since 2001. He also contributed over \$250,000 to Political Actions Committees (PACs) and an additional \$90,000 in “joint fundraising contributions” for Republican candidates. His wife, Nancy Kinder, donated over \$90,000 to the National Republican Senatorial Committee, and since 2001 she has contributed over \$350,000 to Republican candidates and PACs, plus more than \$80,000 in joint fundraising contributions.<sup>93</sup> Richard and Nancy Kinder were also major financial supporters of George W. Bush, raising well over \$1 million for his two presidential candidacies.<sup>94</sup>



Richard Kinder is still making political contributions. In 2011, he gave thousands of dollars to top Republicans like House Speaker John Boehner and David Dewhurst, a former Texas candidate for the US Senate.<sup>95</sup> He supported Mitt Romney's presidential bid with at least \$19,000 of gifts and he is avidly pro-fossil fuels, telling *Forbes* magazine in 2012:

*"I think that for any of our lifetimes fossil fuels are going to be the primary source of energy in this world.... I'm a huge believer in the genius of mankind, and I think we'll continue to find new ways to utilize, explore for and produce more and more fossil fuels."*<sup>96</sup>

Even the family's ostensibly charitable foundation, the Kinder Foundation, may be pushing a political agenda. The Foundation contributed \$10 million to the George W. Bush Presidential Center in part to support the Bush Institute, the Center's policy arm that promotes public policies related to "free market capitalism" and energy production.<sup>97</sup>

## What do the facts about Kinder Morgan mean for the Gulf Coast?

Despite Kinder Morgan's assurances to the contrary, there are good reasons to be concerned about the company's coal expansion plans.

Kinder Morgan's existing coal export operations are clearly dirty and are often in violation of clean air and clean water laws. Moreover, the company's overall track record of crime, fraud, deceit, and political meddling are worrisome. Until Kinder Morgan can demonstrate that it has cleaned up its act, decision-makers who want to protect the public interest should be extremely cautious about inviting Kinder Morgan to do business in their communities.

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**Conversations for  
Responsible  
Economic Development**

# **Assessing the risks of Kinder Morgan's proposed new Trans Mountain pipeline**

**Conversations for Responsible Economic Development**

*Building informed discussion about  
people, pipelines and purpose  
on Canada's West Coast*

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Revised version May 2013 (initially published Feb 2013)

## About CRED

**Conversations for Responsible Economic Development is a collaboration of business owners, academics, landowners and everyday residents of British Columbia who support responsible economic development.**

We love and value the west coast of British Columbia for its creativity, innovation, quality of life and unparalleled natural beauty. This is why we live, work and own businesses here. We share a common concern around the impact the proposed new Kinder Morgan Trans Mountain pipeline would have on the province, and in particular the communities closest to it. The expansion of the Trans Mountain Pipeline, if it goes ahead, would be a rare development project that would inevitably influence the region's economic development path for at least the next 40 years. It would involve a new pipeline running underneath communities from Edmonton to Burnaby and an increased frequency of tanker traffic through the Burrard Inlet and the Salish Sea.

However, so far there has been a real lack of public information available about the project. We came together to respond to this concern - our goal is to conduct independent research about all aspects of the Kinder Morgan proposal and share the results with others. We believe that better decisions will be made if there is an open, robust and informed conversation about the project's risks and potential benefits before the approval process any further forward. We invite everyone to participate in the conversation to ensure we are getting all of the facts – before it's too late.

## Our advisers

CRED was created and is guided by a team of advisers from a diverse range of sectors:



**Meeru Dhalwala, restaurateur**

Co-founder of Vij's and Rangoli restaurants, organizer of the Joy of Feeding international food festival and author of two cookbooks.



**Dr Erica Frank, University Neighbourhoods Assn**

Canada Research Chair in Preventive Medicine and Population Health, UBC professor in public health and medicine, founder of NextGenU.org.



**Ridge Frank-White, student**

Co-Chair of Emergency Preparedness Committee for UBC's University Neighbourhoods Association and 11th grade student at St George's School.



**Dallas la Porta, realtor**

Licensed realtor with La Porta Properties, real estate photographer and North Shore resident for 27 years.



**Liz McDowell, consultant**

Organizational development consultant. Founder of the Otesha Project UK and World Economic Forum Global Shaper.



**Bradley Shende, M2O Digital Agency & Carsurfing**

Creative technologist, filmmaker, digital producer and strategist. Commentator for Global, CTV, CKNW and Discovery's How Stuff Works.



**Tarah Stafford, Montserrat Ink**

Screenwriter, producer, sustainability advocate and founder of Cool Neighbourhoods.



**Dr. Rashid Sumaila, UBC Fisheries Centre**

Director at UBC's Fisheries Economics Research Unit. Internationally published on fisheries and natural resources, including oil spill economic impact studies.

# EXECUTIVE SUMMARY

## *Assessing the risks of Kinder Morgan's proposed new Trans Mountain pipeline*

The west coast of Canada is a thriving region known for its natural beauty, quality of life and, increasingly, its spirit of innovation. The region is also currently charting the course of its economic future. In this context, projects like Kinder Morgan's proposed oil pipeline expansion should not be ignored or underestimated, as they will inevitably and significantly influence the direction we take.

All British Columbians who live, work and own businesses on the west coast will be directly impacted by the outcome of the decision whether to expand the pipeline. Now is the time – while approval of the project is still under consideration – to ask the right questions. What would it mean for people and businesses on Canada's west coast if Vancouver became a major oil exporting port? What would be the impact on Vancouver's reputation as one of the greenest cities in the world? Who will this project benefit and who will it put at risk? What risks are we willing to assume and which are unacceptable? This report aims to answer these questions, in particular the potential costs and benefits to our local economy. It also aims to generate more questions that need to be answered before a final decision is made.

**The proposal:** Kinder Morgan Canada is proposing a \$5.4 billion project to build a new pipeline alongside its existing 1,150-kilometre Trans Mountain pipeline system between Edmonton, Alberta and Burnaby. Its goal is to increase pipeline capacity to at least 890,000 barrels per day, up from the current level of 300,000 barrels per day.

### Our key findings:

- **Route:** There is significant uncertainty over the exact pipeline route and whether it will be routed around densely populated areas in the Fraser Valley.
- **Spills:** In 15 years of operations, Kinder Morgan has accrued a significant number of spills, largely the result of human error. This includes four along the Trans Mountain route since 2005.
- **Jobs:** The proposal would create 50 permanent jobs. An oil spill would put at risk industries that together employ over 200,000 people locally including tourism, film and TV, real estate, high tech, agriculture and coastal industries.
- **Tax revenues:** The expansion would not make a significant contribution to provincial tax revenues.
- **Liability:** In the case of a major tanker spill, taxpayers would likely be responsible for the burden of costs, as a company's liability is limited to \$1.3 billion and a major spill could easily cost ten times this amount.
- **Local fuel needs:** The proposal is designed to export oil sands products to foreign markets. As a result, the pipeline is not required to meet domestic fuel needs.
- **Spill response:** Canada does not currently have the ability to respond effectively to a major spill in our waters.
- **Health risks:** There is a lack of consensus about the properties of diluted bitumen - the main substance that would travel through the pipeline - including its health impacts and how to effectively respond to a diluted bitumen spill.
- **Public opinion:** A recent survey found that 50% of BC residents oppose the proposal and 22% support it. Amongst those very familiar with the proposal's details, 70.9% are opposed.

Based on this report, we question whether there would be significant enough benefits for British Columbians to offset the risks. This report, however, is only a starting point. We look forward to an engaging conversation over the coming months about what the proposal means for responsible economic development on Canada's west coast.



# 1. Need to know facts: pipeline history and proposal details

## History and background

The Trans Mountain pipeline was originally built in 1952 to ship Alberta light crude oil to refineries in the Vancouver area and Washington state. It was designed to meet the Pacific Northwest's energy needs.<sup>1</sup> Until 2005, the pipeline was owned by the BC Gas Company and it transported natural gas, jet fuel and oil.

In 2005 Kinder Morgan purchased the public BC Gas Company. In addition to other oil products, they now use the pipeline to ship diluted bitumen from Alberta's oil sands. Kinder Morgan has elected to treat diluted bitumen the same as other heavy oils - opting not to conduct any studies on its health impacts, how it reacts in a marine environment, or any other research specific to diluted bitumen. They have also relied on existing spill prevention and response plans and risk assessments for its transportation and storage.

Increasingly, the bitumen transported on the Trans Mountain pipeline is being reallocated from BC and Washington refineries for export by tanker to offshore markets.<sup>2</sup>

Over the past number of years, there has been incremental pipeline expansion activity, including new pump stations added in 2007 and the Anchor Loop Expansion through Jasper National Park and Mount Robson Provincial Park completed in 2008. The current capacity of the pipeline is 300,000 barrels per day.

## Expansion plans

**Kinder Morgan Canada is now proposing to build a new pipeline alongside its existing 1,150-kilometre Trans Mountain pipeline system between Edmonton, Alberta and Burnaby, British Columbia.** The \$5.4-billion project would increase the capacity of the system to at least 890,000 barrels per day.<sup>3</sup>

## Details of construction

The expansion would create a dual-line pipeline. According to Kinder Morgan, the existing line would be used to carry refined products, synthetic crude oil and light crude oils, and the new 36-inch line would exclusively carry heavier oils such as diluted bitumen.

The project would also necessitate nine new pump stations, 18 additional storage tanks and the expansion of existing pump stations along the route. Finally, the project will require the expansion of the Westridge Marine Terminal in Burnaby.<sup>4</sup> If the application to the NEB is successful, construction would start in 2016 and the pipeline would be in operation by 2017.



## What is diluted bitumen?

Bitumen has very different properties than conventional oil. It is a heavy and viscous oil that occurs mixed with sand, clay and water and is found underneath Canada's boreal forest. Rather than liquid like conventional oil, it has a sludgy consistency similar to sand mixed with molasses. As a result, it needs to be heated and diluted with powerful chemical solvents to be transportable.<sup>11</sup> This mixture of bitumen and up to 30% diluents is called diluted bitumen, or dilbit. Although the exact components of the diluents are a trade secret that companies are not required to reveal, they are widely understood to contain highly volatile substances such as benzene, a known carcinogen. There is debate over how diluted bitumen reacts in water - most industry officials claim that it floats on the top of water, similar to conventional oil, while many environmental groups claim that once the lighter oils in the dilbit evaporate, the remaining weathered heavy oil can submerge or sink.

## What would the exact route be?

**Current route:** The existing Trans Mountain pipeline runs through the communities of Rearguard, Albreda, Chappel, Blue River, Finn, McMurphy, Blackpool, Darfield, Kamloops, Stump, Kingsvale, Hope, Wahleach, Sumas, Port Kells, and Burnaby. In addition, the pipeline traverses 15 First Nations communities and dozens of other towns.

**What it runs underneath:** It runs directly under several schools, including Stoney Creek Community School and Lyndhurst Elementary in Burnaby, and Watson Elementary in Chilliwack. Dozens of additional schools are within a couple kilometres of the pipe, including Forest Grove Elementary in Burnaby and twelve schools in Chilliwack. In addition, the pipeline runs underneath golf courses, shopping centres, residential neighbourhoods and the aquifers that supply drinking water to Abbotsford<sup>5</sup> and Chilliwack.<sup>6</sup>

**New route:** As Kinder Morgan has not put forward its proposal yet, there is significant uncertainty about the exact planned route. In some high population areas, like Burnaby, Langley and Chilliwack, communities have grown so much since the original pipeline was built in the 1950s that Kinder Morgan might propose diverting the expansion along a new route.

## Why is it called a twinning?

The project is a twinning in the sense that it would create two pipelines where there is currently only one. However, the twinning project would actually triple pipeline capacity because the new 36-inch line would have more than double the volume of the existing 24-inch line. The two combined lines would have the potential volume of over 3 times the current line<sup>7</sup> and, as noted earlier, they would result in a fivefold increase in tanker traffic.

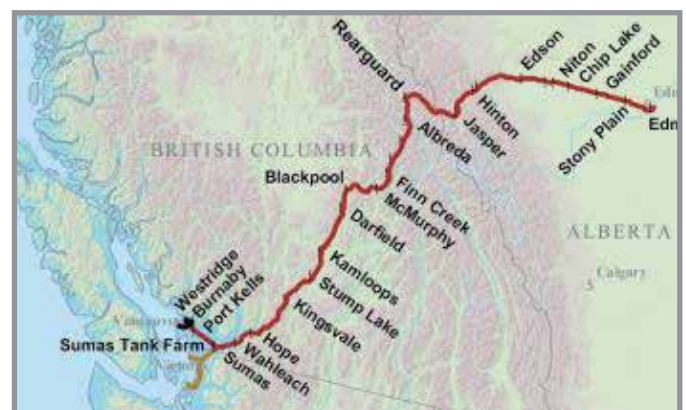
## Tanker traffic

**Increased traffic:** Kinder Morgan has indicated that the required tanker traffic for an increased volume of exports is roughly 444 vessels per year<sup>8</sup> transiting Burrard Inlet, more than a fourfold increase from current levels. Kinder Morgan plans for each Aframax tanker, which is 245 metres long and 42 metres wide (longer than Vancouver's tallest building, the Shangri-La), to carry approximately 575,000 barrels of oil.

**Dredging:** There is a risk that future plans will include dredging the bottom of the Second Narrows Bridge to be able to accommodate the larger Suezmax tankers, which can hold up to 1 million barrels of oil.<sup>9</sup> Although Kinder Morgan's expansion plans do not depend on dredging the bottom of Burrard Inlet, the company has not ruled it out either. In 2008, Kinder Morgan dredged the waters around its Burnaby terminal to allow passage for Aframax vessels.<sup>10</sup>

## The bigger picture: other proposed pipelines

The Trans Mountain Expansion Project is part of a larger oil sands expansion strategy. The proposed Enbridge Northern Gateway project is the other main proposal on the table in British Columbia. Both pipelines would allow oil sands products to reach the coast for export to foreign markets, and both would involve significant risk to local communities and BC's coastal waters. There are also pipelines proposed along routes through the US (Keystone XL) and to the east coast via Montreal (Line 9).



## 2. Who is Kinder Morgan and what is their safety and environmental track record?

### Who is Kinder Morgan?

Kinder Morgan, Inc. is an U.S. energy transport company headquartered in Houston, Texas. Kinder Morgan was formed in 1997 when former Enron executives Richard Kinder and William Morgan bought Enron's liquid pipeline assets, Enron Liquids Pipeline, L.P. Its core business is to move fossil fuels such as coal, oil, natural gas, and, increasingly, diluted bitumen from mines and wellheads to utilities, refineries, and manufacturers. It is the 84th largest company in the world and the fourth largest energy company in the United States and owns or operates approximately 80,000 miles of pipelines with an enterprise value of \$94 billion.<sup>1</sup>

### Specific safety violations

- In the United States, in 2004, a Kinder Morgan pipeline ruptured, spilling some 1,500 barrels of diesel oil into California marshes. The company pleaded guilty to water pollution and failure to notify authorities, and was assessed \$5.5 million in fines and penalties.<sup>7</sup>
- Again in 2004 in California, a pipeline struck by a municipal utility backhoe burst into flames, killing five workers and injuring four others. Investigators found that Kinder Morgan Energy Partners made an error in staking out the pipeline location. Kinder Morgan was fined by the state fire marshal, pled no contest to six felony charges and paid over \$89 million in penalties and victim compensation.<sup>8</sup>
- A lawsuit launched by a Nevada mother in 2009 alleges that Kinder Morgan failed to adequately monitor and repair a pipeline that was leaking jet fuel into the ground beneath a school playground. The lawsuit alleges that this leak contributed to a number of childhood cancer cases, including the death of her 10 year-old son Ryan Brune.<sup>9</sup>

### Safety track record

Carl Weimer, executive director of the Pipeline Safety Trust, a US-based non-profit organization, has noted that Kinder Morgan has a poor safety record since acquiring a huge network of pipelines in a short time period. The National Response Center, the sole federal point of contact for reporting oil and chemical spills in the U.S. and its territorial waters, has found Kinder Morgan responsible for 1,800 violations since it was incorporated in 1997, nearly 500 of which are pipeline incidents.<sup>2</sup>

### Trans Mountain spills

Since purchasing the Trans Mountain pipeline in 2005, Kinder Morgan has been responsible for four major spills:

**Abbotsford 2005:** A ruptured pipeline dumped a total of 210,000 litres of crude oil into the Abbotsford area and into Kilgard Creek. In a 2007 report from the Transportation Safety Board of Canada, Kinder Morgan was criticized for a delay in response time because the line between the Sumas tank farm and the Sumas pump station was not part of a leak detection system.<sup>3</sup>

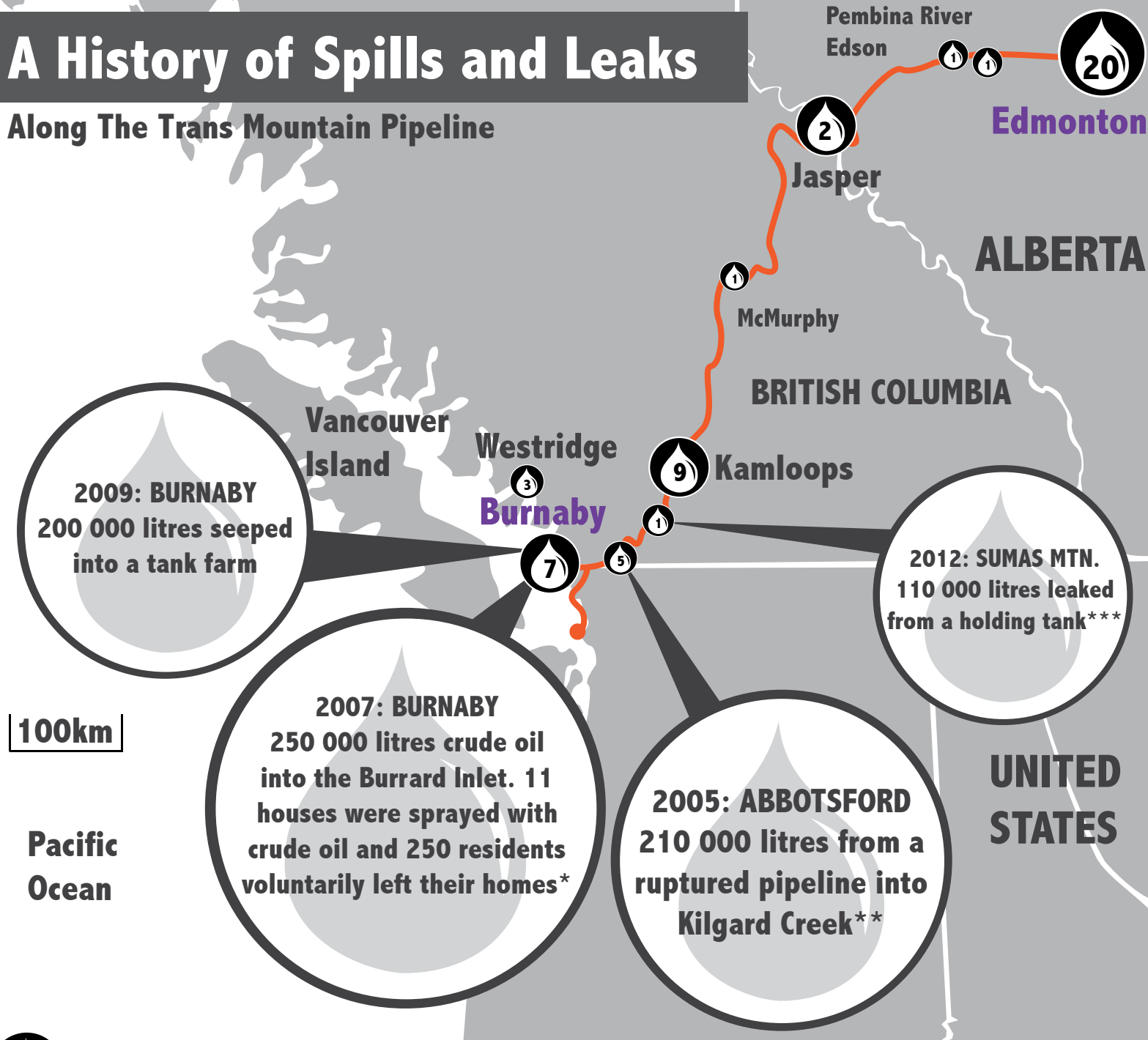
**Burnaby 2007:** A road crew ruptured a pipeline, causing 250,000 litres of crude oil to flow into Burrard Inlet Bay via the Burnaby storm sewer system. Eleven houses were sprayed with oil, many residential properties required restoration and approximately 250 residents voluntarily left their homes. Cleanup took more than a year. The Transportation Safety Board ruled the accident was the fault of Kinder Morgan as it was responsible for ensuring the excavation crew knew the pipeline's exact location before they started digging.<sup>4</sup>

**Burnaby 2009:** 200,000 litres seeped from a storage tank into a surrounding containment bay at the Burnaby Mountain tank farm, causing strong fumes locally.<sup>5</sup>

**Sumas 2012:** 110,000 litres of oil leaked from a Sumas Mountain holding tank, caused by freezing water placing pressure on a gasket. The National Energy Board's investigation found that "the leak was detected later than it should have been," the company's management of procedures was "inadequate" and that the operator "failed to recognize the leak situation" on two occasions. It took three alarms and a shift change before someone was sent out to investigate.<sup>6</sup>

# A History of Spills and Leaks

## Along The Trans Mountain Pipeline



**28)** Spills with undetermined locations, bringing total reportable spills since 1952 to **78**

The four spills highlighted above took place under Kinder Morgan's ownership. More details:

\*Cleanup of the Burnaby spill took more than a year. The Transportation Safety Board ruled the accident was the fault of the company as it was responsible for ensuring the excavation crew knew exactly where the pipeline was before they were allowed to start digging.

\*\*The Transportation Safety Board of Canada criticized Kinder Morgan for a delay in response time because the line between the Sumas tank farm and pump station was not part of a leak detection system.

\*\*\*In the case of the Sumas spill, the National Energy Board's investigation found that "the leak was detected later than it should have been," the company's management of procedures was "inadequate" and that the operator "failed to recognize the leak situation" on two occasions.

### 3. What are the economic risks of the project? What are the economic benefits?

#### How many jobs will be created if this project goes ahead? What kind of jobs will they be?

According to Kinder Morgan, the expansion project will create 50 permanent jobs.<sup>1</sup> There will also be an unknown number of temporary jobs created during the construction phase, which is estimated by Kinder Morgan to last for less than two years. It is as yet unknown whether Kinder Morgan will choose to employ workers from BC or Canada or temporary foreign workers for these roles.

#### Tax revenues

The Trans Mountain website estimates that the project would create \$355 million in increased provincial tax revenues and about \$600 million in municipal tax revenues in BC over the project's six years of construction and 30 years of operations, for an average of \$26.5M per year.

This is a strikingly small share of BC's overall tax revenues. The corporate taxes from the Trans Mountain expansion would make up only 0.7% of projected corporate provincial taxes for 2013/14 and 0.05% of overall provincial tax revenues for the year (projected to be \$20.944 billion).<sup>2</sup>

#### What jobs would a spill put at risk?

##### Iconic Vancouver industries

Mountains and ocean are not only a core part of the lifestyle of residents of the Lower Mainland, in many ways, the landscape forms a significant part of the regional economy.

Whether it is real estate development, tourism, hospitality or coastal industries – or the burgeoning high tech and film sectors – many BC residents rely upon the natural environment to support their careers, families and lifestyles, and many businesses trade on Vancouver's 'greenest city' brand. As a result, some of the West Coast's most iconic industries could be significantly impacted by an oil spill. Taken together, these industries employ more than 320,000 people in the Lower Mainland.<sup>3</sup>

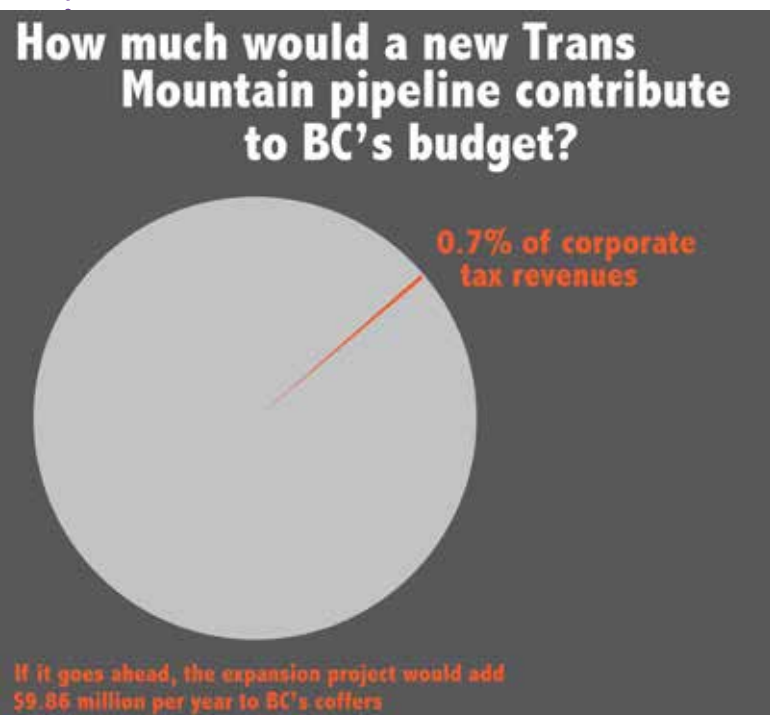
Although it's impossible to say how many of these 320,000 jobs would be directly affected in the case of a spill, a 2012 UBC study investigating the potential costs of a tanker spill along BC's north coast found that one large-scale incident could result in up to 43% job losses amongst coastal industries.

##### Tourism

Other areas impacted by oil spills have experienced significant job losses in the tourism sector. A paper published in the Canadian Journal of Fisheries and Aquatic Sciences estimates that the Deepwater Horizon spill could have an \$8.7 billion impact on the Gulf of Mexico economy, including 22,000 job losses.<sup>4</sup> A report prepared by Oxford Economics for the U.S. Travel Association noted that tourism in the region was expected to fall by 10-20%<sup>5</sup> and, according to a report prepared for the Louisiana Office of Tourism, leisure spending is expected to be impacted through to the end of 2013.<sup>6</sup> BC's tourism industry employs 127,000 people,<sup>7</sup> a large proportion of whom could be affected depending on the size of a spill and the breadth of media coverage.

##### Farming and agriculture

The Fraser Valley contains some of the more fertile farmland in the world, supplying a significant percentage of BC's food consumption.<sup>11</sup> Studies in other locations have found that crude oil spills impacted food production by increasing soil acidity and toxicity.<sup>12</sup>



## Port trade and coastal industries

A tanker spill could close the Port of Vancouver, which trades \$75 billion of goods each year,<sup>8</sup> for days, weeks or even months. It would also disrupt fishing, prawning and other related activities on the Fraser River, which makes up a significant part of the regional economy. Salmon fishing alone contributes \$750 million a year to BC's GDP.<sup>9</sup> Although no economic analysis has been done to date focused on BC's south coast, the same 2012 UBC study mentioned earlier estimated that a single large-scale incident could cost local fishermen, the Port of Prince Rupert, BC Ferries and marine tourism operators roughly 4,000 full-time jobs.<sup>10</sup>

## What would be the direct cost of a spill?

It is impossible to know how much an oil spill would cost. However, it is possible to estimate some of financial risks associated with a project like this based on historic major spill scenarios including the Exxon Valdez, Deepwater Horizon and the Enbridge Kalamazoo River spill.

### Direct costs of historical oil spills

*Adjusted for inflation*

Enbridge Kalamazoo River <sup>13</sup> (2010) .....	\$725m
BP Deepwater Horizon <sup>14</sup> (2010) .....	\$41.6b*
Exxon Valdez <sup>16</sup> (1989) .....	\$6.3b
Amoco <sup>16</sup> (1978) .....	\$3b

\*Clean-up is still ongoing and total cost may remain unknown for several years

In Washington State, the Department of Ecology conducted a 2004 study on the potential impacts of an oil spill. They concluded that a major spill could cost up to \$10.8 billion USD and adversely affect 165,000 jobs within the state, in addition to direct clean-up costs.<sup>17</sup>

The UBC study mentioned above found that a medium-sized spill on BC's north coast could have a regional economic impact of up to \$189 million with estimated direct clean-up costs of \$2.4 billion and a large-scale spill could have a regional economic impact of up \$308 million in output with estimated direct clean-up costs of \$9.4 billion.

## Who would pay?

In our initial report, we stated that Kinder Morgan held \$1.3 billion insurance in the case of a spill on land. However, it now appears that this insurance does not apply to land-based spills. In actual fact, it is uncertain how much insurance, if any, Kinder Morgan holds to cover costs arising from a spill on land. If a major spill happened along the pipeline route, there is a high risk that costs would fall to the BC and Federal government, as the BC government's technical analysis on the conditions to support heavy oil pipelines has noted.<sup>18</sup>

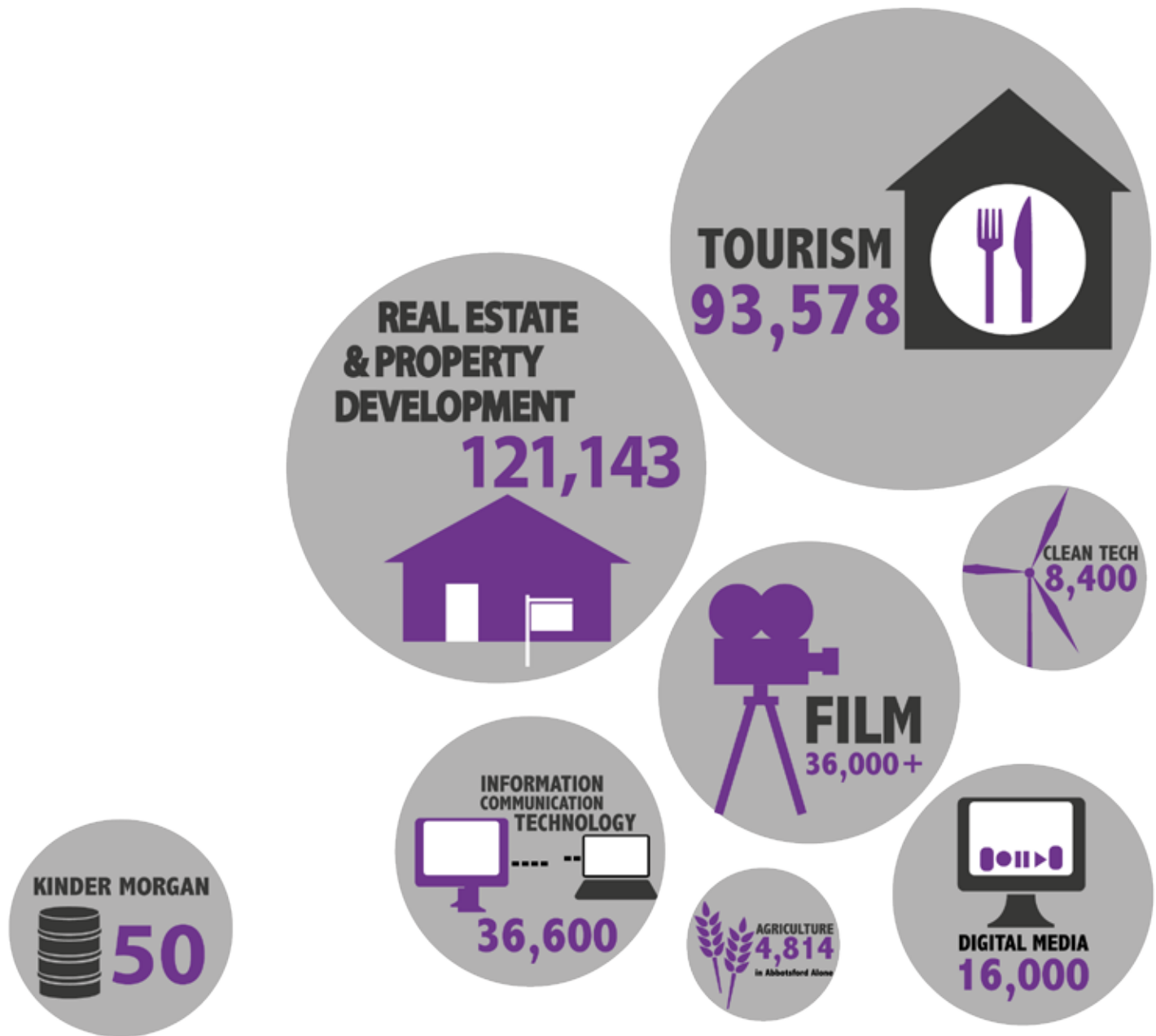
Kinder Morgan's Trans Mountain expansion is legally structured as a limited liability partnership (LLP). LLPs are not an unusual structure; since the Exxon Valdez spill, most oil companies have structured themselves in this way. However, the LLP structure means that there are real uncertainties about whether Kinder Morgan would provide any financial resources if a spill claim exceeded their insurance coverage. The City of Vancouver has proposed a bylaw that would force Kinder Morgan to carry enough insurance to cover the entire cost of a worst-case spill; however, this has not yet been passed.<sup>19</sup> UBC's University Neighbourhoods Association has also requested proof of insurance against direct and indirect local spill damage. It has not yet been provided.

## Ship source spill liability

A study by the University of Victoria's Environmental Law Centre found that Canadian law would be highly inadequate in the event of a large oil spill at sea.<sup>20</sup> Once the bitumen or other product has been loaded onto a tanker, Kinder Morgan is no longer liable for any leaks or spills that may occur and the liability is transferred over to ship owners, where there are significant liability risks.<sup>21</sup> As many of these vessels are registered as international companies with secret boards, it is difficult to know much about their reputations.<sup>22</sup> Even if the ship owner was proven to be at fault and was asked to pay for the cost of the spill, the success of recovering amounts in excess of insurance limits is dependent on that person or corporation's assets. In some instances the only asset the ship owner will have is the ship. Although there are several funds available to cover the cost of marine spills, the maximum total funds available through all the compensation schemes combined would be capped at approximately \$1.34 billion.<sup>23</sup>

# Jobs Created and Jobs Risked

## The Economics of Kinder Morgan's Proposed Trans Mountain Expansion



### JOBS CREATED

(Plus temporary construction jobs)

### JOBS RISKED

(Up to 43% of these jobs could be affected by a spill)

#### INFORMATION SOURCES

Film, digital, clean tech, ICT and accommodation/food: all from the Vancouver Economic Commission <http://www.vancouvereconomic.com/>  
Agriculture: Fraser Valley Regional District report: Agricultural Economy <http://www.fvrd.bc.ca/AboutUs/Pages/DistrictStatistics.aspx>  
Real Estate: Real Estate Board of Greater Vancouver and Fraser Valley Real Estate Board  
Property Development: the Urban Development Institute  
Trans Mountain expansion: Kinder Morgan website <http://www.transmountain.com/benefits-for-british-columbia>

## 4. Would the expanded pipeline serve local energy needs?

### Energy versus fuel

When assessing local energy needs, it is important to note that crude oil and diluted bitumen travelling from the oil sands cannot contribute towards BC's electricity or heating needs (with the exception of remote rural or northern communities that may use diesel for heating). Oil sands products that are refined locally serve fuel needs for transportation, particularly cars, trucks and aviation.

### Meeting local fuel demand

The original purpose of Trans Mountain pipeline was to supply oil for Lower Mainland use. Today, the pipeline supplies approximately 90% of BC's gasoline and diesel.<sup>1</sup> Some of this arrives through the pipeline as refined products, and the rest arrived as crude product and is processed by the region's one refinery, operated by Chevron and located in Burnaby, which produces approximately 50,000-55,000 barrels of gasoline and other fuels per day.<sup>2</sup>

**Where the fuel goes:** As the pipeline's capacity has increased incrementally under the ownership of Kinder Morgan, the proportion that is refined and used to meet domestic energy needs in BC has shrunk significantly, and today the majority of pipeline crude oil is exported for profit.

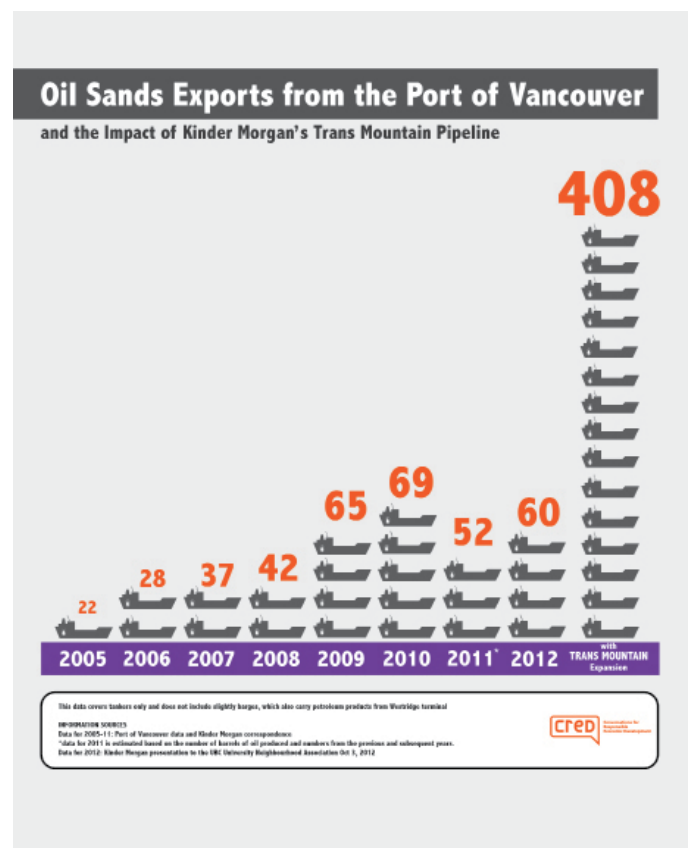
According to Kinder Morgan's data, in 2010:

- 25% of pipeline products were refined for use in the Lower Mainland
- 4% stayed in Kamloops
- 44% percent travelled via pipeline to Washington state
- 27% percent was loaded onto tankers for shipment.<sup>3</sup>

### Oil for export

Between 2005 and 2012 marine traffic exporting Trans Mountain crude oil rose from 22 to 96 tankers per year, reflecting a growing demand from overseas markets beyond the US.<sup>4</sup> If the expansion is approved, Kinder Morgan intends to increase marine exports to at least 444 vessels per year - a full 78.6% of total pipeline capacity.<sup>5</sup> Some of these exports would likely go to California and the rest would be for new markets.

When exports to Washington are added into consideration, there is a high risk that Chevron's Burnaby refinery will be forced to continue to import crude oil using other transportation methods to meet local fuel demand. Kinder Morgan executives have confirmed that the Trans Mountain Expansion Project is an export strategy and is not focused on local energy security.<sup>6</sup>





## 5. If the project goes ahead, how likely is a leak or spill?

### On land: along the pipeline route

**Some spillage is inevitable and is counted by pipeline operators as a routine expense.** In Canada, an average of 44 leaks per year are reported to the National Energy Board from pipeline systems at pumps, valves and other fixtures, and two ruptures per year are reported along pipelines. Each year, on average, there is one leak per 11,100 kilometres of pipeline.<sup>1</sup> Industry figures show that more than 3.4 million litres of fossil fuels have been accidentally released from pipelines every year in Alberta since 2006.<sup>2</sup>

**The Trans Mountain line:** Since reporting began in 1961, operators of the Trans Mountain pipeline have been responsible for 78 spills along the pipeline route.<sup>3</sup>

**Risks from diluted bitumen:** Diluted bitumen typically must be piped under higher temperatures and pressures - raising the risk of pipeline failures.<sup>4</sup> These leaks can have serious impacts, including toxic substances leaching into the ground. One litre of spilled oil can contaminate a million litres of groundwater.<sup>5</sup>

#### A history of local incidents

- In October 1978, the freighter Japan Erica crashed into the Second Narrows CN rail bridge, shutting down North Shore bulk terminals for three months.
- In August 2006, the Westwood Anette punctured a tank on a piling near Squamish and spilled 29,000 litres of fuel.<sup>6</sup>
- In March 2006, the Queen of the North ran aground and sank 130 km south of Prince Rupert, carrying 246,000 litres of fuel cargo. Ongoing oil discharges from the sunk vessel remain an environmental concern.<sup>7</sup>
- In December 2012, the coal freighter Cape Apricot collided with a conveyor at the Westshore Terminals port, spilling 35 tonnes of coal powder into the waters off Roberts Bank.<sup>8</sup>

### Spill prevention: regulation and monitoring

Traditionally, regulation and monitoring of oil and gas development projects have been the responsibility of the arms' length National Energy Board and the federal government. Recent sweeping changes have significantly reduced the federal government's role in monitoring and regulating development activities, and previously independent NEB decisions can now be overruled by the federal cabinet. More streamlined environmental approval processes, reduced consultation with First Nations governments, less research capacity and different communication protocols are all indicative of a significantly diminished role for the federal government.<sup>13</sup> Under these circumstances, it is important to decide if current oversight is sufficient to ensure the safety of Canadians.

### At sea: tanker spills and leaks

**There are no fail-safe methods to transport oil or diluted bitumen over water.** While industry has made strides in lessening the frequency of oil spills, there are approximately four major oil tanker spills a year globally.<sup>9</sup>

In 1999, a Coast Guard analysis estimated that a major spill could be expected in Canadian waters every seven years.<sup>10</sup> Since then, safety technologies have improved but tanker traffic has also increased significantly, so the current risk is difficult to measure.

**Human error:** Accidents such as collisions and grounding are the leading cause of large spills. So while the technology of tankers has improved, there are still people at the heart of tanker operation and human error is inevitable.

**In Burrard Inlet:** Between 1998 and 2008 there were 17 reportable marine incidents in the Second Narrows Movement Restricted Area.<sup>11</sup> Aframax tankers that pass through the Burrard Inlet leave just 1.5 metres of clearance between the ocean floor and the ship's keel. And while vessels are double hulled and escorted by tug, because of their weight and size, tankers navigating through the Inlet must wait until daylight high tide before passing through.

In 2010, the Auditor General recommended that a comprehensive risk analysis was needed, as Canada is unprepared to respond to a large ship source oil spill.<sup>12</sup> This analysis has yet to be carried out.

## 6. What would the spill response process be?

### Response process on land

Any spill over 1.5 cubic meters must be reported to the National Energy Board.<sup>1</sup> When oil is spilled at a pump station (i.e. Burnaby or Sumas), the company is often able to contain it. If a spill happened along the pipeline route, complete containment would be impossible. Instead, the strategy would be to recover as much as possible, what the BC Ministry of Environment terms “removal and remediation”. At the moment, there is no requirement for responsible parties to carry out restoration of damaged species or habitats, or public spaces.<sup>2</sup>

### Marine response process

**Who leads the response:** If the shipowner or another party accepts responsibility, they would set off an Incident Response Command chain of action. Ship owners are required to have contracts with the Western Canada Marine Response Corporation, which is able to respond to a spill within between six and 72 hours, depending on the spill size and location.<sup>3</sup> If the responsible party can't be found, the Coast Guard will lead clean-up efforts. The closest Coast Guard ship is located 30 minutes away in Richmond.

**Clean-up techniques:** Booms, skimmer and other techniques seen in the Deepwater Horizon and Kalamazoo River spills would be deployed. However, booms can only be used in calm waters so weather conditions would significantly affect spill response. In addition, if the heavy bitumen sinks to the bottom of the water, as it was found to do in the Kalamazoo River<sup>4</sup>, these techniques would not be effective.

**Recovery rates:** In the case of a diluted bitumen spill, lighter oils in the mixture could evaporate, leaving behind the heavy viscous bitumen. Transport Canada has noted that responders to the Erika spill of the French coast in 1999 experienced a recovery rate of just 5% for viscous oils, since traditional recovery equipment either didn't function properly or quickly became clogged.<sup>5</sup> Even in the case of conventional oil, a 10-15% recovery rate is considered success.<sup>6</sup> This means that at least 85% of the spill would be likely to remain in Burrard Inlet or on the ocean floor.

### Spill response preparedness

**Government oversight:** Both provincial and federal governments hold responsibility for hazardous spill response:

- The BC Ministry of Environment and federal government hold joint responsibility for land-based spills and those close to shore.
- The federal government is solely responsible for regulating shipping and navigation, as well as all environmental impacts at sea.
- The main federal bodies responsible are the Coast Guard and Transport Canada.

The International Maritime Organization, the Pacific Pilotage Authority and the Port Metro Vancouver are also responsible for the movement of oil at sea. The BC Oil & Gas Commission is responsible for oversight of land-based transport. Municipal and First Nations governments are responsible for conducting risk assessments and preparedness plans.

**Serious concerns:** Recent cuts to the Coast Guard will have an impact on the ability to respond to spills in a timely and efficient fashion, as the number of regional offices is reduced from five to three,<sup>7</sup> and the Kitsilano and Vancouver stations are closed. Environment Canada has also said it will close its Vancouver oil spill response offices and hand responsibility for federal response to a consolidated Montreal office.<sup>8</sup>

**A 2010 report from the Office of the Auditor General found that Canada is under-prepared to respond to a large ship source oil spill.**<sup>9</sup> According to the report, the Coast Guard:

- Has a national emergency management plan that is 10 years out-of-date.
- Does not verify the readiness of private sector response organizations to respond to spills.
- Lacks a reliable system to track the number, size or environmental impacts of spills.

The BC Government's Technical Analysis carried out in 2012 concludes that “*enhancing spill management on Canada's west coast is critical; existing capacity is insufficient for future tanker traffic.*” In the same report, the government noted that companies are often unwilling or unable to respond effectively to spills on land.<sup>10</sup>

## 7. What are the health and environmental risks of a spill?

### Health risks

**Uncertainties and conflicting opinions:** Because the large-scale transportation of diluted bitumen is relatively new, many of the health and environmental impacts of a spill are uncertain. There is conflicting information on the health impacts of exposure to crude oil and bitumen - while some studies claim that all oil exposure is toxic, other sources refute this, claiming instead that while refined light oils (i.e. gasoline and jet fuel) are indeed highly toxic, heavy crude oils do not pose a threat to human health.<sup>1</sup> There is also debate over whether diluted bitumen is more abrasive, corrosive and acidic than conventional crude.

**Airborne contamination:** What is certain is that diluted bitumen has added solvents that evaporate into the air in the case of a spill. Many of the solvent's components are a trade secret that companies are not required to divulge; however, benzene (a known carcinogen that is highly toxic through either short or long-term exposure)<sup>2</sup> and other neuro-toxins with proven health risks are widely understood to be included. In the case of a major spill, airborne contamination and resulting evacuation would be likely.

### Health impacts in Kalamazoo, Michigan

In the case of the Kalamazoo River spill, the only major diluted bitumen spill to date, local residents and EPA responders discovered bitumen and diluent do not stay together once released into the environment.

As the diluent separated from the bitumen, toxic fumes of benzene and toluene began spreading through the air. In total, almost 60 per cent of the local community experienced adverse symptoms including nausea, dizziness, headaches, coughing and fatigue.<sup>3</sup> Health officials recommended evacuation of those living close to the spill and clean-up crews were given respirators to protect them from toxic fumes.<sup>4</sup> Sections of river were closed immediately and only began reopening almost two years after the spill.<sup>5</sup>

### Environmental risks

**Impacts of a land-based spill:** The environmental impacts of an oil spill on land are generally localized, and therefore carry less risk than water-based spills. However, there would still be local impacts to habitats, wildlife and recreational areas. In addition, studies have shown that land-based spills can contaminate groundwater for many years and at distances up to thousands of meters from the spill source.<sup>6</sup>

**Impacts of a marine spill:** Diluted bitumen is toxic to marine life, difficult to clean up and likely to persist for decades in water, beaches, sediment, and entire marine environments. Put simply, the environmental impacts of a large oil spill in Burrard Inlet or anywhere in the Salish Sea would be catastrophic, far-reaching and long-lasting.

The BC Government's technical analysis noted that: *"The legacy of a spill and cleanup can last for decades. Indeed, the impacts from the Exxon Valdez spill have still not been completely addressed."* It goes on to note that ongoing chronic impacts have been noted in many species, and some were still continuing to decline as of 2004.<sup>7</sup>

**The west coast's vulnerable ecosystem:** The Burrard Inlet is one of Canada's most productive marine and terrestrial ecosystems. A spill of any size would impact many different species of fish and wildlife at various life stages.<sup>8</sup> A spill would also put one of the west coast's most iconic mammals at risk: orcas are shown to be impacted by oil exposure and are unlikely to be able to detect and avoid spills.<sup>9</sup>

**Persistence:** Scientists have just started studying the impacts of oil spills over time, painting a more complex portrait of what happens. On land, it appears that although the bulk of the damage happens quickly, the oil then moves underground and continues to do low-level damage to wildlife over many years. A study of marshlands affected by a 1969 oil spill in West Falmouth, Massachusetts discovered similar concentrations of soil contamination 30 years later.<sup>10</sup> At sea, the persistence of impacts is similar: some scientists have even suggested that impacts of the Exxon Valdez spill may persist for centuries.<sup>11</sup>

## 8. What is the global significance of this project?

For a full picture of the project's risks, it is important to understand the connections between the Trans Mountain pipeline, the Canadian oil sands and global climate change.

### Trans Mountain and the Alberta oil sands

Building the Trans Mountain pipeline will only make economic sense if the oil sands undergo significant expansion. Therefore, the risks of oil sands expansion should also be considered when making an informed choice about this particular pipeline.

In 2011, the Alberta oil sands exported approximately 1.74 million barrels of crude or modified crude oil per day, mostly through existing pipelines, demonstrating that this level of export capacity already exists.<sup>1</sup> However, companies operating in the oil sands have approvals to produce over 5.2 million barrels of oil per day, with another four million barrels per day of permits in progress.<sup>2</sup>

The main justification for expansion of the Trans Mountain route (as well as other proposed pipelines from the oil sands to the coast) is to accommodate this expanded production.<sup>3</sup>

### Risks of oil sands expansion

Building the pipeline not only commits BC's west coast to a specific economic development path, but it will also set us on a global path where we need to prepare for a warming world.

A recent PWC report demonstrates that in order to maintain a likelihood of keeping climate change within 2 degrees celsius of warming (widely understood to be a 'safe' threshold beyond which serious climate tipping points will happen) the global rate of decarbonization needs to increase sixfold every single year for the next 39 years, a feat never before achieved.<sup>4</sup>

The oil sands are the fastest growing source of emissions in Canada.<sup>5</sup> Many studies show that if fully developed, they will likely release enough carbon to send the world over some significant climate tipping points. NASA climate scientist James Hansen has estimated that there are 250 gigatons of carbon locked in the tar sands - almost half of the entire global emissions budget.<sup>6</sup>

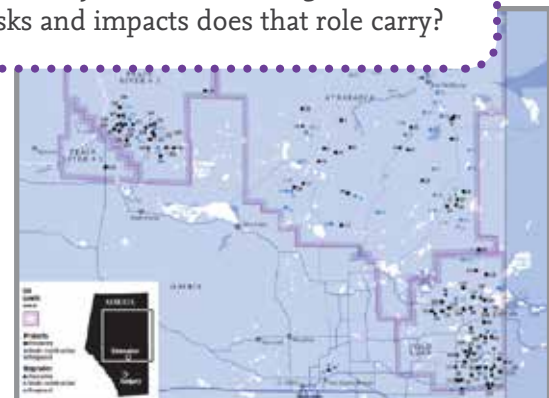
### Canada in a warming world

A recent National Round Table on the Economy and Environment (NRTEE) report warns that by failing to develop a low-carbon economy, Canada might be risking its competitiveness as carbon-intensive products become subject to trade restrictions, harming its international reputation and losing out on a first-mover advantage in the rapidly growing international market for low-carbon goods and services.<sup>7</sup> The report concludes that Canada is well placed to build upon existing strengths and innovate in other areas, from low-emission mining to electric car manufacturing, but in order to build these industries we need to act fast.

Past NRTEE reports in addition to the 2006 Stern Review make a strong business case for addressing climate change on the basis of cost-benefit analysis. Simply put, it will cost far more to deal with the impacts of climate change than it will cost to build a low-carbon economy.<sup>8</sup>

In addition, Canada will be impacted by a warming world. The 2012 Degrees of Change report maps out the most likely impacts Canadians will face at different levels of warming, including different agricultural patterns, altered rainfall, reduced winter seasons, a rapidly melting arctic and change in sea levels.<sup>9</sup>

There is a direct link between building the infrastructure for significant oil sands expansion and global climate impacts. Which begs the question: are we prepared to be a major contributor to global climate change? What risks and impacts does that role carry?



## 9. Who else is concerned about the pipeline?

### First Nations

Many First Nations governments in BC are concerned about new oil pipelines and the resulting increase in coastal tanker traffic. To date, 133 nations have signed the Save the Fraser Declaration, which opposes all tar sands projects in the Fraser River watershed and migrating salmon routes, and asserts their title and rights under Indigenous Peoples' laws.<sup>1</sup> The declaration expresses concern about the significant risk to watersheds and the plants, animals, fish and people who depend on them. Any oil spill would impact their ability to practice their way of life, including the ability to hunt, fish and practice cultural and spiritual traditions.

The Squamish and Tsleil-Waututh Nations have also formally declared opposition to Trans Mountain expansion in a Save the Salish Sea declaration.<sup>2</sup>

### Municipal governments

The Cities of Burnaby, Vancouver and West Vancouver<sup>3</sup> have all passed resolutions against the Kinder Morgan pipeline. The UBC University Neighbourhoods Association has expressed serious concerns and in September 2012 the Union of BC Municipalities passed a resolution opposing any pipeline projects that would result in an increase in tanker traffic in coastal waters.<sup>4</sup> They are particularly concerned that BC communities will bear most of the project's risks without accruing many of the benefits.

### In a recent poll of British Columbians:

- 50% of respondents oppose the proposed new Trans Mountain pipeline
- 22% support the proposal
- 70.9% of respondents who know a great deal about the proposal oppose it
- People living along the pipeline route rank pipelines and tankers as a top issue facing BC, just slightly behind the economy / financial crisis

### BC residents

**Local communities:** In Burnaby<sup>5</sup> and the Fraser Valley<sup>6</sup>, local residents concerned about the risk of pipeline spills in their communities have formed groups to oppose Kinder Morgan.

**Wider opposition:** There has also been more widespread citizen opposition to the project. In September 2012, thousands of people came together in Victoria and in communities across BC to protest pipeline expansion as part of the Defend Our Coast campaign.

**Public opinion:** Surveys show that the majority of general public sentiment is opposed to the project. A Stratcom poll carried out for the Living Oceans Society in August 2012 showed that 50% of all BC residents and 52% of those living along the pipeline route oppose the project, compared to only 22% who support it. In addition, the more people were informed about the proposal, the more likely they were to strongly oppose it. Amongst residents who had heard a great deal about expanding oil pipelines and tanker traffic in BC, 70.9% were opposed to expanding the Trans Mountain pipeline.<sup>7</sup>

### Environmental organizations

Many environmental organizations actively campaign against oil sands expansion because of concerns about climate change, environmental degradation, water contamination, and the detrimental impact on communities living in northern Alberta who have been negatively impacted by oil and gas development, in particular First Nations. A few organizations are also actively campaigning against the Kinder Morgan pipeline, including the Wilderness Committee, the Council of Canadians, Tanker Free BC, the Living Oceans Society, the Georgia Straight Alliance, West Coast Environmental Law and Forest Ethics Advocacy.

## 10. What happens next?

### The application process

Kinder Morgan has not yet filed a formal application with the National Energy Board (NEB). Their target date for this step in the process is early 2014.

If Kinder Morgan decides to put forward a full proposal, the NEB will then carry out a regulatory review, assessing proposal details, environmental and socio-economic impacts. Consultation with members of the public and First Nations governments will occur at some point in this process. Impacted parties, including local residents, government officials and other individuals, may be granted the ability to intervene in the NEB hearings. During the review process, Kinder Morgan will be required to set out a detailed pipeline route.

At the end of the regulatory review, the NEB will recommend whether the project should go forward. Lastly, the federal government will have the option of overriding the NEB's recommendation.<sup>1</sup>

If the project is approved, Kinder Morgan aims to start construction in 2016 and complete the new pipelines in 2017.

### Kinder Morgan's timeline

Major project milestones as represented on the Kinder Morgan Trans Mountain website:<sup>2</sup>

- **LATE SPRING/EARLY SUMMER 2012**  
*Meetings & discussions*
- **SUMMER 2012**  
*Continued engagement and tolling application*
- **JUNE 2012 TO SPRING 2014**  
*Continued engagement, studies and assessments*
  - Continue open and transparent engagement
  - Undertake comprehensive pipeline routing studies, traditional knowledge studies and socio-economic assessments
- **LATE 2013**  
*Filing of comprehensive facilities application*
- **2014 TO 2015**  
*Regulatory review*
- **2016 to 2017**  
*Proposed construction dates*
- **2017**  
*Proposed start date for operations*

## SOURCES AND END NOTES

### Need to know facts: pipeline history and proposal details

1. Royal Commission on Energy Second Report, 1959 <http://epe.lac-bac.gc.ca/100/200/301/pco-bcp/commissions-ef/borden1958-59-eng/borden1958-59-eng.htm>
2. In 2006, 2008 and 2011 Kinder Morgan applied for and received permission from the National Energy Board to reallocate crude oil from BC and Washington refineries for export by tanker to offshore markets
3. Economist Robyn Allan notes that the capacity could be much larger than 890,000 barrels per day. If Kinder Morgan could expand capacity by upgrading the pipeline's pumping power similar to Northern Gateway, the daily supply reaching Burnaby could be 1.1 million barrels a day. This could significantly raise the volume of tanker traffic in Burrard Inlet up to 475 crude oil tankers a year
4. All information from the Trans Mountain Project Plan: <http://www.transmountain.com/project-plan>
5. BC Ministry of Environment website [http://www.env.gov.bc.ca/wsd/plan\\_protect\\_sustain/groundwater/aquifers/absumas.html](http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/aquifers/absumas.html)
6. City of Chilliwack website <http://www.chilliwack.ca/main/page.cfm?id=205>
7. While calculating pipe throughput is complex and depends on factors including pressure, temperature and the speed that the liquid travels through the pipe, it is clear that the expansion would increase the capacity of the Trans Mountain route by significantly more than double
8. Here 'vessels' refers to both Aframax tankers and slightly smaller oil barges. Kinder Morgan does not include barges in their tanker statistics.
9. Kinder Morgan 2011 Analyst Conference, presentation by Ian Anderson [http://www.kindermorgan.com/investor/presentations/2011\\_Analysts\\_Conf\\_05\\_KM\\_Canada.pdf](http://www.kindermorgan.com/investor/presentations/2011_Analysts_Conf_05_KM_Canada.pdf) and Port Metro Vancouver Overview of Shipping in the Region, 24 November 2010 [http://www.metrovancouver.org/boards/Port%20Cities%20Committee/Marine\\_Shipping\\_Safety\\_Presentation.pdf](http://www.metrovancouver.org/boards/Port%20Cities%20Committee/Marine_Shipping_Safety_Presentation.pdf)
10. Don Whiteley, Dirty Little Secret, March 2009, <http://www.bcwaters.org/2009/May%202009/Dirty%20Little%20Secret.pdf>, p.3; Don Whiteley, Oil exports to Asia drive expansion plans at B.C. ports in Vancouver and Kitimat: Dredging First and Second Narrows in Burrard Inlet to allow passage of larger ships is already on the agenda, Special to The Sun, December 2009, <http://www.vancouversun.com/business/story.html?id=2291515>
11. Alberta Energy website: <http://www.energy.gov.ab.ca/oilsands/793.asp>

Image sources: Tanker map created by the Sierra Club of BC. Pipeline route map from [www.pipelineobserver.ca](http://www.pipelineobserver.ca)

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Fire Department

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**SUBJECT: TRANS MOUNTAIN TANK FARM  
TACTICAL RISK ANALYSIS**

**DATE: 2015 May 01**

Chris Bowcock  
Deputy Fire Chief

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In light of the Trans Mountain Expansion Project (TMEP) proposal by Kinder Morgan Canada (KMC) at the Trans Mountain Tank Farm (TMTF) facility, this evidentiary paper has been to analyze the fire and safety risks, hazard events and consequences associated with the project.

Each of the risks outlined have been validated as legitimate, based upon actual occurrence within the hydrocarbon industry in North America within the past decade, with the specific event occurrences being referenced. The hazard events and consequences are identified industry standard considerations with regard to emergency management of crude oil storage facilities.

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## Executive Summary

On 16 December 2013, Kinder Morgan submitted an application to the National Energy Board (NEB) for the expansion of the Trans Mountain Pipeline system, which includes the expansion of the Burnaby Mountain Terminal from 13 storage tanks to 26. The findings of the fire safety and risk analysis within this paper raise concerns over KMC selection of the Burnaby Mountain Terminal for the densification of storage tank use. Based on the findings of the analysis, the Burnaby Mountain Terminal is not the appropriate location for the expansion of the Burnaby Mountain Terminal as it poses significant constraints from an emergency/fire response perspective, including but not limited to safety of firefighters and effectiveness to combat fire; containment and extinguishment of fire/spill/release; evacuation of employees within the Burnaby Mountain Terminal facility; evacuation of adjacent neighbourhoods, as well as broader areas impacted by release of sulfur based gases and toxic smoke plumes; and, protection of adjacent properties, including conservation lands.

Additionally, the TMEP lacks appropriate consideration for original facility fire protection premises and industry best practices in petroleum storage and fire protection, as the proposal only seeks to comply with minimum federal and provincial code requirements.

This paper has analyzed and identified the impacts of the TMEP with regard to the *reduction in countermeasures* and resulting facility susceptibility to *consequences* resulting from *hazard event* occurrence.

## Countermeasures

The increased consequences arising from risk occurrence is a direct result of the facility configuration changes and additional storage tank locations which reduce the positive impact of the previously engineered fire and safety protection countermeasures. The Countermeasures which will be marginalized by the TMEP, include:

- **Tank Spacing**
  - A 33% reduction in the overall facility Tank Spacing
  - A 45% reduction in the proposed Tank Spacing versus existing Tank Spacing premise
- **Application Positions**
  - A 70% increase in the number of Storage Tanks that do not provide safe deployment positions for fire operations in all potential wind conditions.
  - 100% of the proposed Storage Tanks do not provide safe deployment positions for fire operations in all wind conditions.
- **Distance to Fenceline**
  - A 30% reduction in the facility average Tank to Fenceline Distance
  - A 61% reduction in the average proposed Tank to Fenceline Distance



## Hazard Events

The TMEP degrades the original fire protection premise of the facility and increases the likelihood of spill or fire extension exposing the community to the following hazard events.

- **Regional Seismic Event**

The consequences of a seismic event occurrence are increased due to the location of the facility elevated immediately above residential communities and sensitive environmental areas, watercourses and eco-systems in close proximity, in the outfall downhill direction.

- **Flammable Gas Outfall**

The lighter components of the crude oil when released form flammable outfalls with low ignition points and the significant potential to propagate explosion and fire events.

- **Release of Sulphur based Gases**

The loss of containment of crude oil products presents the potential for poisonous Hydrogen Sulfide and Sulphur Dioxide release.

- **Watercourse Outfall of Liquid Crude Oil Release**

The release of Crude Oil to areas outside of lined secondary containment diking creates the potential of a crude oil introduction into watercourses exiting the TMTF facility.

- **Tank Fire Burnout**

The operations associated with protection of adjacent tanks and the Burnaby Mountain Conservation Area, as well as evacuating persons potentially impacted by a 4 day tank fire event from a facility with such tight proximity to high density residential communities would require an emergency activation of provincial scale.

- **Tank Fire Boilover**

The potential for Boilover exists in any wide boiling range hydrocarbon, such as a crude oil storage tank full surface fire. For a proposed 200' storage tank, a Boilover event can discharge heated and molten crude oil outwards to 2,000', resulting in large area life hazard and the potential for propagation of additional storage tank fires.

## Consequences

The Trans Mountain Expansion Project (TMEP) will create elevated risk and consequences of risk occurrence to the community by increasing the number and size of hydrocarbon storage tanks within an already geographically challenged facility. Hydrocarbon storage tanks on Burnaby Mountain present several public safety risks, which include increased potential for, include:

- **Flammable Gas Outfall against the Fenceline**  
The potential for flammable gas ignition outside the fenceline is based upon the use of the land areas in proximity to the fenceline. The highly populated areas around the TMEP present a high likelihood of ignition.
- **Release of Sulphur Based Gases against the Fenceline**  
Highly toxic Hydrogen Sulfide (H<sub>2</sub>S) will very quickly, upon facility release, expose residential areas to conditions that are immediately dangerous to life. Smoke outfalls from fire event may contain Sulphur Dioxide (SO<sub>2</sub>), in which KMC analysis shows a potential health concern could be felt up to 5.2 km. downwind.
- **Release of Toxic Smoke Plumes against the Fenceline**  
The potential health impacts of exposure to by-products from crude oil combustion are most notably likely to harm those with pre-existing chronic respiratory conditions, increase rates of asthma and cardiovascular illness, with potentially undetermined effects on longer term illness accumulations such as cancer.
- **Heat Discharge against the Fenceline**  
The TMEP reduces the Heat Source distance to Wildland Impact and potential Wildfire exposure of the Burnaby Mountain Conservation Area by 66%.  
The existing TMTF is designed with a set back or buffer distance of not less than 200' from the fenceline.

## **Conclusions**

The TMEP will increase the impacts associated with the risks of crude oil loss of containment or fire across all potential event types due to the increased proximity to residential population densities, highly susceptible conservation forest areas and downhill or downwind sensitivities. The event elapse time prior to life and environmental impact will be significantly reduced by the TMEP, as has many of the engineered in facility configuration countermeasures responsible for the minimization of event growth and corresponding impact escalation have been greatly reduced from original facility premises which fundamentally adhered to the intent of best practices, to the reduced performance of minimum code requirements.

The existing high consequence event potential of a regional seismic event will tax the TMTF facility as the tertiary containment system has not been proposed to be upgraded nor will the secondary containment provisions of existing storage tanks, creating a potential release of 40% of the volumetric crude oil from the facility or up to 2.24 Million Barrels of crude oil. The impact of this loss is not increased by frequency of event occurrence, but by the TMEP not incorporating site wide upgrades to maintain the countermeasure premises currently in place.

Fires occurring in this tank farm will have a potential to be severe in magnitude. Inherent in the layout of this tank farm is the potential of a fire event occurring in such close proximity to adjacent tanks, that subsequent ignition of additional storage tanks is a dangerous reality. A significant emergency management concern in a facility of this type is the escalation from a single tank fire to a multiple tank fire event. The resource requirements and the excessive complexity and risk to emergency responders, typically prevents the safe firefighting of a multiple tank fire event. The TMEP proposal includes the mass densification of the facility, adding many more and many larger product storage tanks. The addition of storage tanks decreases the distance between each tank. The distance between storage tanks is a key design and engineering feature provided to allow firefighters to effectively isolate an active tank fire, preventing a multiple tank fire event. The TMEP proposal effectively increases the risk associated with a multiple tank fire event due to the reduction in storage tank spacing.

The TMEP proposes the increasing of the tank farm storage tank density, by decreasing engineered tank isolation distances, which in turn increases the potential for fire event escalation through extension, in a facility that has reduced its internal fire protection capability without approval. Notable by its absence from the TMEP application to the NEB is a detailed analysis of the effect of the tank spacing reduction on the requirements of mobile and fixed fire protection countermeasures, and the subsequent changes to the fire protection premises currently utilized. Weaknesses in the design of a facility can create fire event situations that cannot be safely or effectively mitigated without allowing a storage tank or several tanks to burnout.

The TMTF was originally approved based on the provision of a 2 tank diameter spacing. In subsequent years the addition of Tank 88 marginally reduced the overall facility tank spacing to 1.86 tank diameters (average), but maintained the original premise of tank spacing to provide tank isolation and reduce escalation and extension potentials. The TMEP massively deviates from the original safety premise and approval basis of providing storage tank isolation for proposed tanks at a proximity distance of 0.5 tank diameters.

The addition of storage tanks into the existing TMTF changes the risk control premises with regard to storage tank isolation by facility design. In order to achieve the desired storage tank volume, KMC is proposing a significant replacement of designed isolation of each storage tank. In essence, the TMEP shifts the control of hazard from an engineered approach of tank isolation, to an emergency response approach. As the authority having jurisdiction for fire protection approval within the City of Burnaby, the Burnaby Fire Department has recently been advised by KMC on May 30, 2014, that the facility no longer has the emergency response ability to extinguish fire events with internal facility resources, and that additional hydrocarbon specialized firefighting resources from regional facilities are no longer available.

To complicate the emergency control activities, because of the tighter tank spacing, many heat exposure cooling operations are not possible due to insufficient firefighting deployment positions. The TMEP proposed to group many tanks with common diking separated only by small intermediate dike segregation. These larger dikes areas reduce the available access and deployment roadway positions to facilitate safe, efficient and effective firefighting stream applications.

The decreased tank spacing within the tank farm has additional significant consequences. Many of the potential tank fire scenarios within the Trans Mountain Tank Farm facility would be inextinguishable due to lack of safe firefighting positions. The general configuration proposed by Kinder Morgan provides insufficient safe access routes and operating positions from which firefighters could apply protective streams to isolate or extinguish fire events. The elevation changes within the Trans Mountain Tank Farm do not provide multiple firefighting positions or consideration for approach elevations to enable safe and effective operations for all potential wind directions. In order to extinguish a tank fire within the Tran Mountain Tank Farm emergency responders could be forced to significantly risk their personal safety in order to overcome the design inadequacies of the facility. Specifically, the configuration of the tank farm on a hillside in such a tight footprint would require firefighting personnel to operate in elevated positions above the tank, exposing them to potentially excessive heat and smoke outfalls. In these instances emergency responders would likely be forced to allow the tank fire to burn out while adjacent tanks are protected.

The TMEP presents a significantly larger fire control risk within the TMTF. The identified increase in events with potential to escalate and extend to adjacent storage tank exposures due to insufficient firefighting deployment positions increases the likelihood of a multiple tank fire (including the potential of having to allow one or several storage tanks to burnout over 2-4 days), toxic smoke plume discharge (including long term chemical exposure to adjacent communities), and heat discharge to areas outside the facility (including high probability of fire extension to the forest areas of the Burnaby Mountain Conservation Area. The risk of community impacts outside of the facility from a TMTF fire event are increased by 70%.

The reality of employing a Burnout tactic for a Tank Fire event within the proposed TMEP configuration is that success associated with preventing fire extension throughout the TMTF and the adjacent community would by no means be assured. Significant potential exists that due to the proposed configuration, density, complexity and proximity to the community impacts and fire spread potentials that would create scenarios where fire containment is not possible.

The cost of this risk potential assumed by the community is not in line with the safety and risk management premises initially utilized for original facility approval by the City of Burnaby. The specific driver of the increased risk is the reduction in the effective of the facility design to limit fire event growth and restrict hazardous impacts to an immediately controllable area of impact during a short emergency response timeframe. It is critical for public safety that design configuration utilized support the protection of life, the environment and property. The TMEP does not provide the basic engineered safety provisions standard in high-impact potential facility design.

The potential for Boilover exists in any wide boiling range hydrocarbon, such as crude oil. For a proposed 200' storage tank, a Boilover event can discharge heated and molten crude oil outwards to 2,000'. A Boilover event occurring from a Tank Fire in the TMTF, the high hazard expected to receive the discharged heated and molten crude oil would encompass the entire TMTF, the Shellmont Tank Farm, the Forest Grove, Meadowood, and Sperling-Duthie Communities, closing Gaglardi Way and the Burnaby Mountain Parkway. It is anticipated that the consequences of Boilover exposure within the areas identified would include human injuries to emergency responders and unevaluated civilians, mass tree top based wildland fire initiation, structural fire initiation to many residential buildings, potential tank fire initiation within the TMTF and the Shellmont Tank Farm and significant isolation of the SFU and UniverCity communities.

The TMEP proposes a reduction in the tank to fenceline spacing of 30% on a facility wide comparison, and utilizes a new tank positioning premise which reduces the tank to fenceline distance by 61%. The decreased tank to fenceline distance and consequential impact potentials to the community presents the higher requirement and increased priority of evacuation operations conducted simultaneously with fire control activities. This response requirement significantly increases the emergency response resource requirements associated with identifiable emergency event potentials.

The TMEP significantly increases the urgency and expedience required to prevent community life and environmental impact outside the facility fenceline in the event of a product release or storage tank fire. The positioning of storage tanks in such close proximity creates a greater potential for citizen exposure within the adjacent communities to the hazardous effects of flammable gas outfalls and sulphur based gases. Additionally, the close proximity of storage tanks to the fenceline dramatically increases the risk of wildland fire to the Burnaby Mountain Conservation Area.

The process undertaken by KMC to seek expansion approval requires that the company, through its federal, provincial and municipal applications, accurately describes the project and its resultant operations within the proposed site. As such, the onus is on the applicant to document and commit to a project that meets the needs of the stakeholders impacted by the project and the authorities having jurisdiction.

What may not be noted by KMC is the aspect of regulatory compliance to City of Burnaby Bylaws, specifically the requirement for Emergency Response Plans and Fire Protection provision that the adequacy of which is determined, solely by the Fire Chief.

With this in mind, the Burnaby Fire Department is resolute in asking increasingly more detailed questions in order to address the increase in risk the TMEP will pose and the operation impacts the project will have on the Burnaby Fire Department and the community for which they advocate.

KMC has undertaken as part of their submission a Qualitative Risk Assessment on Facility Hazards. It is important to note in *section 3.2 Facilities* the KMC states that “*For each valid and independent consequence reduction measure the consequence level will be reduced by one.*” Presumably KMC intends to self-determine acceptable consequences, degrees of consequence reduction and levels of acceptable risk.

Following the NEB Intervener Round 1 Information Request process, in which details around the risk to safety created by the TMEP, KMC failed to answer any of the questions asked by the City of Burnaby and subsequently responded to the City of Burnaby by stating that “There is no further response required”.

No statement intent re approval of the Burnaby Fire Chief in accordance with City Bylaw NO.11860 is apparent within the submission. The point here is KMC has not provided sufficient detail for the Fire Chief to be apprised of the TMEP Facility Hazards or to comment on or approve of the adequacy of the consequence reduction measures. The key concept is that the Qualitative Risk Assessment team does not determine the adequacy of the consequence reduction measures; the Burnaby Fire Department Fire Chief has the responsibility and duty to do so.

## Risk

### Concepts of Risk

Both the regulatory agency and the applicant set levels of emergency preparedness based on risk. The difference is in the methodology of the risk analysis.

The hydrocarbon industry typically attempts to separate risk into two (2) categories. The first are those risks that can be shown to present no or little chance of occurring. These risks are identified as having an acceptably low level of frequency of occurrence.

The second are those risks that, due to their severity and probability of occurrence, require 'consequence reduction measures'. This is based upon criteria that affect the company's profitability in its broader sense (e.g. reputation, liabilities etc.). This process of risk assessment is based on an arguable premise: that sufficiently low frequency risks can remain unmanaged regardless of the severity of the consequence. This premise very often falls at odds with local government's expectation of "necessary".

The City of Burnaby uses a different framework for assessing risk since it has a much broader concern for the wellbeing and stewardship of its citizens and community than Kinder Morgan.

Hydrocarbon Tank Farms by the nature of the commodities received, stored and transferred out have inherent potential for emergency event occurrence. Loss of containment of hydrocarbon products and product ignition events resulting in tank fires and tank dike fire are primary emergency event potential for a Tank Farm.

The potential for a release of crude oil at the TMEP may occur by several specific means including tank overfill, the physical failure of containment provisions and human error damage associated with improperly controlled industrial work in proximity to tankage or piping. The loss of containment of crude oil is a much larger issue than the undesired exposure of the liquid product to the environment requiring collection and soil remediation operations which are very difficult to achieve 100% recovery.

A loss of containment can be provided is several means, including:

- Tank Dike Spill
- Tank Overfill to Secondary Containment
- 3D Pressurized Release
- Piping Loss Outside of a Diked Area

The TMEP proposes to utilize both External Floating Roof Tanks and Internal Floating Roof Tanks. The credible emergency event potentials for these two (2) types of tanks are (as specified by the American Petroleum Institute Recommended Practice 2021 – Management of Atmospheric Storage Tank Fires P.10 Table 1 & P.11 Table 2):

- External Floating Roof Tanks:*
1. Rim Seal Fire
  2. Overfill Ground Fire
  3. Obstructed Full Liquid Surface Fire
  4. Unobstructed Full Surface Fire

- Internal Floating Roof Tanks:*
1. Vent Fire
  2. Overfill Ground Fire
  3. Obstructed Rim Seal Fire
  4. Obstructed Full Liquid Surface Fire

- Special Hazards for  
Tanks Containing Crude Oil:*
1. Slopover
  2. Frothover
  3. Boilover



## Tank Dike Spill

### Description:

- The release of product either from the tank itself or the transfer piping inside the tank containment levee, where the product released accumulates inside the tank levee

### Event Validity:

- Embridge Tank Farm, Crude Oil Tank Farm Release, Mokena Illinois, 2012 Nov 20
- Arthur Kill, Storage Tank Release, Sewaren New Jersey, 2012 Oct 29
- Kinder Morgan, Spill Release to Levee, Abbotsford BC, 2012 Jan 24
- Kinder Morgan, Crude Oil Release to Levee, Burnaby BC, 2009 May 6
- Citgo Refinery, Crude Oil Release past Levee, Lake Charles Louisiana, 2006 July 19
- Louisiana area facilities, Product Release, Louisiana area, 2005 Aug 30

### Typical Cause:

- Tank overflow and piping/valve/flange failures are the typical causes of product loss to the secondary containment of the levee. Due to the volumes within the tank and the rates of flow through the piping systems, large volume losses are reasonable prior to isolation.

### Associated Hazards:

- The loss of containment of flammable products typically results in rapidly expanding and migrating areas of flammable vapor, creating fire and explosion hazards throughout the facility and potentially outside the facility fence line.
- Crude oil loss of containment presents a lower yet still significant risk of flammable vapor generation, but often releases toxic substances immediately hazardous to life. This is most significant with sour crude oil.

### Control Options:

- The early detection and isolation of the release source is critical to minimize the scope of a loss of containment event. For events that aren't easily or remotely isolated a large amount of product can accumulate prior control being achieved. The volume of product accumulated is directly proportionate to the amount of flammables released to the levee.
- With a large flammable or toxic release present, a difficult decision is required. The application of foam solution is the best alternative to suppressing the discharge of toxic outfalls and flammables from a hydrocarbon release. However, there is risk associated with applying foam to unignited flammables.
  - The risk of foam application is due to the generation of static charge from fire streams travelling through the air from the nozzle to landing point. The discharge of this static charge in the flammable vapor could create a product ignition and subsequent levee fire. This risk however does not apply for crude oil as it is not a static electrical charge accumulator.

- The risk in delaying foam application is that the areas exposed to flammable vapors and toxic outfalls will remain uncontrolled for a significant period of time, creating a risk of flammable ignition, fire, explosion and toxic exposure
- Sustained foam solution application from mobile or fixed monitors/pourers at a rate that achieves a comprehensive and maintained foam blanket, which includes:
  - Positioning and operation of high volume mobile foam discharge monitors consistent with available discharge positions, wind conditions and stream reach distances, such that foam applications can be made that land the foam solution accurately and gently at desirable application points within the levee
  - Positioning of connecting hose lines to and from foam proportioning equipment, water supplies, discharge devices and foam concentrate supplies
  - Operation of foam proportioning equipment and foam concentrate supplies
  - Water supply systems consistent with the required capacity to generate sufficient foam solution
  - Water pump and foam proportioning devices capable of providing sufficient foam solution for foam blanket application and maintenance
  - An emergency response team of 8 to 12 highly trained and equipped personnel supported by a highly function staff of facility operational personnel.
- Semi-fixed levee foam system, including:
  - Levee fixed foam pourers designed to apply foam solution comprehensively throughout the tank levee
  - Fixed foam lateral and piping connections to deliver the required foam solution volume to the foam pourers
  - Positioning of connecting hose lines to and from foam proportioning equipment, water supplies, discharge laterals and foam concentrate supplies
  - Operation of foam proportioning equipment and foam concentrate supplies
  - Water supply systems consistent with the required capacity to generate sufficient foam solution
  - Water pump and foam proportioning devices capable of providing sufficient foam solution for foam blanket application and maintenance
  - An emergency response team of 6 to 8 highly trained and equipped personnel supported by a highly function staff of facility operational personnel.
- Fully fixed levee foam system, including:
  - Levee fixed foam pourers designed to apply foam solution comprehensively throughout the tank levee
  - Fixed foam lateral and piping connections to deliver the required foam solution volume to the foam pourers
  - Fixed foam proportioning devices capable of producing foam solution at the required volume to achieve foam blanket application and maintenance
  - Foam concentrate and water supplies sufficient to provide a sustained foam application throughout the event
  - The system is pre-connected together such that the activation of the system requires control valve operation only, and can be operated by a team of two to three (2-3) operations personnel.

Consequences:

- The uncontrolled discharge of toxic and flammable vapor outfall, causing potential life hazards, fire and explosion.
- Fire and explosion against other risk areas within the facility fenceline
- Toxic and flammable outfalls outside of the facility fenceline
- Levee release ignition causing a full surface levee fire generating the toxic outfall of the products of combustion, heat exposure to the tank, and the potential for escalation to a tank fire
- The loss of containment within the levee spreading flammable products throughout the facility outfall retention system, causing potential of secondary fire areas and massively increasing the scope of the event and the subsequent resource requirements to mitigate

### **Tank Overfill to Secondary Containment**

Tank overfill is a common loss of containment scenario for stored crude oil. Even with the continued advent of computerized monitoring and alarm systems such as High Level Alarms, and High-High Level Alarms the overfilling of tanks and the subsequent loss of containment to the secondary containment dike areas still occurs. The containment dike provisions are critical in limiting the size of the spill area.

The risk associated with loss of containment from tank overfill is typically associated with operator error or mechanical/computerized monitoring system failure. The TMEP proposes crude oil product movements to increase by three fold at completion of the project, meaning a much greater impact by human operators on the operations at the TMTF.

### 3 Dimensional Pressurized Release

#### Description:

- A loss of containment generated from a partially damaged pipe, flange or valve, can create a release under pressure that discharges a fine crude oil mist.
- Crude oil released with by this means typically propagates a much larger flammable gas outfall due to the atomization and near 100% release of the light hydrocarbon components.
- Instead of a slow release of light end components from only the surface of the crude oil spill exposed to the atmosphere, the flammable components are released completely during the small droplet exposure to atmosphere.
- The flammable area, concentration and spread of a spill release of this type with a reasonable volume discharge prior to isolation, would be of much greater magnitude than is typically experienced with a tank overfill event.

#### Typical Cause:

- Caused by piping/valve/flange failure due to damage, over pressurization or inadvertent relief

#### Associated Hazards:

- Migrating exposure of flammable vapor and toxic outfalls throughout facility and against adjacent facility risks
- Increased potential to expose areas outside of the facility fenceline
- Increased likelihood to create a life hazard due to traveling flammable exposures

#### Control Options:

- Identification, isolation and restriction of flammable outfall to a controlled area
- Application of a dual agent stream (foam & dry chemical) to extinguish the pressurized fire.
- Sustained foam solution application from mobile monitors at a rate that achieves or exceeds the minimum application to achieve and maintain extinguishment of the accumulated product fire area, which includes:
  - Positioning and operation of highly mobile foam discharge monitors consistent with available discharge positions, wind conditions, heat exposures and stream reach distances, such that foam applications can be made that land the foam solution accurately and gently at desirable application points within product fire area
  - Positioning of connecting hose lines to and from foam proportioning equipment, water supplies, discharge devices and foam concentrate supplies
  - Operation of foam proportioning equipment and foam concentrate supplies
  - Water supply systems consistent with the required capacity to generate sufficient foam solution
  - Water pump and foam proportioning devices capable of providing sufficient foam solution for foam blanket application and maintenance

- An emergency response team of 8 to 14 highly trained and equipped personnel supported by a highly function staff of facility operational personnel.

*Consequences:*

- Escalation of the levee fire to a tank fire either within the levee or in an adjacent levee
- Spread of release fire through the facility's outfall liquid retention system
- Ignition via heat exposure to adjacent facility risks

## **Piping Loss Outside of a Diked Area**

Description:

- A loss of containment resulting from piping failures and physical damage occurring outside of secondary containment areas creates the potential for the spread of crude oil throughout the facility area in outfall directions until retention by tertiary containment is possible.

Event Validity:

- Chevron Inlet Refinery, Gasoline Release, Burnaby BC, 2012 Feb 21
- Chevron Inlet Refinery, Crude Oil Loss, Burnaby BC, 2010 May 27

Typical Cause:

- Caused by piping/valve/flange failure due to damage, over pressurization or inadvertent relief

Associated Hazards:

- Migrating exposure of flammable vapor and toxic outfalls throughout facility and against adjacent facility risks
- Increased potential to expose areas outside of the facility fenceline
- Increased likelihood to create a life hazard due to traveling flammable exposures

Control Options:

- Identification, isolation and restriction of flammable outfall to a controlled area
- Sustained foam solution application from mobile monitors at a rate that achieves or exceeds the minimum application to achieve and maintain extinguishment, which includes:
  - Positioning and operation of highly mobile foam discharge monitors consistent with available discharge positions, wind conditions, heat exposures and stream reach distances, such that foam applications can be made that land the foam solution accurately and gently at desirable application points within product accumulation, and move stream applications quickly to overcome release travel

- Positioning of connecting hose lines to and from foam proportioning equipment, water supplies, discharge devices and foam concentrate supplies
- Operation of foam proportioning equipment and foam concentrate supplies
- Water supply systems consistent with the required capacity to generate sufficient foam solution
- Water pump and foam proportioning devices capable of providing sufficient foam solution for foam blanket application and maintenance
- An emergency response team of 8 to 14 highly trained and equipped personnel supported by a highly function staff of facility operational personnel.

Consequences:

- Ignition of adjacent facility risks
- Trapping or restricting of safe exit routes to unprotected facility operations staff
- Limiting of safe access routes to emergency responders

## **Tank Vent Fire**

Internal Floating Roof Tanks have potential to experience ignition and fire conditions at the vents located on the perimeter of the tank roof. Ignition of the roof's vents typically occurs as a result of lightning strikes, static electrical accumulation or as an escalation event from a dike fire or adjacent tank fire.

Vent fire have the potential to cause ignition of the Internal Floating Roof tank's rim seal area when the pressure-vacuum valve fails to provide high-velocity movement to the exterior of the tank vent.

## Rim Seal Tank Fire

### Description:

- A rim seal fire is the ignition of the periphery edge seal closing the gap between the tank wall and tank roof on an Internal or External Floating Roof Tank.
- Ignition of the roof's rim seal typically occurs as a result of lightning strikes, static electrical accumulation or as an escalation event from a vent fire, dike fire or adjacent tank fire.
- Ignitable mixtures of light end components and air may occur at the rim seal during the initial fill of the tank and for up to 25 hours.

### Event Validity:

- Teppoco, Crude Oil Rim Seal Tank Fire, Texas City Texas, 2009 July 23

### Typical Cause:

- Accumulated induced charge ignition from area lightning strikes

### Associated Hazards:

- A rim seal fire will discharge a reasonable amount of smoke (Reference: Consequences - Release of Toxic Smoke Plumes against the Fenceline, P. 72). Typically, rim seal fire event are extinguishable with semi-fixed or fixed fire protection system. However, an explosive ignition of the flammables at the rim seal can occur with sufficient force as to damage the rim seal foam pourers or the floating roof.
- The historical premise of working from the tank perimeter walkway or roof during a rim seal fire event, has been dismissed in recent years due to the risk of exposure and the lack of rapid escape routes for firefighters.
- If left uncontrolled, heating of proximity roof components cause warping and damage that may allow product or firefighting agents to flood the floating roof.
- Application of foam solution via ground monitors presents a real risk of being applied to the hard roof portion with the potential to partially sinking the floating roof and escalating the fire to a full surface fire event

### Control Options:

- Foam application to a rim seal fire is best provided via fixed foam pourers attached to the tank wall. These foam pourers are designed to gently flow foam solution down the tank wall to the rim seal area. The multiple foam pourers are designed as a comprehensive system which will apply sufficient foam solution to the rim seal area in close enough proximity to each other that allows the foam solution to fill the rim seal area and flow together to completely suppress the rim seal fire.
- Foam delivery to the fixed foam pourers via a fixed foam lateral connection and piping
- Generation of foam solution through either fixed or semi-fixed foam system
  - A fixed foam system is a standalone automated foam generation and delivery system that includes foam pourers, foam lateral, water supply, foam

proportioning device and a foam concentrate supply. The system is pre-connected together such that the activation of the system requires control valve operation only, and can be operated by a team of two to three (2-3) operations personnel.

- Of critical importance is the maintenance and periodic testing of the fixed system to ensure proper operation during emergency events
- A semi-fixed foam system is a foam application system connected to the tank for effective delivery of foam solution that includes foam pourers and a foam lateral. The water supply, foam proportioning device and foam concentrate supply are typically mobile devices that are positioned, connected together and operated by a team of four to six (4-6) appropriately trained and equipped emergency responders. Of critical importance is:
  - The maintenance and periodic testing of the semi-fixed system to ensure proper operation during emergency events
  - The maintenance and periodic testing of the mobile equipment to ensure proper operation during emergency events
  - The ensuring the prompt availability of emergency response personnel
  - The maintenance of emergency response personnel training, skills, knowledge and abilities

Consequences:

- The greatest risk associated with a rim seal fire is the event escalation to a full surface tank fire. Event escalation to a full surface tank fire occurs when the floating roof sinks from initial explosion, warping due to long term heat exposure or from the weight of firefighting agents.
  - A rim seal fire when promptly dealt with will not accumulate sufficient heat to warp the roof components. The prompt control of the rim seal fire is contingent upon a properly functioning foam pourer, foam lateral, foam proportioning and water supply systems. A partial failure to any of these systems will constitute an ineffective fire attack of the entire system causing extended heat exposure and the potential for roof warping and sinking.
  - The partial blockage or the catastrophic failure of a rim seal pourer creates the opportunity for foam solution to be applied in undersigned directions. The high risk of this occurrence is the potential for foam solution to be applied directly to the floating roof, or to be applied at an excessive rate that overflows rim seal area.
- A rim seal fire escalation potential also exists if the foam pourers have been damaged and direct foam onto the floating roof inside of the foam dam. In this case, the fire may continue to burn at the rim seal indicating additional foam application, which would direct additional foam to the floating roof. If sufficient foam solution is applied inside the foam dam or where foam dam damage has occurred during ignition the floating roof may sink causing escalation to a full surface tank fire.
- Rim seal foam pourers are highly susceptible to a lack of maintenance. Foam pourers operating as designed provide a very effective fire suppression application. When



foam pourers are poorly maintained or are provided with an insufficient foam solution discharge rate, the fire attack they present ranges from ineffective to causing fire escalation. A common foam pourer system failure is the lack of consistent operation around the rim seal perimeter, causing areas of insufficient flow to lack foam solution, and other areas to have excessive foam flow which risks flooding the floating roof. Additionally, many unmaintained foam pourer systems experience an over-pressurization and resultant catastrophic failures by having the pourers break completely off. The loss or poor operation of just one (1) foam pourer significantly affects the performance of the entire foam pourer system.

- Water supply systems and foam lateral piping is highly susceptible to corrosion and scale build-up if not properly maintained. The release of metal corrosion and pipe scale during foam lateral emergency use causes an end-point accumulation of debris in the foam pourer. Rim seal foam pourers utilize a metal screen at the final discharge portion of pourer. This screen has two purposes: 1.) to keep wildlife from nesting within the pourer body, and 2.) to aerate the foam solution to create a highly engineered foam bubble. The size of the foam bubble is critical to providing the foam solution with maximum resistivity to thermal breakdown. The accumulation of metal and pipe scale debris at the foam screen will create a partial blockage of the screen surface area. Screen blockage creates the legitimate risk of providing an ineffective rim seal application or a rim seal application that has potential to discharge foam solution to the hard roof area risking roof sinking and event escalation to a full surface fire.
- A pontoon explosion during ignition has legitimate potential to damage the floating roof causing either:
  - An unobstructed full surface tank fire caused by a floating roof full submersion
  - An obstructed full surface tank fire caused by a floating roof partial submersion

## Full Surface Tank Fire

### Description:

- A full surface tank fire is a fire involving the entire horizontal surface area of the tank top
  - Internal floating roof tank fire occurs where the exterior roof has failed and is fully or partially displaced and the internal floating roof is partially or fully sunk.
  - External floating roof tank occurs where floating roof is partially or fully sunk.
- A full surface tank fire can occur in one of two forms; Obstructed or Unobstructed.
  - An unobstructed full surface tank fire occur to External Floating Roof tanks or to Internal Floating Roof tanks where an explosion has occurred with sufficient force to displace the frangible seam on the outer roof design to give way and expel the exterior roof.
  - An obstructed full surface tank fire occurs where ignition of the Internal Floating Roof Tank only partially dislodges the exterior roof or where the floating roof only partially sinks.

### Event Validity:

- Vopak Terminal, Diesel Storage Tank Fire, Essex England, 2013 April 29
- Indian Oil Corporation, Tank Fire (4 fatalities), Surat India, 2013 Jan 5
- Chevron Refinery, Tank Fire, Richmond California, 2012 Aug 6
- Merit Energy, Tank Fire, Samford Texas, 2012 May 8
- Petro China, Diesel Tank Fire, Dalian China, 2011 Aug 30
- Chevron, Tank Fire (4 fatalities), Pembroke Wales, 2011 June 2
- Petroleos de Venezuela, Tank Fire, Bonaire Dutch Caribbean, 2010 Sept 10
- Colonial Pipelines, Tank Fire, Greensboro North Carolina, 2010 June 13
- Sitatpur, Tank Farm Fire (11 Tank Fires), Jaipur India, 2009 Oct 29
- Caribbean Petroleum, Tank Farm Fire (30 Tank Fires), San Juan Puerto Rico, 2009 Oct 9
- Magellan Midstream Partners, Gasoline Tank Fire, Fairfax California, 2008 June 7
- Hertfordshire Oil Storage, Tank Farm Fire (20 Tank Fires), England, 2005 Dec 13

### Typical Cause:

- Incident escalation from a rim seal fire due to sinking of the floating roof
  - Foam solution applied and accumulating on floating roof
  - Warping and failure of floating roof due to extended heat exposure during rim seal fire event
- Explosion within an internal floating roof tank
- Floating roof pontoon explosion during ignition

### Associated Hazards:

- The mass discharge of Toxic Smoke Plumes for several hours to several days
- The mass discharge of heat against adjacent storage tanks for several hours to several days

- The mass discharge of heat to areas outside the fenceline for several hours to several days  
The heating of all piping, storage tanks and internal contents within 1 tank diameter in all directions (at equal elevation; with additional heat exposure to areas at greater elevations and reduced heat exposure to areas at decreased elevations)
- The heating of all piping, storage tanks and internal contents within 2 tank diameters in the downwind direction (at equal elevation; with additional heat exposure to areas at greater elevations and reduced heat exposure to areas at decreased elevations)
- The heating of all piping, storage tanks and internal contents within 1 tank diameter in all directions (at equal elevation; with additional heat exposure to areas at greater elevations and reduced heat exposure to areas at decreased elevations)
- The potential ignition of a Rim Seal Fire on External Floating Roof adjacent storage tanks
- The potential ignition of a Vent Fire or Rim Seal Fire on Internal Floating Roof adjacent storage tanks
- The potential for Slopover, Frothover and Boilover
- Loss of tank structural integrity due to tank warping from heat exposure causing product loss to levee

Control Options:

- Tank structure cooling required to prevent warping and tank failure in order to retain the product within the tanks and prevent exposure tank involvement
- Sustained foam solution application from mobile or fixed monitors/pourers at a rate that achieves or exceeds the rate required to extinguish, which includes:
  - Positioning and operation of high volume mobile foam discharge monitors consistent with available discharge positions, wind conditions, heat exposures and stream reach distances, such that foam applications can be made that land the foam solution accurately and gently at desirable application points to the tank fire surface
  - Positioning of connecting hose lines to and from foam proportioning equipment, water supplies, discharge devices and foam concentrate supplies
  - Operation of foam proportioning equipment and foam concentrate supplies
  - Water supply systems consistent with the required capacity to generate sufficient foam solution for fire extinguishment and fire water cooling streams simultaneously
  - Water pump and foam proportioning devices capable of providing sufficient foam solution for fire extinguishment and fire water cooling streams simultaneously
  - An emergency response team of 24 to 40 highly trained and equipped personnel supported by a highly function staff of facility operational personnel, an emergency operations centre and an incident command team.
  - Fully fixed full surface tank fire system, including:
    - Tank fixed foam pourers designed to provide extinguishment to full surface fire at rate consistent with a delayed application of foam solution
    - Fixed foam lateral and piping connections to deliver the required foam solution volume to the foam pourers

- Fixed foam proportioning devices capable of producing foam solution at the required volume to achieve extinguishment
- Foam concentrate supplies sufficient to provide a sustained foam application
- Water supply sufficient to provide foam solution and cooling fire streams simultaneously and consistently throughout the event
- Exterior facility operations which include proximity isolation, evacuation, security, access control and exposure heat wave fire extinguishment

Consequences:

- Burnout of the tank fire due to an inability to muster a fire extinguishing effort of sufficient affect. Burnout occurs when the entire product within the tank has burned away and what remains is insufficient to support fire. The pumping out of the tank on fire is often utilized to reduce time to burnout. The negative effects to the community are due to unsuppressed heat waves and airborne toxic outfall of the products of combustion that can continue for 2 to 4 days.
- Catastrophic heated product explosion and expulsion from a crude oil tank fire with delayed cooling and extinguishment efforts. Known as a “Boilover”, this event has a high hazard to life at a distance of 15 times the diameter of the original tank fire.
- Warping and heat breakdown of an uncooled tank exterior causing tank rupture and catastrophic loss of internal products to the dike, and likely subsequent levee fire or dike overrun and fire to adjacent areas of the facility and in outfall grade directions
- Adjacent tank fires propagated from heat wave exposures uncontrolled by tank cooling initiatives. The extinguishment of multiple fire events typically exceeds the capability of most regional industrial response cooperatives.

## Regional Seismic Event

The reality of the geographical area of southeastern coastal British Columbia is the expected occurrence of a high magnitude seismic event. Depending on magnitude and duration, a significant seismic event has potential to:

- Structural damage to piping throughout facility, causing loss of primary containment
- Structural damage storage tanks, causing a loss of primary containment
- Geo-physical damage secondary containment diking, causing loss of secondary containment
- Structural damage to fire water main, causing an inability for the system to provide the specified volume and pressure
- Structural damage to the fire protection semi-fixed and fixed systems, causing potentially ineffective fire applications
- Introduction of ignition sources from facility infrastructure damage
- Structural damage to Control Room, automated control and monitoring systems
- Geo-physical damage tertiary containment provisions, causing loss of facility containment

The consequences of a seismic event occurrence are increased due to the location of the facility. The TMTF is located, elevated immediately above residential communities and sensitive environmental areas, watercourses and eco-systems in close proximity, in the outfall downhill direction. The TMTF is located, immediately below a high density treed environmental conservation area, a highly populated university and high density residential community, in direct outfall uphill direction.

The resulting damage, loss of containment and fire potentials associated with an expected regional seismic event would likely encompass the following impacts:

- Long Duration exposure of Lochdale, Sperling-Duthie, Meadowood, Forest Grove, Simon Fraser University, and UniverCity to long duration flammable gas outfalls
- Long Duration exposure of North and Central Burnaby, West PortMoody and West Coquitlam to sulphur based gas outfalls
- Extensive wildland fire event extending across the Burnaby Mountain Conservation Area
- Residential structure fires across Wildland Interface with Burnaby Mountain Conservation Area
- Long duration exposure of environmentally sensitive watercourses to crude oil, including Eagle Creek, Brunette River and Burnaby Lake

## Countermeasures

### Facility Design

The design of a hydrocarbon facility is a critical component of the safety of the facility. Tank spacing, topography, distance to the fenceline, access/egress routes and overall facility configuration impact the risk, hazard, consequence and complexity of emergency management operations.

### Tank Spacing

The fundamental premise in reducing emergency event consequence is the designed isolation of initiating hazards from adjacent risks. Facility design must consider and attempt to configure components such that the possibility of a cascading, escalating, growth or moving/changing emergency event is reduced. Tank spacing is the primary method to which a hydrocarbon facility isolates hazards. By placing storage tank with sufficient separation, the risk associated with a multiple emergency event occurrence is reduced.

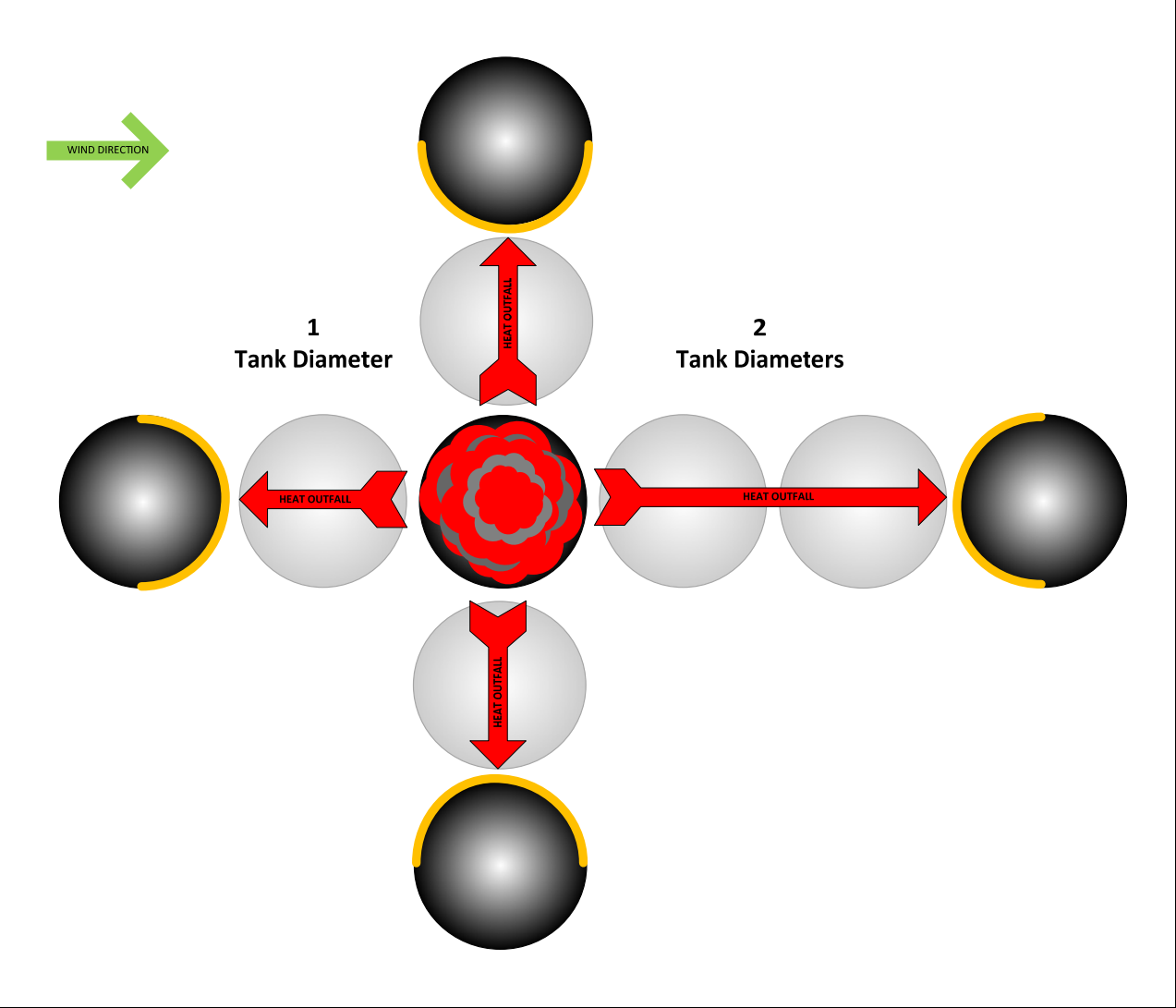
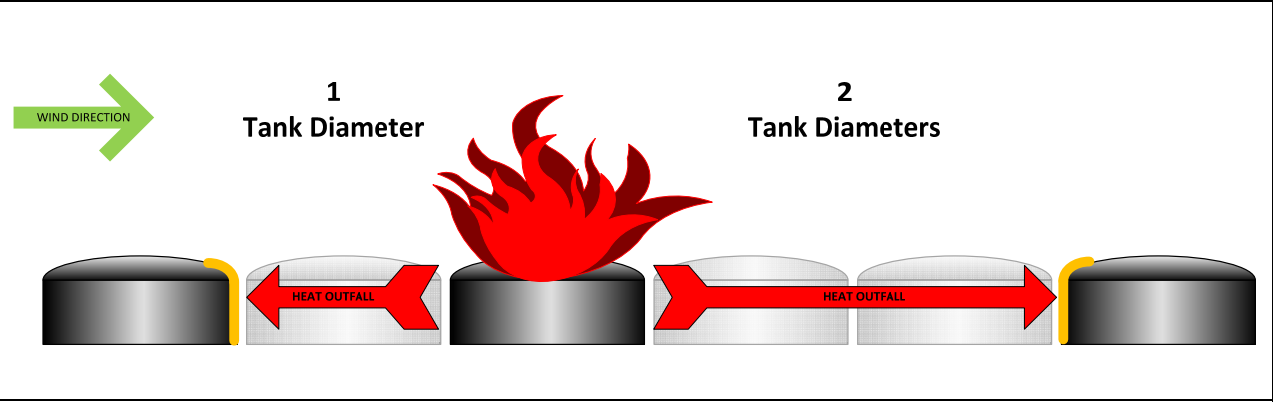
The goal of tank spacing is to provide sufficient distance between each tank that, in the event of an emergency event occurrence at one tank, the consequences of that event can be prevented from impacting other adjacent tanks. The heat outfall from a full surface tank fire will expose adjacent tanks, piping and structures within one (1) tank diameter in all directions, and two (2) tank diameters in the downwind directions. The premise of the one (1) tank diameter in all directions and two (2) tank diameters in the downwind direction is based upon a zero elevation change between tanks. The acceptance of practical tank spacing requirements has been formed with the design perspective of 2 dimensional topography, or topography without an elevation change.

Of specific concern are storage tanks located uphill. Tanks located uphill of a tank fire (at the same tank spacing) receive significantly greater heat exposure than a tank located at the same elevation. The heat discharged from a tank fire is released in an inverted triangular dispersal pattern vertically away from the tanks surface (Reference Diagram 1), impacting tanks at the same spacing distance (vertical distance) but at an increased elevation with a greater heat accumulation potential.

To achieve the same tank isolation characteristics in a facility that has elevation changes, two (2) options exist to achieve best practices, in the absence of direction from consensus standards:

1. The increasing of tank spacing to meet or exceed the one (1) diameter minimum heat outfall potential.
2. Provide heat outfall modeling against the actual tank size, spacing and topography to identify the increase in distance requirements for uphill locations.

**Diagram 1**  
**Storage Tank Heat Exposure**



The tanks, piping and structures within these heat outfall distances can require cooling to reduce heat accumulation to facing surfaces. Without the provision of cooling measures to surfaces exposed to heat outfalls of this nature, the potential for accumulations causing a secondary fire event are dramatically increased. The criticality of cooling provisions is based upon the distance from the heat source. The need for immediate, simultaneous and/or increased cooling operations due to reduced tank spacing can significantly impact emergency response requirements in order to achieve incident isolation and prevent incident escalation, including:

- Increased fire stream discharge devices provided with all supporting equipment to provide an effective cooling stream application for all potential wind directions
- Increased firefighting personnel to position and operate cooling stream application devices
- Increased fire water and/or firefighting agents
  - Increased fire water volume, as required for all simultaneous operations conducted for the full duration of the heat exposure and fire event
  - Increased fire water pump volume and pressure capacity
  - Increased fire water main and distribution system capacity
  - Increased foam proportioning system capacity (if cooling streams and cooling streams are required simultaneously from a single firefighting water / foam solution fire main, as has been identified as a potential plan by KMC)
  - Increased foam concentrate requirement (if cooling streams and cooling streams are required simultaneously from a single firefighting water / foam solution fire main, as has been identified as a potential plan by KMC), as required for all simultaneous operations conducted for the full duration of the heat exposure and fire event
- Increased need for multiple safe access routes to firefighting discharge positions  
Access routes that allow emergency responder access and emergency egress to and from effective deployment positions, and are available free from heat exposure and negative outfalls for all wind direction potentials.
- Increased need for multiple safe deployment positions  
Positions that allow stream application to exposed tank surfaces, and are available free from heat exposure and negative outfalls for all wind direction potentials.
- Increased levels above minimum standard requirements for semi-fixed or fixed fire protections system for tanks within the potential heat exposure area
- Increased facility operations associated with transfer out of products from heat exposed storage tanks
- Increased facility need to retain un-utilized storage capacity to accommodate transfer out volumes from heat exposed storage tanks

A negative impact of reduced tank spacing is the subsequent reduction in perimeter roadway access. Roadway access is critical for emergency responders to be capable of approaching, and escaping from hazardous conditions from all directions possible. Hydrocarbon facilities that do not provide roadway access to all sides of a storage tank within reasonable proximity, create significantly increased risk and limitations to the safe operations that can be conducted for fire events.



Potential exists, when safe access and/or safe deployment positions are not present, that emergency responders may not have the ability to position to cool adjacent tanks or attack a tank fire. In the event that an adjacent tank exposed to heat exposure can't be provided cooling to its affect surfaces that the original tank fire event can extend to a second tank fire event. In the event that an extinguishing stream can't be applied to the surface of a tank fire, it is likely that defensive strategy would need to be employed to protect adjacent tanks while allowing the original tank fire to burnout over several days.

The original TMTF facility utilized the following tank space premise:

- Reference *Appendix A – Tank Spacing Analysis*

Tank	Table 1 Spacing in Tank Diameters		
	Even Elevation	Downhill	Uphill
71	2	na	2
72	2	2	na
73	2	na	2
74	2	3.5	na
81	2	na	2
82	2	2	na
83	2	na	2
84	2	2	na
85	2	na	2
86	2	2	na
87	2	na	1.5
88	1	1.5	na
90	1	2	na
<b>Average</b>	<b>1.85</b>	<b>2.14</b>	<b>1.92</b>

On significant note is that prior to addition of Tank 88 in the far North-West corner of the facility, the TMTF utilized a designed tank spacing premise of two (2) Tank diameters in all directions.

The TMTF facility tank spacing at the completion of the TMEP

- Reference Appendix A – Tank Spacing Analysis

Tank	Table 2 Spacing in Tank Diameters		
	Even Elevation	Downhill	Uphill
71	1.8	na	1.8
72	1.5	1.8	na
73	1.8	na	2
74	0.5	1.2	na
75	0.5	na	1.2
76	0.5	1.2	na
77	0.5	na	1.2
78	0.5	1.2	na
79	0.5	na	1.2
80	0.5	1.5	2
81	2	na	2
82	2	2	1.5
83	2	2	2
84	2	2	1.5
85	0.5	na	2
86	0.5	1.5	1.5
87	2	na	1.5
88	1.2	1.5	na
89	0.5	na	1
90	1.2	2	2.2
91	0.5	1.2	na
93	0.5	1.2	na
95	0.5	1	1
96	0.5	0.8	na
97	0.5	1.2	0.8
98	0.5	0.8	na
<b>Average</b>	<b>0.98</b>	<b>1.42</b>	<b>1.55</b>

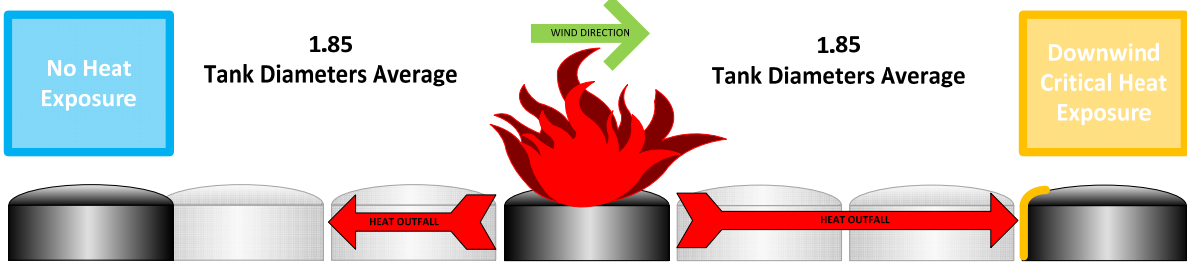
- Reference Appendix A – Tank Spacing Analysis

Tank	Table 3 Spacing in Tank Diameters		
	Even Elevation	Downhill	Uphill
74	0.5	1.2	na
75	0.5	na	1.2
76	0.5	1.2	na
77	0.5	na	1.2
78	0.5	1.2	na
79	0.5	na	1.2
80	0.5	1.5	2
89	0.5	na	1
91	0.5	1.2	na
93	0.5	1.2	na
95	0.5	1	1
96	0.5	0.8	na
97	0.5	1.2	0.8
98	0.5	0.8	na
<b>Average</b>	<b>0.50</b>	<b>1.13</b>	<b>1.20</b>

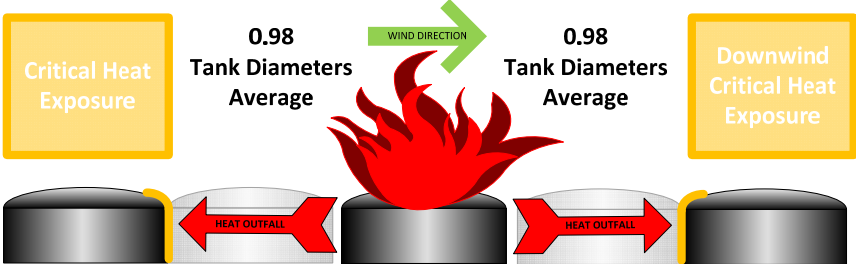
Configuration	Table 4 Average Spacing in Tank Diameters		
	Even Elevation	Downhill	Uphill
<b>Current TMTF</b>	<b>1.85</b>	<b>2.14</b>	<b>1.92</b>
<b>Post TMEP</b>	<b>0.98</b>	<b>1.42</b>	<b>1.55</b>
<i>Change</i>	- 0.87 - 47%	- 0.72 - 34%	- 0.37 - 19%
<i>Overall</i>	- 0.81 Tank Diameters - 33%		
<b>New TMEP Tanks</b>	<b>0.50</b>	<b>1.13</b>	<b>1.20</b>
<i>Change</i>	- 1.35 - 59%	- 1.01 - 39%	- 0.72 - 37%
<i>Overall</i>	- 1.03 Tank Diameters - 45%		

**Diagram 2**  
**Storage Tank Heat Exposure**

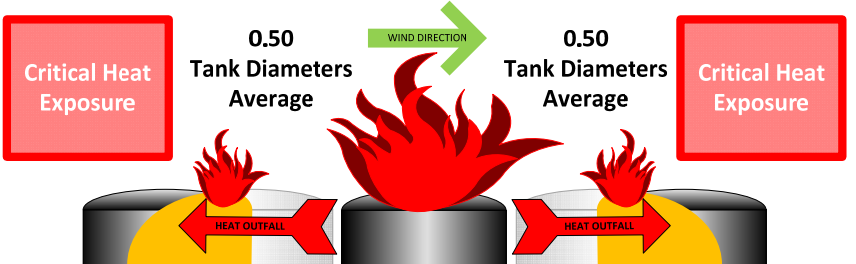
**Current Trans Mountain Tank Spacing**



**Post TMEP Trans Mountain Tank Spacing Average**



**TMEP New Tank Trans Mountain Tank Spacing**



The new tank installation proposed by the TMEP significantly changes the conceptual design of the TMTF with respect to storage tank spacing. The existing TMTF configuration provides a separation of 1.85 tank diameters (average). The importance of the existing spacing, is that it provides sufficient spacing to ensure that only the tanks in the downwind direction will experience heat outfall exposures that may require immediate cooling in order to prevent incident escalation through fire extension. The proposed TMEP configuration of the TMTF will reduce the tank spacing by 33% (average). The spacing provided by this project places many tanks so close together that in the event of a full surface tank fire or a dike fire, several adjacent tanks many need to be immediately cooled in order to prevent incident escalation through fire extension. Therefore the tighter tank spacing will significantly increase the firefighting operations required to control a tank fire or dike fire event.

The addition of storage tanks into the existing TMTF changes the risk control premises with regard to storage tank isolation by facility design. In order to achieve the desired storage tank volume, KMC is proposing a significant replacement of designed isolation of each storage tank. In essence, the TMEP shifts the control of hazard from an engineered approach of tank isolation, to an emergency response approach. As the authority having jurisdiction for fire protection approval within the City of Burnaby, the Burnaby Fire Department has recently been advised by KMC on May 30, 2014, that the facility no longer has the emergency response ability to extinguish fire events with internal facility resources, and that additional hydrocarbon specialized firefighting resources from regional facilities are no longer available.

To complicate the emergency control activities, because of the tighter tank spacing, many heat exposure cooling operations are not possible due to insufficient firefighting deployment positions. The TMEP proposed to group many tanks with common diking separated only by small intermediate dike segregation. These larger dikes areas reduce the available access and deployment roadway positions to facilitate safe, efficient and effective firefighting stream applications.

The TMEP proposes the increasing of the tank farm storage tank density, by decreasing engineered tank isolation distances, which in turn increases the potential for fire event escalation through extension, in a facility that has reduced its internal fire protection capability without approval. Notable by its absence from the TMEP application to the NEB is a detailed analysis of the effect of the tank spacing reduction on the requirements of mobile and fixed fire protection countermeasures, and the subsequent changes to the fire protection premises currently utilized. Weaknesses in the design of a facility can create fire event situations that cannot be safely or effectively mitigated without allowing a storage tank or several tanks to burnout.

In conclusion the TMTF was originally approved based on the provision of a 2 tank diameter spacing. In subsequent years the addition of Tank 88 marginally reduced the overall facility tank spacing to 1.86 tank diameters (average), but maintained the original premise of tank spacing to provide tank isolation and reduce escalation and extension potentials. The TMEP significantly deviates from the original safety premise and approval basis of providing storage tank isolation for proposed tanks at a proximity distance of 0.5 tank diameters.

On Page 208 & 209 of 754, Question 01.13.05 (ii) of the City of Burnaby IR – Round 1:

*City of Burnaby:* Will Trans Mountain provide tank spacing consistent with 1 tank diameter?

*KMC – TMEP:* It is important for Trans Mountain to follow the statutory requirements for storage tank spacing at Burnaby Terminal, where the topography will allow, in order to provide the number of tanks and the capacity of the tanks required to support the proposed expanded operation at Westridge Marine Terminal.

KMC's answer to this inquiry in the NEB approval process identifies hierarchy for design consideration that infers where topography limitations exist; the required capacity for expanded operations will be prioritized over safety needs for tank spacing.

## Application Positions

The proposed TMEP storage tank configuration significantly limits the access/egress routes to and from the hazard areas of the tank farm. The proposed use of significantly greater storage tank density has impacts on the availability of appropriate application positions to control major fire events. The primary concerns created by the TMEP related to deployment positions are:

- Insufficient deployment positions to cool adjacent tanks to prevent event heat exposures from escalating into fire extension
- Insufficient roadway option to allow for safe access and egress of deployment positions to provide all necessary fire stream applications in all potential wind conditions

The design factors presented in the TMEP that limit deployment positions include:

- Reduced tank spacing that requires significantly more heat exposure cooling operations, creating the simultaneous use of more operating positions
- Reduced tank spacing that creates physical impediments to the application of extinguishment and cooling streams from safe, effective and efficient operating positions
- Large multiple tank diking areas that limit the roadway access, and don't provide access around the tank fire event from all directions and in all wind conditions
- Access roadways provided at or above the elevation of the potential tank fire roof level, creating increased outfall heat exposures and hazards of use
- Access roadways with insufficient proximity or elevation to provide suitable operating positions to utilize for applying firefighting streams at appropriate distances

To ensure the safety, effectiveness and efficiency of firefighting stream deployment positions to apply suitable firefighting streams, consider the following fire protection requirements of application positions:

- Provide unimpeded road access around the perimeter of each individual tank
- Provide position option other than those from downwind
- Provide deployment positions without exposing personnel and equipment to significant heat outfall
- Provide unrestricted emergency egress routes
- Do not utilize positions above tank level
- Do not positioned below dike wall in the liquid product outfall direction
- Provide sufficient roadway setbacks from heat event discharge to allow for firefighting positioning or direct emergency evacuation routes

Wind direction has massive effect on how responder will access and position at hydrocarbon emergency events. The downwind and uphill directions affected by a tank fire will receive twice the heat outfall that the other directions experience, creating significant hazards to operating personnel. Wind has an extremely high impact on firefighting streams applied from Type 2 mobile monitors. The reach of firefighting streams is reduced up to 50% when applied from the downwind direction for both water and foam solution streams applied from mobile devices, thus requiring firefighting personnel to position in higher heat exposure areas in order to apply their stream effectively.

When both water or foam solution streams are applied from greater distances due to the avoidance of heat outfalls created by operating at elevations above the tank floor, or due to a lack of proximity roadway access, fire stream losses attributed to fall out can range from 20 – 50% for water, and 30 – 60% for foam solution. This requires a typical doubling of the discharge firefighting stream volume to achieve the necessary application rate.

On Page 299 of 754, Question 01.13.05 (bb) of the City of Burnaby IR – Round 1:

*City of Burnaby:* Will the containment provisions from each Trans Mountain storage tank be provided with outfall and accumulation areas away from adjacent assets and risks?

*KMC – TMEP:* General design considerations for the proposed new secondary containment areas will include appropriate outfall routes and setbacks from other infrastructure and property lines, safe access routes and locations for positioning emergency response personnel and equipment, and fire-fighting agent application, including drop-out loss potential during windy conditions.

On Page 210 & 216 of 754, Question 01.08.05 (r) of the City of Burnaby IR – Round 1:

*City of Burnaby:* Please confirm that Trans Mountain will construct an all-weather road to the tanks to handle use by heavy trucks and emergency equipment?

*KMC – TMEP:* Two classes of access roads will serve the proposed new storage tanks at Burnaby Terminal. The main roads will provide access



above the various terraces on which the tanks are located. These roads will be the primary routes for emergency response and will also provide access to the electrical service buildings, the radial walkways and stairways, the vapour recovery and treatment systems, the fire-water systems, and any other centralized equipment or systems. The secondary roads will provide access into and within the storage tank secondary containment areas. These roads will be primarily intended for routine inspection and maintenance activities, but may also be used for emergency response, if appropriate. All of the roads will be “all-weather” and designed and constructed in accordance with the applicable codes, standards, and practices for the intended services, vehicle types and loads, and travel frequencies, to the extent that the topography of the site will allow. The existing access roads at the Burnaby Terminal site are shown in Figure 3.4.6, Section 3.4.3.1, Volume 4A of the Facilities Application. Trans Mountain anticipates that the proposed new access road layout will be similar in concept.

On Page 293 & of 754, Question 01.13.05 (ii) of the City of Burnaby IR – Round 1:

*City of Burnaby:*

With consideration for industry standards of firefighting agent drop-out, including the drop-out loss potential of high wind operations with firefighting foam, will the containment levees for each Trans Mountain storage tank provide safe operating distances for the deployment, positioning and operation of portable fire suppression equipment for all tank fire and levee release/fire event potentials, in all wind direction and strength conditions, such that the required application rate of firefighting agents can be achieved to combat advanced pre-burn time tank fires?

**KMC – TMEP:** General design considerations for the proposed new secondary containment areas will include appropriate outfall routes and set-backs from other infrastructure and property lines, safe access routes and locations for positioning emergency response personnel and equipment, and fire-fighting agent application, including drop-out loss potential during windy conditions.

Weaknesses in the design of a facility can create fire event situations that cannot be safely or effectively mitigated without allowing a storage tank or several tanks to burnout. Reference *Appendix B - Deployment Position Analysis*, for detailed Tactical Analysis of tank fire event scenarios related to safe, effective and efficient firefighting deployment positions.

The original TMTF facility utilized the following tank space premise:

- Reference *Appendix B – Deployment Position Analysis*

Tank	Table 5 Limitations of Deployment Positions		
	Wind Direction	Location	Reason
71			
72			
73			
74	North	Northeast of Tank 74	Potential Heat Exposure
81	Southeast	East of Tank 81	Potential Heat Exposure
82			
83	Northwest	Northwest of Tank 83	Potential Heat Exposure
84			
85	Northwest	West of Tank 85	Potential Heat Exposure
86			
87	North	Northwest of Tank 87	Potential Heat Exposure
88	East	East of Tank 88	Dangerous Heat Exposure
90	Northwest	North of Tank 90	Potential Heat Exposure

The TMTF facility tank spacing at the completion of the TMEP

- Reference Appendix B – Deployment Position Analysis

Tank	Table 6 Limitations of Deployment Positions		
	Wind Direction	Location	Reason
71			
72			
73			
74	West	West of Tank 74	Dangerous Heat Exposure
75	Northwest	North of Tank 75	Dangerous Heat Exposure
76	Northwest	North of Tank 76	Dangerous Heat Exposure
77	North	Northwest of Tank 77	Dangerous Heat Exposure
78	Northwest	North of Tank 78	Dangerous Heat Exposure
79	Northwest	Northwest of Tank 79	Dangerous Heat Exposure
80	North	North of Tank 80	Dangerous Heat Exposure
81	Southeast	East of Tank 81	Potential Heat Exposure
82	Northeast	North of Tank 82	Dangerous Heat Exposure
83	Northwest	Northwest of Tank 83	Potential Heat Exposure
84	Northeast	North of Tank 84	Dangerous Heat Exposure
85	Southeast	Northeast of Tank 85	Dangerous Heat Exposure
86	Northeast	Northeast of Tank 86	Dangerous Heat Exposure
87	East	East of Tank 87	Dangerous Heat Exposure
88	East	East of Tank 88	Dangerous Heat Exposure
89	Northeast	Northeast of Tank 89	Dangerous Heat Exposure
90	Northwest	North of Tank 90	Dangerous Heat Exposure
91	South	South and East of Tank 90	Dangerous Heat Exposure
93	Northeast	North of Tank 93	Dangerous Heat Exposure
95	Northeast	North of Tank 95	Dangerous Heat Exposure
96	Southeast	North & South of Tank 96	Dangerous Heat Exposure
97	Northeast	North of Tank 97	Dangerous Heat Exposure
98	East	North & East of Tank 98	Dangerous Heat Exposure

Configuration	Table 7 Limitations of Deployment Positions		
	Total Storage Tanks	Tanks without Issue	Tanks with Limited Deployment Positions
<b>Current TMTF</b>	<b>13</b>	<b>6</b>	<b>7</b>
<b>Post TMEP</b>	<b>26</b>	<b>3</b>	<b>23</b>
<i>Change</i>	<i>+ 100%</i>	<i>- 3</i> <i>- 50%</i>	<i>+ 16</i> <i>+ 70%</i>
<i>Overall</i>	<i>70% increase in the number of Storage Tanks that do not provide safe deployment positions to control potential fire events</i>		
<b>New TMEP Tanks</b>	<b>14</b>	<b>0</b>	<b>14</b>
<i>Change</i>	<i>-</i>	<i>0%</i>	<i>100%</i>
<i>Overall</i>	<i>100% of the proposed Storage Tanks will not provide safe deployment positions to control potential fire events</i>		

The TMEP presents a significantly larger fire control risk within the TMTF. The identified increase in events with potential to escalate and extend to adjacent storage tank exposures due to insufficient firefighting deployment positions increases the likelihood of a multiple tank fire, and toxic smoke plume, and heat discharge to areas outside the facility. The risk of community impacts outside of the facility from a TMTF fire event are increased by 70%.

The cost of this risk potential assumed by the community is not in line with the safety and risk management premises initially utilized for original facility approval by the City of Burnaby. The specific driver of the increased risk is the reduction in the effective of the facility design to limit fire event growth and restrict hazardous impacts to an immediately controllable area of impact during a short emergency response timeframe. It is critical for public safety that design

configuration utilized support the protection of life, the environment and property. The TMEP does not provide the basic engineered safety provisions standard in high-impact potential facility design.

### **Distance to Fenceline**

The TMEP expands the existing TMTF with high density storage tank configurations into the northern and eastern corners of the existing facility property. The proposed configuration changes the tank to fenceline distances of the facility. The tank to fenceline distance is critical as it directly impacts time elapse to hazard impacts to the community life, environmental health and property outside the TMTF facility.

Directly adjacent to the TMTF facility are the residential neighborhoods of Forest Grove, Meadowood, Sperling Duthie and Lochdale. Of specific and notable proximity is Forest Grove Elementary school in immediate danger of exposure to hazardous event exposures due to its close proximity on the southern outfall of the facility.

The TMEP proposed TMTF configuration presents the following increased potentials for community impact outside the facility fenceline:

- Reduced response, set-up and firefighting suppression time prior to harmful community impact
- Increased depth of hazard impact past the fenceline prior to preventive or corrective action
- Increased preventive or corrective operations required to inhibit fire event escalation and extension

The reduction in the distance and elapse time to exterior fenceline community impact creates a greater magnitude of exposure impact and directly

The TMEP creates emergency control scenarios risking the residential areas in proximity, Simon Fraser University, UniverCity village and the Burnaby Mountain Conservation Area, related to:

- Fenceline exposure to heat, including subsequent fire extension to the proximity treeline and high potential for treetop driven wildfire  
Smoke exposure to the community
- Sulphur based gas exposure to the community
- Ignition of flammable gas releases within community

The original TMTF facility utilized the following tank distance to fenceline premise:

- Reference Appendix C – Tank Distance to Fenceline Analysis

<b>Tank</b>	<b>Table 8 Distance to Fenceline in Tank Diameters</b>
71	4.5
72	1.5
73	3.5
74	1
81	5
82	4
83	7
84	5.5
85	6.5
86	3.5
87	2.5
88	1
90	2
<b>Average</b>	<b>3.65 Tank Diameters</b>

The TMTF facility tank distance to fenceline at the completion of the TMEP

- Reference Appendix C – Tank Distance to Fenceline Analysis

Tank	Table 9 Distance to Fenceline in Tank Diameters
71	4.5
72	1.5
73	3.5
74	0.5
75	2
76	0.5
77	1.5
78	1
79	1
80	1.5
81	4.5
82	4
83	7
84	5.5
85	6.5
86	3.5
87	2.5
88	1
89	3.5
90	2.5
91	0.5
93	1.5
95	2.5
96	1.5
97	2
98	0.5
Average	2.56 Tank Diameters

▪ Reference Appendix C – Tank Distance to Fenceline Analysis

Tank	Table 10 Distance to Fenceline in Tank Diameters
74	0.5
75	2
76	0.5
77	1.5
78	1
79	1
80	1.5
89	3.5
91	0.5
93	1.5
95	2.5
96	1.5
97	2
98	0.5
Average	1.43 Tank Diameters



<b>Configuration</b>	<b>Table 11</b> <b>Average Tank Distance to Fenceline in Tank Diameters</b>
<b>Current TMTF</b>	<b>3.65</b>
<b>Post TMEP</b>	<b>2.56</b>
<i>Change</i>	<i>- 30%</i>
<b>New TMEP Tanks</b>	<b>1.43</b>
<i>Change</i>	<i>- 61%</i>

The TMEP proposes a reduction in the tank to fenceline spacing of 30% on a facility wide comparison, and utilizes a new tank positioning premise which reduces the tank to fenceline distance by 61%. The decreased tank to fenceline distance and consequential impact potentials to the community presents the higher requirement and increased priority of evacuation operations conducted simultaneously with fire control activities. This response requirement significantly increases the emergency response resource requirements associated with identifiable emergency event potentials.

The TMEP significantly increases the urgency and expedience required to prevent community life and environmental impact outside the facility fenceline in the event of a product release or storage tank fire. The positioning of storage tanks in such close proximity creates a greater potential for citizen exposure within the adjacent communities to the hazardous effects of flammable gas outfalls and sulphur based gases. Additionally, the close proximity of storage tanks to the fenceline dramatically increases the risk of wildland fire to the Burnaby Mountain Conservation Area.

## Emergency Response

The onus remains on Kinder Morgan to produce an acceptable business case and, through a formal review, obtain the Fire Chief's approval of the TMEP consequence reduction measures at the Burnaby Trans Mountain Tank Farm facility (TMTF). Once approved, the consequence reduction measures set forth are to become part of the facility's operating permit requirements.

Issues Critical Interest of:

1. Trans Mountain Site Densification
2. Risk of Products Present
3. Emergency Management Scope
4. Management of Security Potentials

The Burnaby Fire Department's focus in reviewing the Kinder Morgan Volume 7 application to the NEB Act Section 52 is keyed upon the three (3) general sensitivities of; transferring primary fire/release responsibility, the level of preparation commitment by Kinder Morgan and the scale of Kinder Morgan emergency response resources.

The underlying premise within this document of utilizing the Burnaby Fire Department to replace or take-on Kinder Morgan's responsibility to provide primary specialized hydrocarbon emergency response is a critical issue. This potential increase in the Department's responsibility would also include potentially significant liability for the health, environmental & economic outfalls generated from Kinder Morgan emergency event control operations. The operational impacts of this increase service request constitute a large escalation in response capability both from staffing consideration and from the requirement to acquire, maintain, inspect & train to, very specialized hydrocarbon equipment. Current shift staffing levels are marginally sufficient to protect & manage a hydrocarbon facility event with only current responsibility to protect the Citizens of Burnaby through notification, high & low risk evacuation, area isolation & rescue, while maintaining only a minimum service need elsewhere within the city. In essence, the Burnaby Fire Department can manage larger scale hydrocarbon events with current staffing & resources, but would require a significant resource increase to simultaneously manage interior fence line & exterior fence line operations.

An additional impact of the changes in the emergency response capabilities of, most notably, the TMTF facility, is the significant gap presented by the required management of major scale hydrocarbon events within the Burnaby – Port Moody area. The Upper Burrard Inlet Petrochemical Mutual Aid Group (UBIPMAG) was predicated upon the cumulative emergency response resources of all the partner companies. With the loss of the fire brigades & mobile resources from the Kinder Morgan & Shell Burnaby facilities, these companies no longer present any value for partnership with Suncor Burrard Products Terminal & Chevron Burnaby. Because of this inequality in resource commitment the UBIPMAG agreement has been dissolved; with Suncor & Chevron increasing their internal capabilities to achieve the ability to stand alone manage all of their event potentials, including the low frequency major impact events. For Kinder Morgan, the dissolution of the UBIPMAG and no agreement on change in the roll of the

Burnaby Fire Department, leaves the TMTF facility without the requisite fire protection capability for any of their fire/release risks.

Within this application many requirements for emergency response preparation & resource allocation are vaguely stated & present without a concrete plan or commitment. From the City's perspective the interpretation of this application should be in one of three (3) forms.

#### Option 1

This option would have the City table decision (or primarily oppose the application pending adjustment) on the application until a comprehensive plan complete with commitments to the specific detail & content of the facility resource allocation & emergency response preparedness responsibilities are provided. This option is challenged in the inherent lack of detail present within these global project documents, where commitments can be vague, clouded, hidden or subject to differing interpretation.

#### Options 2

This option would have the City, post-approval, utilize the fire bylaw to enforce the provision of appropriate emergency response resources & preparedness. This option is challenged by the difficulty & burden of enforcement, created by undocumented expectations at project approval & the lack of pre-project notification to applicant.

#### Option 3

This option would be a combination of both Option 1 & 2, with a requirement to receive greater detail in the application prior to approval with the City retaining the opportunity to adjust or require additional emergency management resources & preparedness provisions based on the bylaw strength in the post-approval phase.

In Kinder Morgan Canada Risk Assessment Trans Mountain Expansion Project – Burnaby Terminal Project, October 1<sup>st</sup>, 2013 Doug McCutcheon and Associates, Consulting

- P. 31 "Risk is the combination of consequence and probability. It is often referred to as: "Risk = Consequence X Probability"
- The consequences of concern for the realistic worst case scenario (a fire with heavy smoke) are:
  - Radiant heat exposure to workers and anyone within 224m of the dike walls represents an exposure of 4kW/m<sup>2</sup> from a dike fire. For a tank top fire that distance shrinks to 71m from the dike wall.
  - It seems impossible but at a distance of 536 m from a dike fire and 184m for a tank top fire the public will feel the heat and could be exposed to 1 kW/m<sup>2</sup> which is are for 1st degree type burns (sunburn level).
  - The impact of a SO<sub>2</sub> cloud can be felt 5.2km downwind from a crude oil fire.
  - The impact of a large volume of smoke as a result of a fire could extend outwards for approximately 43 km. causing possible public outrage."

- P. 32 “Nearby workers will be exposed to the effects of a major tank or tank area fire. Although workers can seek protection indoors from the radiant heat evacuation requirements will be needed for beyond the 86 - 224 meter distance in the event of a fire.”
- P. 33” Toxic SO<sub>2</sub> is a concern. The analysis shows SO<sub>2</sub> levels can extend outwards 5.2km for a dike fire and 2.2km for a tank top fire should a crude tank catch fire.’. “Appropriate emergency planning involving foam addition and shelter-in-place or evacuation plans is needed.”

### Relevant Local Changes in Industry Fire Protection

Historically, the Hydrocarbon Industry within the Burnaby – Port Moody area have provided frontline emergency response capabilities in the form of management personnel, field fire suppression resources & trained industrial fire brigades. Whether, these emergency management provisions were mandated by the bylaws, the inspectors, the Fire Chiefs, the City Councils of the day, or were put in place out of due diligence, these resources have become the basis for city fire prevention approvals.

As the Hydrocarbon Industry in the area, started the strategic move away from operating refineries and toward bulk commodity storage terminals during the 1980’s, trained personnel & fire resources became more difficult to fund. As a result, in order to maximize the investment dollars of each facility & retain the emergency protection that each facility required, the Hydrocarbon Industry within the area formed the UBIPMAG. This group included Chevron Burnaby, Petro-Canada Burrard Products Terminal, Shell Burnaby & Terasen Trans Mountain & Westridge.

The premise of the UBIPMAG was the following:

- Each facility operated an industrial fire brigade composed of an Incident Command Team (Management Personnel), Fire Suppression Personnel (Operations Personnel) & Fire Suppression Mobile & Fixed Systems.
- Each facility retained the operational firefighting ability to mitigate higher frequency minor to moderate scale events as the primary control agency. Additional support in non-hydrocarbon specialized fire service operations, where required, was provided by the Burnaby Fire Department (for facilities geographically located within Burnaby). Additional hydrocarbon specialized fire service operations were provided by the other partner companies of the UBIPMAG.
- Each facility would provide the primary fire response to major scale events as the primary agency, supported by the industrial fire brigade & resources from partner companies for additional hydrocarbon specialized fire service operations & by the Burnaby Fire Department (for events geographically located within Burnaby) to provide non-hydrocarbon specialized fire

operations.

- Each facility would maintain the ability to manage an emergency event through the application of trained company management personnel to form the events Incident Command Team.
- Each facility would maintain their company's emergency response resources & fire brigade capabilities.

The value of the UBIPMAG was that participating companies no longer bore the full cost of providing a response capability to lower frequency - high resource requiring event potentials. The cost in essence was shared between each of the partner companies, with each dependant on the other to fulfill their fire protection requirements.

Through the 1980's & 1990's as the hydrocarbon industry in Canada massively downsized & restructured. Emergency response capabilities at many area facilities began to be significantly underfunded, especially for facilities deemed as non-profit bearing (Bulk Commodity Terminals). This hit the certain facilities hard than others.

Petro-Canada, now Suncor Burrard Products Terminal, funded by Canadian dollars, was able to maintain their full response capability. With the exception of a short period where the facility struggled to staff their Emergency Response Team due to a two (2) year soft-labour dispute, Suncor has fully maintained, & most recently actively expand their emergency response capabilities. Chevron Burnaby experienced a minor decrease in their capabilities during the 1990's, but has been holding steady for the last decade. During this period, these two partners of the UBIPMAG were able to maintain some semblance of frontline emergency response capabilities, including; management personnel, field fire suppression resources & trained industrial fire brigades.

Shell Burnaby facilities (including the Shellburn Products Terminal, Burmount Truck Loading Facility, & Shellmont Tank Farm) experienced a dramatic reduction in personnel & funding. For a significant period of time, the Shell Burnaby facilities attempted to prop up their emergency response capability through the use of a small number of facility personnel coordinated & managed by a contract emergency response provider. As the Shellburn Products Terminal continued to lose personnel, the operation of an industrial fire brigade under this model became less feasible. In order to maintain a fire protection capability for the higher frequency small & moderate scale events, Shell Burnaby invested in fully automatic Fixed Fire Protection Systems. These systems replaced the more traditional fire brigade operations with fire protection systems that allowed a single facility operator to initiate the automated application of fire streams to higher frequency minor & moderate scale event potentials. The traditional mobile equipment & technically trained personnel were replaced completely by automated fixed fire protection systems. In this change, a gap was allowed to develop. Fixed fire protection systems are typically very expensive, and useful for only a single event potential. Also, the use of a fixed fire protection systems is typically not feasible (by effectiveness or by Cost-Benefit analysis – Company) for the lower frequency large scale event potentials. The emergency response gap

that has occurred is this; the Shell Burnaby facilities no longer retain the ability to provide an industrial fire brigade. While they are capable of controlling many of their fire/release risks with automated systems, the facilities have no resource ability to initiate a response to several higher frequency minor & moderate event potentials, & all of the lower frequency major event potentials.

The Trans Mountain & Westridge facilities, previously operated by Terasen, and now by Kinder Morgan, faced a similar challenge. The Trans Mountain & Westridge facilities have always struggled to provide sufficient personnel to staff a fire brigade. Unlike Shell Burnaby that had a large number of employees when the Shellburn Refinery operated, the Trans Mountain & Westridge facilities have always had significantly less personnel available. During the 1990's, the Trans Mountain & Westridge facilities, faced the same challenge as Shell Burnaby, in that it was deemed either unachievable or unsustainable (economically or logistically) to maintain a fire brigade with mobile fire protection equipment. However, unlike Shell Burnaby, Terasen – Kinder Morgan, made no notable attempt to replace the loss of their fire brigade & mobile response resources with any other fire protection provisions. Recently Kinder Morgan's strategy for fire protection was to gain the agreement of the Burnaby Fire Department to change the Department's responsibilities with regard to hydrocarbon facility events. Kinder Morgan has requested that the Burnaby Fire Department take-on the Hydrocarbon Company's previous (& bylaw specific) responsibilities to provide hydrocarbon specialized fire operations as the primary response agency.

The Imperial Oil facility, although a smaller scale operation, also presents similar unmanaged risk potentials. The Burnaby based Imperial Oil truck loading rack & tank farm is protected by an aging fixed fire protection system. Other than the single fixed fire protection system, this facility maintains no other emergency response capability to manage or control any other fire/release risk potential.

## **Burnaby Fire Department Level of Service**

The application for hydrocarbon facility expansion or operational change often develops into active discussion on the level of emergency preparedness required to be provided by the applicant. The construction, purchase, maintenance & training costs of these emergency response systems can be significant. The difficulty in determining the appropriate level of emergency preparedness is due to the fundamental premise of how levels of emergency prevention and response resources are established. The City of Burnaby Fire Bylaw is based upon a simple principal in order to protect the community as a whole: if a risk is present, it must be addressed.

This is very relevant for the hydrocarbon industry as their inherent business plan is to handle high risk commodities for profit. The costs associated with the handling of these commodities, including emergency preparedness and protection should reside firmly as a business expense to the operator, having a bearing on the profitability of the operations but not downloaded to the City of Burnaby's existing tax base.

While the tax base provides for City services to the applicant, it does not extend to extraordinary risks posed by the Oil and Gas industry in Burnaby. These services as provided by the industry in Burnaby have historically included:

- Standard emergency response services
- Participation in Drills and Exercise
- Use of BFD resources at industry incidents within the scope and training of the department.
- Regulatory activities associated with being the "Authority Having Jurisdiction"

The Fire Department has historically never owned or operated any industry specific fire suppression equipment or agreed to manage or operate non-BFD equipment.

On Page 336 & 209 of 754, Question 01.13.05 (ii) of the City of Burnaby IR – Round 1:

*City of Burnaby:* Will existing municipal and third party services to Westridge Marine Terminal require upgrading?

*KMC – TMEP:* As discussed in Section 3.4.4.10, Volume 4A of the Facilities Application, Trans Mountain will seek additional power supply capacity from BC Hydro. Trans Mountain may also seek a natural gas connection from Fortis BC to supply support gas for the proposed new vapour combustion unit.

This question was provided to identify the scope of City service increase required by the TMEP. The answer clearly identifies the service upgrades, and does not include the identification of an upgrade in the fire service response required by the TMEP. The Burnaby Fire Department provides municipal structural, incipient wildland fire protection, public education, fire prevention, investigation, technical rescue and medical interventions. The Burnaby Fire Department does not provide technical hydrocarbon firefighting, but will support and assist companies within Burnaby with Fenceline operations and basic structural firefighting activities such as augmenting remote water supply and low hazard exposure protection. The NEB IR Response identifies no additional service of the Fire Department above existing established levels.



## Hazard Events

Crude oil loss of containment events can propagate many secondary event impacts as the flammability of the product disperses from the facility or in the event of spill ignition and subsequent fire:

- Flammable Gas Outfall of Fenceline
- Release of Sulphur Based Gases
- Liquid Product Release to Watercourse Outfall to Fenceline
- Dike Spill Ignition
- Release of Toxic Smoke Plumes
- Heat Discharge against Fenceline
- Tank Rim Seal Ignition
- Flammable or Ignited Product Loss from Secondary Containment

### Flammable Gas Outfall

Reference: Consequences – Flammable Gas Outfall against the Fenceline, P. 66

### Release of Sulphur based Gases

Reference: Consequences – Release of Sulphur Based Gases against the Fenceline , P. 69

### Watercourse Outfall of Liquid Crude Oil Release

The release to areas outside of lined secondary containment diking creates the potential of a crude oil introduction into watercourses exiting the TMTF facility. The release of crude oil to earthen surfaces outside secondary containment provisions, presents the expansion of the release to the subterranean water shed system of Burnaby Mountain. The natural water shed system off Burnaby Mountain would route collected crude oil to areas of downstream impact to Eagle Creek.

### Dike Spill Ignition

Description:

- Fire of an accumulated flammable release retained fully or partially within the secondary containment of the tank levee
  - The contained release of crude oil to the dike area presents the risk of ignition and subsequent dike fire.
  - The unignited spill of crude oil presents the risk of delayed flammable gas ignition.
  - The ignition of these spills can be sudden and explosive in nature when the flammable gases are confined and maintained in higher concentrations by atmospheric conditions or physical barriers.

Typical Cause:

- The ignition of migrating flammable release vapors back to flammable liquid accumulation within or partially within a tank levee

Associated Hazards:

- Significant toxic airborne outfall products of combustion
- Heat wave requiring immediate extinguishment in order to prevent levee tank ignition at rim seal or full surface
- Loss of tank structural integrity due to tank warping from heat exposure
- Heat exposure to adjacent tanks, piping and areas of risk within the facility

Control Options:

- The early detection and isolation of the release source is critical to minimize the volume of the product release. For events that aren't easily or remotely isolated, a large amount of product can accumulate prior to control being achieved. The volume of product accumulated is directly proportionate to the amount of product available to fuel the burning fire.
- Sustained foam solution application from mobile or fixed monitors/pourers at a rate that achieves or exceeds the minimum application to achieve and maintain extinguishment, which includes:
  - Positioning and operation of high volume mobile foam discharge monitors consistent with available discharge positions, wind conditions, heat exposures and stream reach distances, such that foam applications can be made that land the foam solution accurately and gently at desirable application points within the levee
  - Positioning of connecting hose lines to and from foam proportioning equipment, water supplies, discharge devices and foam concentrate supplies
  - Operation of foam proportioning equipment and foam concentrate supplies
  - Water supply systems consistent with the required capacity to generate sufficient foam solution

- Water pump and foam proportioning devices capable of providing sufficient foam solution for foam blanket application and maintenance
- An emergency response team of 14 to 20 highly trained and equipped personnel supported by a highly function staff of facility operational personnel.
- Semi-fixed levee foam system, including:
  - Levee fixed foam pourers designed to apply foam solution comprehensively throughout the tank levee to achieve and maintain an extinguishing foam blanket
  - Fixed foam lateral and piping connections to deliver the required foam solution volume to the foam pourers
  - Positioning of connecting hose lines to and from foam proportioning equipment, water supplies, discharge laterals and foam concentrate supplies
  - Operation of foam proportioning equipment and foam concentrate supplies
  - Water supply systems consistent with the required capacity to generate sufficient foam solution
  - Water pump and foam proportioning devices capable of providing sufficient foam solution and cooling fire water streams to provide tank cooling, foam blanket application and maintenance
  - An emergency response team of 6 to 8 highly trained and equipped personnel supported by a highly function staff of facility operational personnel.
- Fully fixed levee foam system, including:
  - Levee fixed foam pourers designed to apply foam solution comprehensively throughout the tank levee to extinguish a full surface levee fire
  - Fixed foam lateral and piping connections to deliver the required foam solution volume to the foam pourers
  - Fixed foam proportioning devices capable of producing foam solution at the required volume to achieve foam blanket application and maintenance to achieve extinguishment
  - Foam concentrate and water supplies sufficient to provide a sustained foam application throughout the event
  - The system is pre-connected together such that the activation of the system requires control valve operation only, and can be operated by a team of two to three (2-3) operations personnel.

Consequences:

- The Release of Toxic Smoke Plumes
- The discharge of heat against adjacent storage tanks
- The discharge of heat to areas outside the fenceline  
The potential ignition of a Rim Seal Fire on External Floating Roof adjacent storage tanks
- The potential ignition of a Vent Fire on Internal Floating Roof adjacent storage tanks

- The potential release of flammable or ignited product from the secondary containment provisions spreading to outfall retention systems throughout the facility prior to arrival at the tertiary containment system.

## **Tank Fire Burnout**

The risk of Tank Fire Burnout exists whenever extinguishment of a hydrocarbon tank fire event cannot be fully managed to extinguishment. The term refers to the utilization of a Defensive or Passive Strategy for managing a tank fire event (refer to *Appendix D – Burnaby Fire Department General Tank Fire Protocol – General Strategy Type*). Tank Fire Burnout is utilized as a tactic of ending a Tank Fire by allowing it to completely burn off all of the crude oil present with the tank. Once the crude oil has burned off, the fire self-extinguishes.

Tank Fire Burnout, as a contingency tactic, has historically been utilized as an option for fire extinguishment when adverse environmental conditions exist, a lack of firefighting resources are present or when the facility design precludes safe offensive firefighting operations. Tank Fire Burnout can be utilized as a passive tactic when the more aggressive tactics of direct fire extinguishment and firefighting may significantly endanger responders, due to conditions like insufficient firefighting resources, uncontrolled safety concerns due to imminent event escalation from boilover, or tank failure. Tank Fire Burnout can also be utilized as a defensive tactic when current resources are required for the protection of exposed tanks / facility components as a means of minimizing the escalation of the incident, for instance as an initial action while resources are mustered, a command structure is formed, during size-up and actions plan development or when sufficient resources are just not available. As a defensive tactic the response priorities focus on the safety of responders, the protection of exposed components, the protection of the environment.

Typically the operation of “pumping out the tank”, or transferring as much of the product from the burning tank to an alternate safe storage tank, is utilized in concert with the strategy of allowing a tank to burnout. By reducing the volume of product available to the fire, the total length of time required for the tank to self-extinguish is reduced. However, for crude oil, pumping out the tank is not recommended (American Petroleum Institute 2021 Recommended Practice – Management of Atmospheric Storage Tank Fires – June 2006 – 8.3.2 Assessing the Tank Fire Situation).

- P. 28-29 “The time to reach boilover depends on the amount of material in the tank. Tanks holding wide boiling range materials (such as crude oil) should not be pumped out since pumping removes the buffer between the water layer and hot heavy ends.”

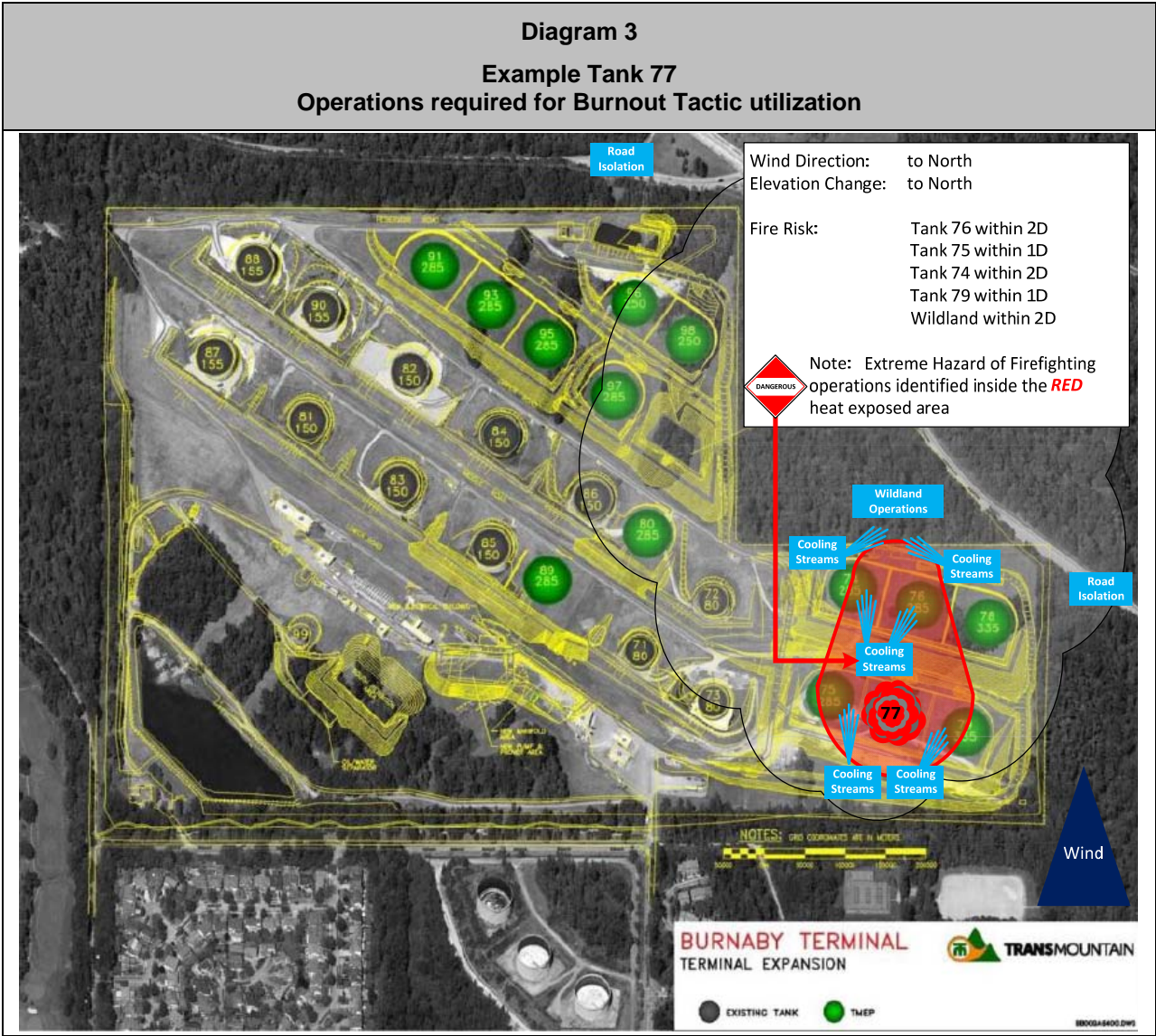
Therefore the use of a Tank Burnout tactic exposes the community to the full potential impact and duration of toxic smoke and heat discharge based upon the volume of crude oil present at the time of ignition.

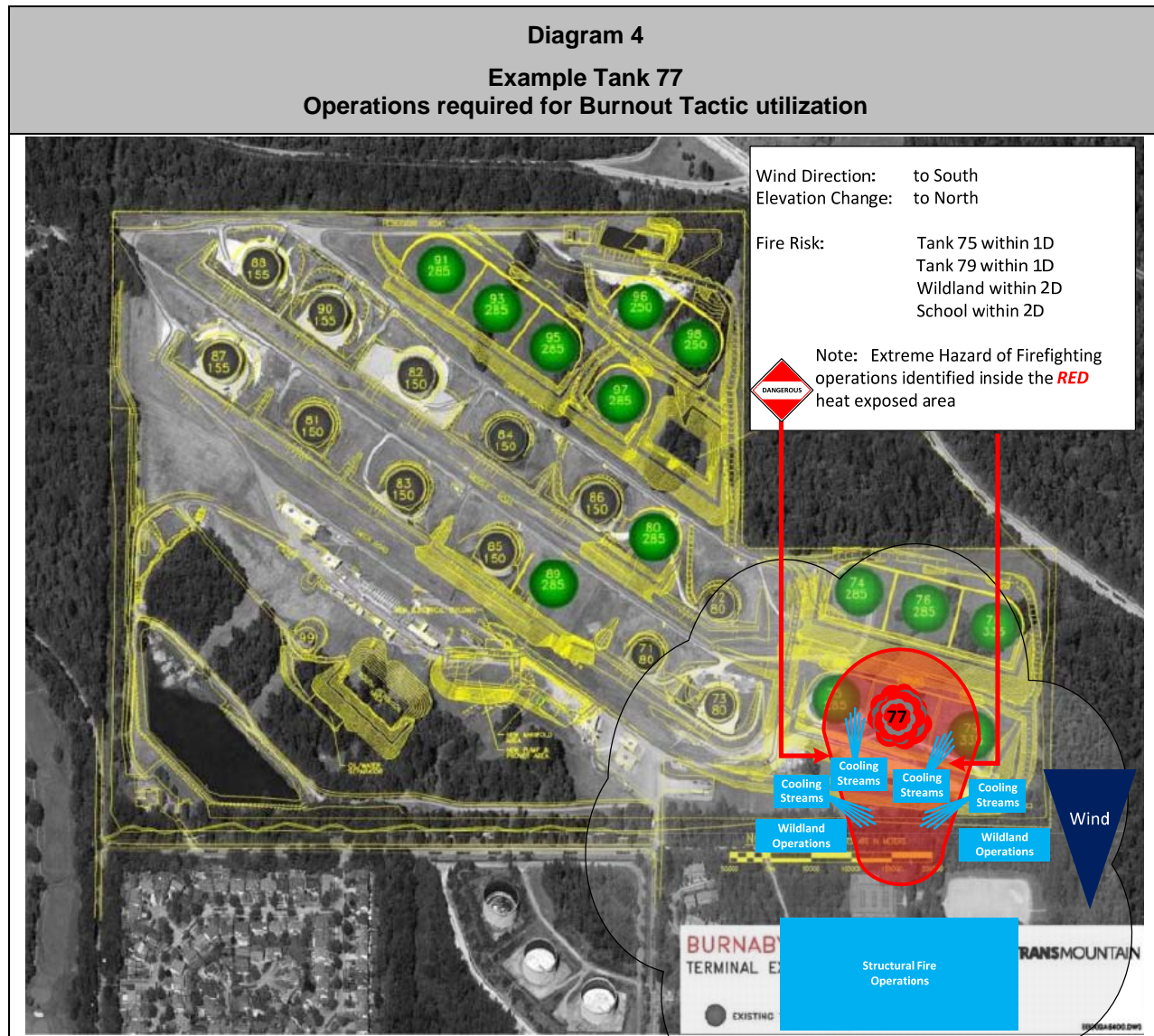
The use of Tank Fire Burnout as a tactic will require the simultaneous evacuation of personnel from areas exposed to potential incident escalations and hazardous outfalls. The operations associated with evacuating persons potentially impacted by a 4 day tank fire event from a facility with such tight proximity to high density residential communities would constitute an emergency activation of provincial scale.

The consequences of utilizing Tank Fire Burnout as an extinguishment tactic are several. In a defensive strategy, as would be required in the TMEP configuration due to the density of the tank farm (close tank proximity), extensive fire operations would be necessary to simultaneously cool multiple adjacent fire spread risks, such as other storage tanks and the wildland exposure at the fenceline (Reference Diagram 3 & Diagram 4). The operations of providing these cooling streams in close proximity to the extensive and continuing heat output of a tank fire presents significant responder risk and high potential for secondary fire occurrence. By nature allowing the tank to burnout over a period of 3 – 4 days would expose the community to longer term and higher concentrations of toxic smoke exposure. The total water volume requirement to operate cooling streams for 3 – 4 days would be in the range of 5 million usgal. This volume of water is not present within the fire water reservoir system utilized by the TMTF, nor is the ability for the runoff water to be retained and fully treated prior to discharge to sensitive watercourses within the City of Burnaby.

Additionally, note that within the Diagram 3 & Diagram 4, both examples require multiple large caliber cooling streams to be operated against heat exposed areas impacted from the tank fire. Even in the event that a tank is only being permitted to burn without extinguishment operations for short timeframes prior to mounting an offensive fire attack to extinguish, the emergency response will be forced to take immediate action in order to prevent incident escalation including fire spread to adjacent storage tanks and wildland areas. For tank fire event that are not able to mount a safe offensive attack for extinguishment, the cooling activities, like those identified in the diagrams provided will be required continually for 3 - 4 days.

In Diagram 3 which represents the Burnout tactic applied to Tank 77 in a wind to the North aptitude, fire water stream volume required to cool the heat impact adjacent storage tanks and wildland area would be in the magnitude of 6,000 usgal/min for 3 – 4 days, or 3,500,000 usgal.





The reality of employing a Burnout tactic for a Tank Fire event within the proposed TMEP configuration is that success associated with preventing fire extension throughout the TMTF and the adjacent community would by no means be assured. Significant potential exists that due to the proposed configuration, density, complexity and proximity to the community impacts and fire spread potentials that would create scenarios where fire containment is not possible.

## Tank Fire Boilover

The potential for Boilover exists in any wide boiling range hydrocarbon, such as crude oil. Boilover occurs when the heat created at the top portion of a full surface tank fire causes the heavy components of the crude oil to form a solid crust like plate at or near the surface. As the fire continues to burn, this developing crust increases in depth and therefore total weight. When the weight of the developing crust can no longer be suspended by the less dense liquid crude oil underneath, the crust formation begins to slowly sink toward the bottom of the tank. As the crust formation moves toward the bottom of the tank, the water content present within the crude oil is restricted from moving upward through the crude oil and released from the surface of the tank. This trapped water formation is heated along with the contents of the tank. When the water content trapped below the crust formation is heat sufficient to change the physical state of the liquid water to steam, a volumetric expansion occurs, which converts 1 usgal of water to greater than 1,700 usgal of steam. As many gallons of water are potentially present within storage tanks the size currently present in the TMTF and proposed by the TMEP, a mass and sudden increase in the volume of the tank content occurs. The steam rapidly expanding in the bottom portion of the tank, will suddenly force the heated crude oil contents above out the top of the tank, discharging heated and molten crude oil over the area 10 times the tanks diameter. For a proposed 200' storage tank, a Boilover event can discharge heated and molten crude oil outwards to 2,000'.

A Boilover event occurring from a Tank Fire in the TMTF, the high hazard expected to receive the discharged heated and molten crude oil would encompass:

- The entire TMTF
- The Shellmont Tank Farm
- Forest Grove Community
- Meadowood Community
- Sperling-Duthie Community
- Closing Gaglardi Way
- Burnaby Mountain Parkway

In Kinder Morgan Canada Risk Assessment Trans Mountain Expansion Project – Burnaby Terminal Project, October 1<sup>st</sup>, 2013 Doug McCutcheon and Associates, Consulting

- P. 3 Executive Summary “Should such a scenario develop ample time will be available for emergency procedures to implement appropriate action”

The statement made in the NEB Submission for the TMEP with regard to ample time being available to implement appropriate control options to prevent a Boilover event is questionable.

The American Petroleum Institute 2021 Recommended Practice – Management of Atmospheric Storage Tank Fires – June 2006 – 8.3.2 Assessing the Tank Fire Situation, states.



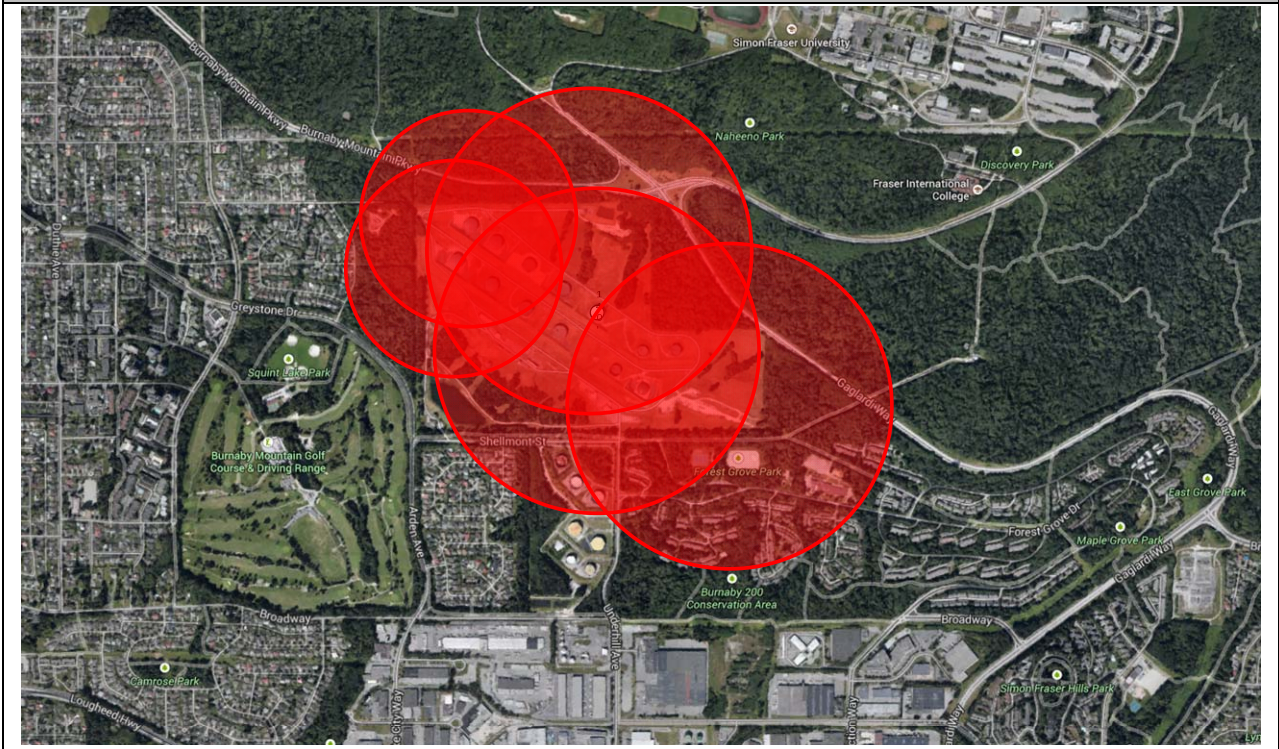
- P. 28-29 “The time to reach boilover depends on the amount of material in the tank. Tanks holding wide boiling range materials (such as crude oil) should not be pumped out since pumping removes the buffer between the water layer and hot heavy ends. While the rate of descent of the hot layer varies, as a first approximation it can be estimated to travel down from the burning fuel surface at the same rate at which fuel burns. Thus, the hot layer will be as far below the surface as the burning surface is below the original liquid level in the tank. From the original tank level, the descent of the heat wave is twice the rate of burning. In general, if foam cannot be applied successfully within 4 hours of the fire starting in a relatively full crude oil tank, then the incident commander should begin clearing the area within 10–15 tank diameters.”

KMC application to the NEB for the TMEP seems to directly contradict the recommendation of the American Petroleum Institute (API) and their recommendation for the management of storage tank fires. API is largest US oil & natural gas industry trade organization and represents 400 corporations with regard to governmental, legal and regulatory agencies. Of note Kinder Morgan Energy Partnership, L.P. is an active API Member Company.

The scope of the area potential impacted by a Boilover scenario is illustrated in Diagram 5. It is anticipated that the consequences of Boilover exposure within the areas identified would include:

- Human Injuries to Emergency Responders and unevaluated civilians
- Mass Tree Top Based Wildland Fire initiation
- Structural Fire initiation to many residential buildings
- Potential Tank Fire initiation within the TMTF and the Shellmont Tank Farm
- Significant isolation of the SFU and UniverCity communities

**Diagram 5**  
**Storage Tank Boilover**  
**Impact Areas**



## **Consequences**

The Kinder Morgan application for expansion at the Trans Mountain Tank Farm facility presents many uncontrollable and unacceptable safety risks to the City of Burnaby. The Trans Mountain Expansion Project (TMEP) will create elevated risk to the community by increasing the number and size of hydrocarbon storage tanks within an already geographically challenged facility. Hydrocarbon storage tanks on Burnaby Mountain present several public safety risks, which include the release of liquid hydrocarbon products, flammable vapors, toxic smoke and heat. In its application to the National Energy Board (NEB), Kinder Morgan has specifically identified the release of sulfur based gases, toxic smoke plumes and tank fire boilover as facility safety risks. Tactical firefighting analysis, presents the additional risks of wildland fire initiation due to the close proximity of fire hazards to the forested fenceline, the isolation of SFU communities by endangering travel on both Gaglardi Way and Burnaby Mountain Parkway during fire events and the potentials for tank fire burnout or a multiple tank fire event.

The location of the Trans Mountain Tank Farm presents risks of downhill liquid product release to the Forest Hills residential area solely because of its uphill elevation. The immediate impact to lives during a liquid product release is associated to exposure of gaseous sulphur compounds and the potential ignition of flammable vapors. The most significant liquid release scenario, is also the most difficult to prevent from occurring. The potential liquid product release scenario stemming from an expected regional area seismic event would be catastrophic in nature, and has potential to release the contents of several if not all of the storage tanks simultaneously, overwhelming the facilities retention provisions and flowing unrestricted to highly populated residential areas and sensitive environmental habitats.

The risk of fire is always present when flammable commodities are stored, handled or transported. Extensive engineering, control systems and design provisions have been unable to completely prevent fires from occurring in hydrocarbon storage facilities. Ignited hydrocarbon products present serious health impacts due to the very toxic nature of the smoke released. Operations at emergency events are prioritized by the protection of life, the protection of the environment, followed by the protection of property. An emergency event at the proposed Trans Mountain Tank Farm would likely require the Burnaby Fire Department to operate in the following manner. The primary operations would focus on the rescue of workers from the facility, followed by the protection of lives at high risk in the adjacent communities. The secondary operations would include the prevention of environmental impact and the continuity of basic emergency service throughout the City of Burnaby. Because of magnitude of the resource requirements for primary and secondary operations, the Burnaby Fire Department would have to choose to risk exposing life and the environment in order to commit department personnel to assist Kinder Morgan with any active firefighting operations inside the Trans Mountain facility to control the fire event itself.

With the exception of immediate evacuation, it is extremely difficult to control or prevent the harmful exposures created by discharging smoke from a fire event to lives within the community. In order to protect the citizens in proximity to the facility, evacuation of from areas exposed to smoke outfalls may be required. Hydrocarbon storage tanks are susceptible to fires

that can grow quickly into events that would expose the citizens of Burnaby in large numbers requiring emergency services to focus the bulk of available resources on executing the safe removal of lives from the areas of smoke exposure while extinguishing wildland and building fires outside the fenceline in immediate proximity to the heat outfall. The emergency services within the city of Burnaby would be challenged to maintain basic services elsewhere within the city during an event of this nature. The operations required to isolate and restrict access to areas of hazard, evacuate areas immediately or potentially impacted by toxic smoke outfalls, and prevent fire extension outside the fenceline would create a major demand and overwhelm the resources currently present. The location of proposed new storage tanks massively decreases the buffer zone currently in place at the facility, moving facility hazards significantly closer to the public, reducing the time to negative impact on the community, as well as providing many increased event risks previously not present.

Fires occurring in this tank farm will have the potential to be more severe in magnitude. Inherent in the layout of this tank farm is the potential of a fire event occurring in such close proximity to adjacent tanks, that subsequent ignition of additional storage tanks is a dangerous reality. A significant emergency management concern in a facility of this type is the escalation from a single tank fire to a multiple tank fire event. The resource requirements and the excessive complexity and risk to emergency responders, typically prevents the safe firefighting of a multiple tank fire event. The TMEP proposal includes the mass densification of the facility, adding many more and many larger product storage tanks. The addition of storage tanks decreases the distance between each tank. The distance between storage tanks is a key design and engineering feature provided to allow firefighters to effectively isolate an active tank fire, preventing a multiple tank fire event. The TMEP proposal effectively increases the risk associated with a multiple tank fire event due to the reduction in storage tank spacing.

The decreased tank spacing within the tank farm has additional significant consequences. Many of the potential tank fire scenarios within the Trans Mountain Tank Farm facility would be inextinguishable due to lack of safe firefighting positions. The general configuration proposed by Kinder Morgan provides insufficient safe access routes and operating positions from which firefighters could apply protective streams to isolate or extinguish fire events. The elevation changes within the Trans Mountain Tank Farm do not provide multiple firefighting positions or consideration for approach elevations to enable safe and effective operations for all potential wind directions. In order to extinguish a tank fire within the Tran Mountain Tank Farm emergency responders could be forced to significantly risk their personal safety in order to overcome the design inadequacies of the facility. Specifically, the configuration of the tank farm on a hillside in such a tight footprint would require firefighting personnel to operate in elevated positions above the tank, exposing them to potentially excessive heat and smoke outfalls. In these instances emergency responders would likely be forced to allow the tank fire to burn out while adjacent tanks are protected.

Many of the new proposed storage tanks in the TMEP will share containment diking. Because of the tight facility footprint, in order to provide containment diking as many as four (4) storage tanks will share a common containment dike. These large dike areas also prevent firefighting

crews from positioning effectively. Many wind directions may require firefighting personnel to operate from locations immediate downhill from the containment dike, or operate excessively close to the fire/spill area. In the event of a sudden wind shift or foam blanket burn through, the operating positions dictated by these large dike sizes, could cause firefighting personnel to be exposed to extending fire, flammable atmospheres and/or be cut off from their safe escape routes.

Many scenarios exist with the proposed configuration of the Trans Mountain facility that would likely present an unacceptable risk, or an inability to effect access to protect adjacent tanks, during a tank fire burnout, thus risking escalation of a single tank fire to a multiple tank fire event. The outfall toxic smoke plumes would have significant impacts within the community, its people, their environment and their property. Historically the hydrocarbon industry has accepted the strategic option of allowing a tank fire to burnout over several days as a method of tank fire extinguishment for fires that cannot be combatted safely. The TMEP proposal presents many conditions that provide no legitimate and safe strategies for extinguishment, other than allowing tank fire burnout.

The TMEP presents many tank fire scenarios that do not permit immediate containment, control and extinguishment. If allowed to burnout over several days, crude oil storage tanks may experience an explosion known as Boilover. Boilover is an explosive discharge of molten crude oil from the tank to all potential areas inside of 10 - 15 times the diameter of the storage tank (example: for a 200' Tank diameter, the area immediately hazardous to life is 2,000' – 3,000'). Within this hazard area should boilover occur, it is expected that unprotected lives and property would be significantly impacted. Post boilover event operations would include the medical aid to impacted life, and extensive fire suppression requirements for many residential and commercial structures, as well as wildland areas impacted within the hazard zone. The potential for a secondary hydrocarbon tank fires within the Trans Mountain facility or the adjacent Shellmont Tank Farm is an anticipated result of a boilover event.

Due to its geographical location, tank farm density, proximity of hazards to the fenceline and the potential hazardous release and fire events, the Kinder Morgan TMEP proposal and the emergency event scenarios identified within the proposal present an unacceptable magnitude risk and consequence to the city of Burnaby.

In the TMEP NEB Application Volume 7 Risk Assessment & Management of Pipeline & Facility Spills, Section 3.2.2 - Secondary Containment and Tank Fire Risk Assessment, states:

“The risk assessment begins with identification of hazards or concerns. This step relies on regulations and company direction to determine what is considered a hazard. Possible scenarios are fire and explosion risks from flammable materials, boil over from an internal tank fire, and toxic smoke plumes. Since a product release is the most likely event to occur, the Trans Mountain Pipeline (ULC) Trans Mountain Expansion Project Volume 7  
Volume 7 - Risk Assessment and Management of Pipeline and Facility Spills Page 7–20  
realistic worst case scenario is a fire and/or explosion of flammable material. Even

though a boilover scenario is not considered likely, this hazard is considered for emergency planning purposes. In addition, because the product in the storage tanks may contain trace amounts of sulphur, the hazard of human exposure is also considered for emergency planning purposes.”

This portion of the application clearly identifies the hazards that require emergency planning as potential incidents:

- Fire and Explosion of flammable materials
- Boilover from an Internal Tank Fire  
(therefore a full surface Internal Floating Roof Tank Fire)
- Toxic Smoke Plume release
- Sulphur based gas release

### **Flammable Gas Outfall against the Fenceline**

The release of crude oil products from primary containment within the TMTF can present the potential for flammable gas outfall to areas outside the fenceline. Crude oil contains components that when released from the containment provided by piping and storage tanks causes the release of high volatile “Light Ends”. The lighter components of the crude oil when released form flammable outfalls with low ignition points

Regardless of the preventative measures undertaken by a facility, the nature of the commodity, risks of emergency events associated with product release are legitimate.

In Kinder Morgan Canada Risk Assessment Trans Mountain Expansion Project – Burnaby Terminal Project, October 1<sup>st</sup>, 2013 Doug McCutcheon and Associates, Consulting

- P. 29 “From an operational view there is a higher than accepted probability for releases caused through the handling of materials during transfers as well as through tank leaks and spills.”

The risk to the community exists when a pipe or storage tank loss of containment results in a flammable gaseous release. The proximity of the release to the fenceline is of significant issue. Typically the hazard of a flammable gas release is reduced by the “weathering” of the flammables prior to their engagement with an ignition source. Weathering is the dispersal of the flammable gaseous hydrocarbon light ends. Weathering includes the dispersal to elevation of the atmosphere by flammable products lighter than air, and dispersal due to loss of concentration at ground level due to dilution with common air atmosphere during travel away from the propagating source.

Ignition sources within the facility are mostly controlled by electrical classification save the potential for ignition by a passenger or industrial motor vehicle, or hot work. Outside the fenceline any manner of ignition source is possible. The positive effects of weathering are significantly reduced with the movement of storage tanks, diked area and piping significantly closer to the fenceline. The TMEP proposes a significantly reduced buffer zone to the

community, reducing the positive effects of weathering prior to community infiltration and presenting flammable gas exposure risks to the community much sooner upon release.

The potential for flammable gas ignition outside the fenceline is based upon the use of the land areas in proximity to the fenceline. The highly populated areas around the TMEP present a high likelihood of ignition by the natural community activities. The TMEP has planned not to provide a notification mechanism to initiate community protection from a flammable gas release. The first emergency based actions to prevent flammable gas ignition will be provided by City of Burnaby emergency responders.

Of significant interest is the TMEP states that it will take full responsibility for an emergency event occurring, it also states that the TMEP takes no responsibility to provide immediate community notifications for this type of public safety hazard.

On Page 436 of 754, question 25.07 (c.) of the City of Burnaby IR – Round 1:

*City of Burnaby:* Will Trans Mountain personnel have the skills, knowledge, training and ability to deploy, move, adjust and augment spill containment booms immediately at spill occurrence, and simultaneously with:  
i) initial site emergency management actions, notifications, isolation provisions, activation of both internal and external resources?  
ii) the discontinuing of transfer operations, field access, assessment, intervention and mitigation operations in a safe, effective and efficient manner for all emergency event potentials?

*KMC – TMEP:* Kinder Morgan Canada (KMC) takes full responsibility for any emergency that results from the Trans Mountain Pipeline system.

On Page 188 of 754, Question 07.23 (e.) of the City of Burnaby IR – Round 1:

*City of Burnaby:* Is Trans Mountain going to provide an Emergency Notification System or an early warning system to communicate risk to the public?

*KMC – TMEP:* Kinder Morgan Canada does not currently have an early warning system to communicate risk to the public. Application Volume 7, Section 4.8 outlines the process to enhance Kinder Morgan Canada's (KMC) existing emergency management programs as they relate to the Trans Mountain Pipeline system to address the needs of TMEP. The final programs will be developed in a manner consistent with the NEB's draft conditions related to emergency management.

Of note, during the TMTF 2009 storage tank overfill event, KM failed to notify the community in any manner during the release of flammable gas from a crude oil loss of containment. The Burnaby Fire Department received many emergency calls for assistance from citizens residing in proximity to the TMTF complaining of foul odours. Upon investigation, the Burnaby Fire Department identified that the odours had originated from the TMTF and a spill occurrence several hours earlier. The lack of community notification likely presented risk of flammable gas ignition outside the facility fenceline. The ability or unwillingness to either inform the community or inform City of Burnaby emergency responders does not characterize event management focused on public safety interests as a priority.

A similar event occurring from a storage tank in much closer proximity to the fenceline, such as presented by the proposed TMEP configuration, would present a much higher likelihood of ignition and severe life hazard. Specifically, proposed Tanks 91, 93, 95, 96, 97 and 98 all present significant risk of flammable release ignition by motor vehicles utilizing Burnaby Mountain Parkway or Gaglardi Way (The risk likelihood is increased due to the elevated location of the roadway. The elevated topography will provide significantly less dispersal.). Tanks 75, 77 and 79 present a significantly higher risk of flammable risk potential to the Forest Grove community area directly South from the tank diking edges (although the elevation change in this area favors increased dispersal, higher density residential areas and an Elementary School are present to the South extremely close to the proposed tank dike edges.)

Storage tank diked areas and product piping situated close to the fenceline creates a significant increase in the fire risk to the adjacent community and the facility itself. The control of such close proximity releases may not be possible by the application of firefighting foam agents to the spill surface in a timeframe that could reduce the risk of flammable gas exposure prior to ignition.

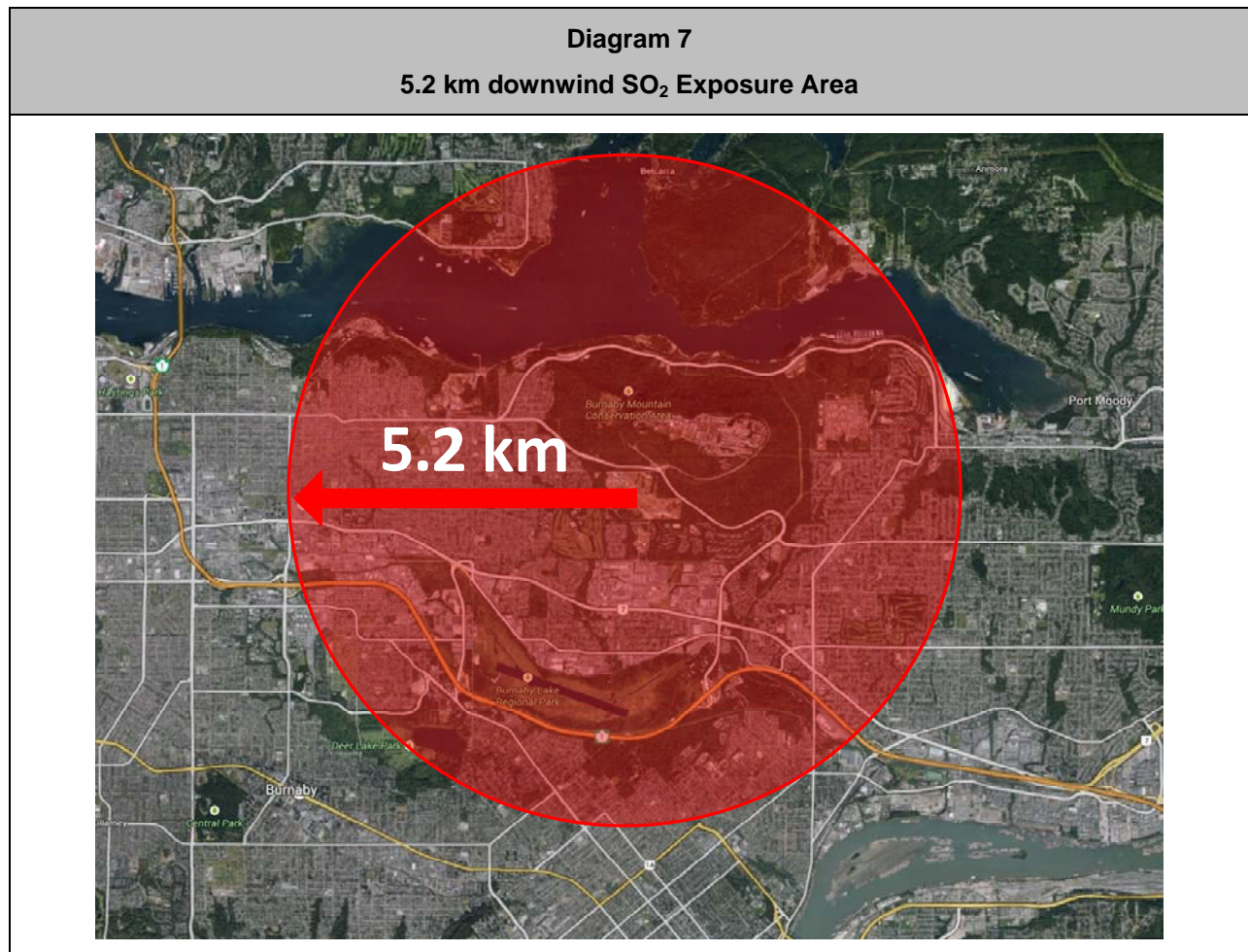




Sulphur Dioxide is another compound generated from the combustion of crude oil with sulphur content.

In Kinder Morgan Canada Risk Assessment Trans Mountain Expansion Project – Burnaby Terminal Project, October 1<sup>st</sup>, 2013 Doug McCutcheon and Associates, Consulting

- P. 3 “However as there is a possibility some of the oil will contain small amounts of Sulphur which will be converted to Sulphur Dioxide (SO<sub>2</sub>) in a fire, the analysis shows a potential health concern could be felt up to 5.2 km downwind”



The design basis of the TMEP that moves crude oil storage tanks closer to the fenceline, creates close proximity potential release or spill of crude oil into secondary containment dikes and the potential for the release of Sulphur based gases to areas outside the fenceline. These gases that dissipate very slowly because of their molecular weight, present legitimate health hazard to populated areas.

In Kinder Morgan Canada Risk Assessment Trans Mountain Expansion Project – Burnaby Terminal Project, October 1<sup>st</sup>, 2013 Doug McCutcheon and Associates, Consulting

- P. 3 “Included are the analysis of the smoke plume from the and a consideration of the Sulphur component in the oil, which has been recognized as a health concern”

The potential health effects of Hydrogen Sulfide are:

*Low Concentrations:*

- Irritation of eyes, nose, throat and respiratory system
- Breathing difficulties in Asthmatics

*Moderate Concentrations:*

- Coughing, difficulty breathing, headache, dizziness, nausea, vomiting, staggering and excitability

*High Concentrations*

- Shock, convulsions, inability to breathe, extremely rapid unconsciousness, coma and death

In considering the likelihood of the life impact to the community members from a potential release that includes Hydrogen Sulfide, distance from the facility to adjacent residential living is critical. At its greatest impact the TMEP facility will be 20 meters from residential property. This proximity would provide very little opportunity to notify adjacent residential community members prior to harmful impact.

Of significant interest is the TMEP takes no responsibility to provide immediate community notifications for this type of public safety hazard. While KMC states on ..... It takes full responsibility.....

On Page 188 of 754, Question 07.23 (e.) of the City of Burnaby IR – Round 1:

*City of Burnaby:* Is Trans Mountain going to provide an Emergency Notification System or an early warning system to communicate risk to the public?

*KMC – TMEP:* Kinder Morgan Canada does not currently have an early warning system to communicate risk to the public. Application Volume 7, Section 4.8 outlines the process to enhance Kinder Morgan Canada’s (KMC) existing emergency management programs as they relate to the Trans Mountain Pipeline system to address the needs of TMEP. The final programs will be developed in a manner consistent with the NEB’s draft conditions related to emergency management.

The detail not present in KMC’s answer to the above 07.23 question, is that within the existing emergency management programs at TMTF, KMC has no immediate emergency communication plans, protocols or procedures to notify the community at the first identification of hazard to the community.

The reduction magnitude of distances from the proposed crude oil storage tanks to the exterior facility exposures are as follows (approximate values based on KMC TMEP NEB Application devoid of accurate technical plans):

- Distance to Life Impact via Primary routes of travel from SFU and UniverCity  
20% Reduction Magnitude  
250' Distance  
1 ½ Tank Diameters  
Expected impact from a Full Surface Tank Fire, Dike Fire or Spill to require abandonment of all routes leaving Burnaby Mountain as unsafe

### **Release of Toxic Smoke Plumes against the Fenceline**

The risk to human life and the environment of release toxic smoke plumes for crude oil fires which includes exposures to soot clouds, liquids, aerosols and gases, particulate matter, metals, sulfur compounds and nitrogen oxides, specifically:

- Carbon Dioxide
- Carbon Monoxide
- Sulfur Dioxide
- Nitrogen Oxides
- Volatile Organic Compounds
- Polycyclic Aromatic Hydrocarbons
- Hydrogen Sulfide
- Acidic Aerosols
- Solid Carbon
- Nickel
- Vanadium
- Arsenic

The potential health impacts of exposure to these products of crude oil combustion are most notably likely to harm those with pre-existing chronic respiratory conditions, increase rates of asthma and cardiovascular illness, with undetermined effects on longer term illness accumulations such as cancer.

The depositing of solid soot containing amounts of the metals, aerosols and liquids identified above can create imbalances and may harmfully affects to the delicate environmental balance associated with wildland and watercourse habitats in direct impact from the outfall smoke.

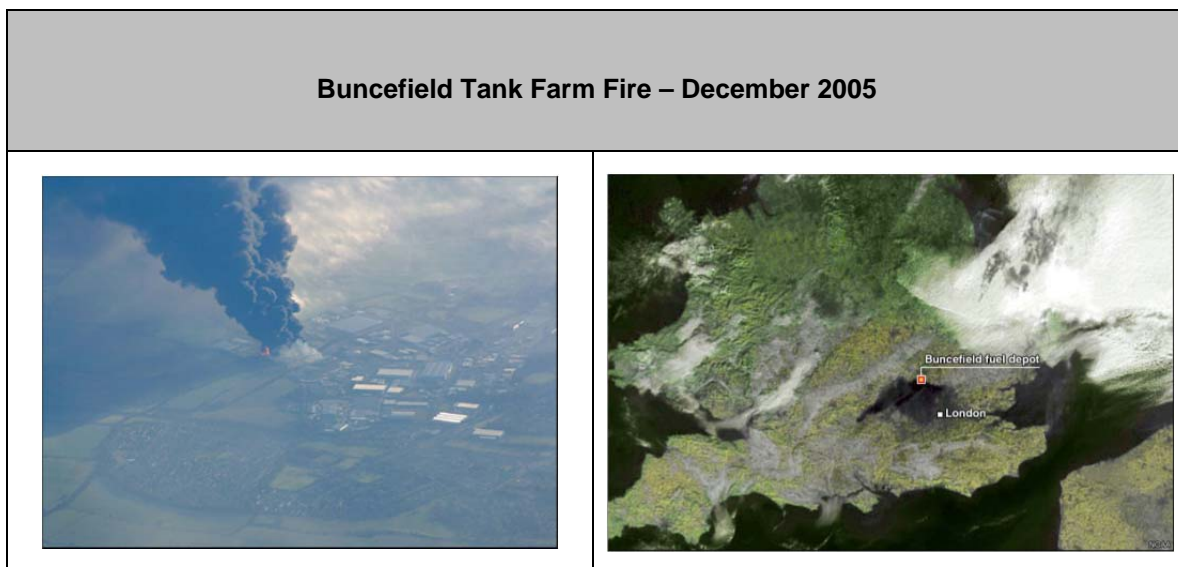
The smoke discharge associated with an uncontrolled full surface tank fire would significantly impact the health of all lives in the outfall region of smoke as the extent of long term illness occurrence is currently unestablished. As of June 2014, KMC's plan for the control of a full surface tank fire was based on the utilization of resources mobilized from Alberta and the state of

Texas, with an expected arrival time of within 24 hours. Considering that the required equipment mustering, organizational and planning work associated with mitigating an full surface tank fire can take several hours and the direct fire attack is likely to take nearly 2 hours if initially effective, KMC has stated it is expecting of a timeframe of toxic smoke discharge prior to possible extinguishment of 1 – 2 days.

It is expected that the 1 – 2 day burn time would generate sufficient toxic smoke plume discharge to significantly affect the entire Greater Vancouver Regional District, with specifically high concentration of exposure and respiratory health hazards to all Burnaby, Port Moody, Coquitlam and New Westminster residents at risk with pre-existing respiratory conditions.

In Kinder Morgan Canada Risk Assessment Trans Mountain Expansion Project – Burnaby Terminal Project, October 1<sup>st</sup>, 2013 Doug McCutcheon and Associates, Consulting

- P. 6 “A toxic impact up to 5.2 km downwind due to SO<sub>2</sub> created in a fire, and smoke impacts as far out as 43 km.”  
INSERT area ENCOMPASSED
- P. 25 “Toxic concerns were identified for smoke (soot) and for SO<sub>2</sub> downwind of the site. These are both issues that should be included in the site emergency plan. From a risk exposure point of view the impacts are very hard to define due to weather conditions and just the turbulence created by the heat from a fire. The likely result will be significant mixing of any SO<sub>2</sub> in the air to reduce the impact at ground level. However it cannot be ignored that the emergency plan needs to extend outwards to 5.2km for SO<sub>2</sub> concerns assuming 70% combustion efficiency. The Buncefield UK experience in terms of smoke impacts as shown in the above photographs gives a vivid picture of what a similar fire could look like.”



The reduction magnitude of distances from the proposed crude oil storage tanks and the exterior facility exposures are as follows (approximate values based on KMC TMEP NEB Application devoid of accurate technical plans):

- Distance to Life Impact via Primary routes of travel from SFU and Univercity  
20% Reduction Magnitude  
250' Distance  
1 ½ Tank Diameters  
Expected impact from a Full Surface Tank Fire or Dike Fire to require abandonment of all routes leaving Burnaby Mountain

### Heat Discharge against the Fenceline

The existing TMTF is designed with a set back or buffer distance of not less than 200' from the fenceline. The proposed TMEP massively decreases the distance The TMTF sits directly adjacent to the Burnaby residential communities of Lochdale, Sperling-Duthie, Meadowood, Forest Grove (the nearest residential property being 20 m away), as well as in proximity to Simon Fraser University and UniverCity.

In Kinder Morgan Canada Risk Assessment Trans Mountain Expansion Project – Burnaby Terminal Project, October 1<sup>st</sup>, 2013 Doug McCutcheon and Associates, Consulting

- P. 6 “Evaluating the consequences of the release scenarios indicated a low level radiant heat impact radius of up to 205 - 536m from a pool fire. Serious impact is felt up to 86 - 224m from the dike walls.”

INSERT area ENCOMPASSED

- P.21 “For a fully involved dike fire, the type of fire will undoubtedly be a heavy smoke type. With this in mind the major damage is up to 17 meters from the dike wall similar to the Dow calculation of 24 meters. The damage quickly reduces as the radiant heat energy is dissipated outwards. Applying the MIACC Criteria for 4 kW/m<sup>2</sup>, the acceptable level of risk radius is approximately 86 - 224m from the dike wall. The radiant heat energy eventually declines to 1.0 kW/m<sup>2</sup> (sunburn) at a distance of 205 - 536 meters from the dike wall. Of note are the specific tanks close to the northern and eastern boundaries where the impacts can be felt beyond the company property lines.”
- P. 21 “For a tank top fire, the type of fire will undoubtedly generate heavy smoke. With this in mind the major damage is up to 19 – 24 meters from the source of the fire. The damage quickly reduces as the radiant heat energy is dissipated outwards. Applying the MIACC Criteria, for 4kW/m<sup>2</sup>, the acceptable level of risk radius is approximately 56 - 71 m from the source. The radiant heat energy eventually declines to a “safe level” equivalent to a sunburn at about 144 - 184 meters.”

KMC in their NEB application for the TMEP that low level heat will be present at up to 1,750’, and high radiant heat at up to 730’.

The potential of heat exposure from a fire event initiated inside the TMTF facility is of critical issue with the TMEP. KMC stated in their Round 1 response to the City of Burnaby’s Intervener questions that, the reduction in inter-tank spacing within the facility is a product of the number of tank the TMEP requires and the square footage available within the TMTF site. The TMEP has proposed a new facility configuration that places many more storage tanks much closer to the fenceline creating new and significant fire spread risks to adjacent wildland areas.

The heat from a tank fire or dike fire will create heat accumulation on adjacent tanks and flammable exposures dependant on wind direction and elevation difference. Areas of potential fire spread in the downwind direction or at higher elevations from a tank fire or dike fire, are particularly susceptible to heat accumulation and fire spread. Based on a full surface tank fire, all potential fire spread areas within 1 tank diameter will experience heat exposure, except for fire spread areas in the downwind direction and areas of increased elevation, which will experience heat exposure to a distance of 2 times the tank diameter (Reference Table 12).

Table 12					
Trans Mountain Storage Tank Configuration Proximity Risk of Wildland Fire					
Current TMTF			TMEP		
	Distance to Fenceline			Distance to Fenceline	
	Linear Distance	Tank Diameters		Linear Distance	Tank Diameters
Tank 88	1500'	1	Tank 74	50'	¼
Tank 72	200'	1 ½	Tank 78	50'	¼
			Tank 91	100'	½
			Tank 76	150'	¾
			Tank 98	150'	¾
			Tank 88	150'	1
			Tank 79	200'	1
			Tank 80	250'	1 ¼
			Tank 77	250'	1 ¼
			Tank 72	200'	1 ½
			Tank 75	300'	1 ½
			Tank 93	300'	1 ½
			Tank 96	300'	1 ½
			Tank 97	350'	1 ¾
			Tank 95	400'	2

The TMEP increases the potential of exterior fenceline heat impact scenarios by a magnitude of 7.5 times. The current TMTF has potential heat impacts to exterior fenceline areas from only 2 tanks. The TMEP will create potential heat impacts to exterior fenceline sensitivities from 15 tanks. Additionally, as illustrated in Diagrams 8 & Diagram 9, the depth at which the heat impacts from a tank fire event in the proposed TMEP Configuration will penetrate the forested area is extensive. In many cases the depth of heat impact is expected to increase from 100' on a single event potential, to 300' on up to 6 event potentials, and 100' on 5 event potentials.

KMC NEB Application included a Risk for the Trans Mountain Expansion Project – Burnaby Terminal Project, provided on October 1<sup>st</sup>, 2013 by Doug McCutcheon and Associates, Consulting. Within this document a visual representation is provided titles Figure 5: Summary of Risk Distances for Radiant Energy from a Tank Top Fire. Of note, is that both Burnaby Mountain Parkway and Gaglardi Way are fully encompassed, as well as a great portion of the Burnaby Mountain Conservation Area, in the 4 kW/m<sup>2</sup> heat intensity, which described as:

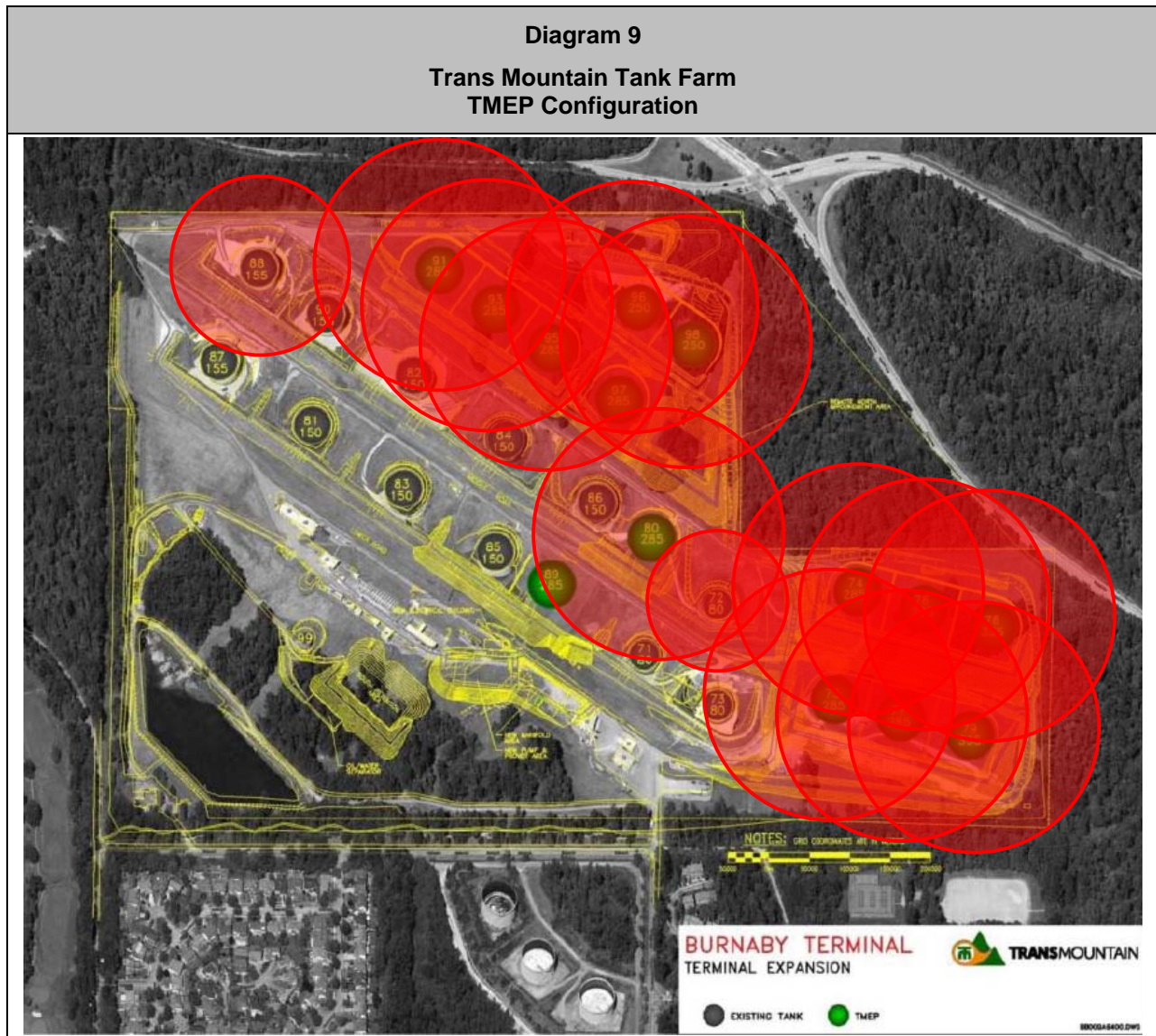
- “Consequential Exposure Damage to People: Significant injury after 100 seconds exposure”



Diagram 8

Trans Mountain Tank Farm  
Current Configuration

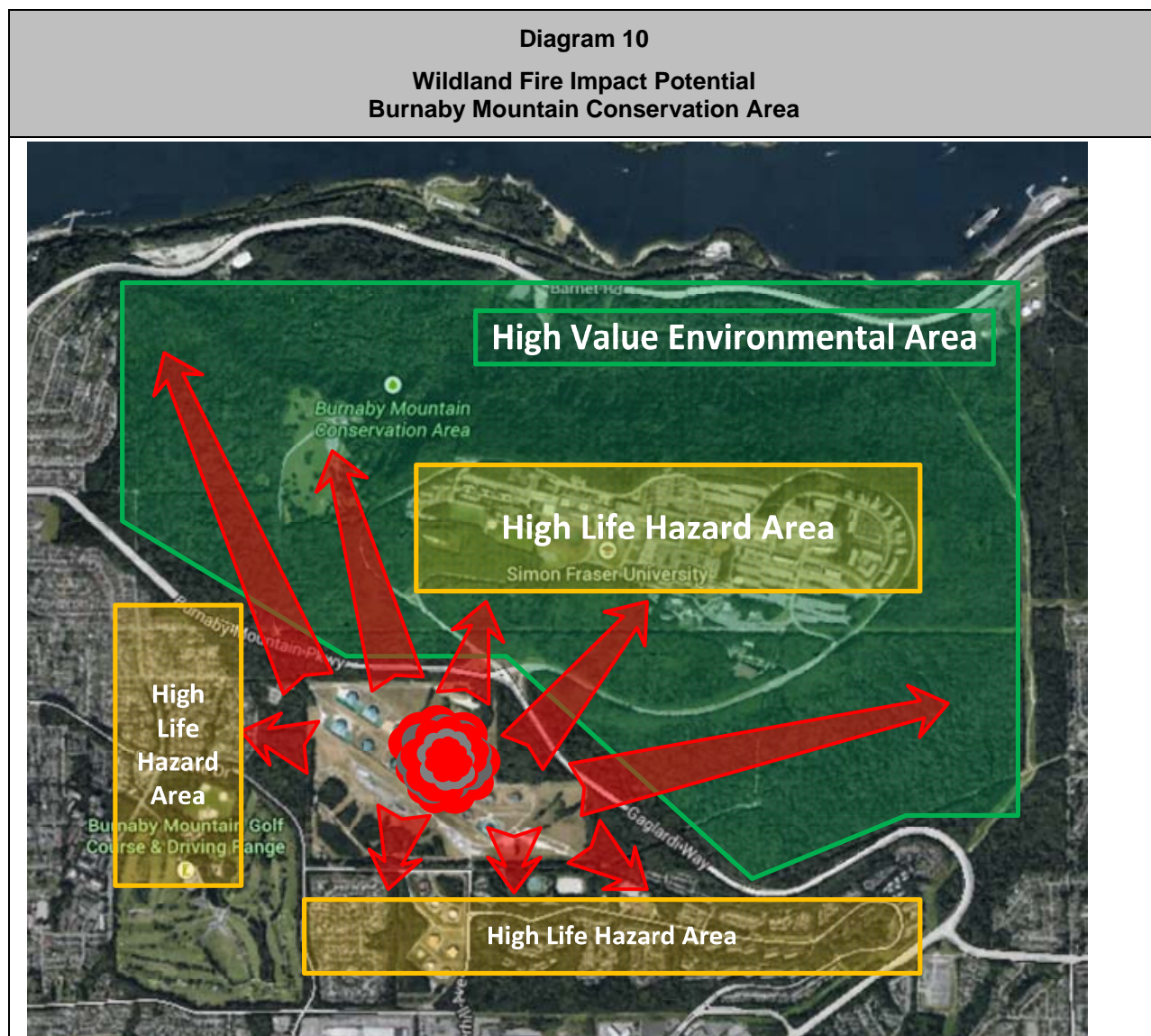




The heavily treed forest area of the Burnaby Mountain Conservation Area, surrounding the TMTF would be highly sensitive to heat exposure from a TMTF tank or dike fire. An uncooled heat exposure to the trees surrounding the TMTF, would create conditions consistent with ignition and development of a rapidly advancing “High Tree Top” Wildfire event. Uncontrolled fire growth of this nature would generate loss potentials that include:

- Significant forest loss on Burnaby Mountain prior to extinguishment
- Significant risk of heat wave impact back on the TMTF and potential ignition of additional Crude Oil Storage Tanks
- Significant interface property loss adjacent to the Burnaby Mountain Conservation Area

- Isolation of the access/egress routes from SFU and UniverCity until extinguishment is achieved
- Potential impacts to the Suncor Burrard Products Refined Hydrocarbon Storage Tanks in the Glenayre neighborhood of Port Moody
- Long duration loss of the parks and recreation usage and quality of the Burnaby Mountain Conservation Area



The reduction magnitude of distances from the proposed crude oil storage tanks and the exterior facility exposures are as follows (approximate values based on KMC TMEP NEB Application devoid of accurate technical plans):

- Distance to Wildland Impact of the heavily treed Burnaby Mountain Conservation Area  
66% Reduction Magnitude  
50' Distance  
¼ Tank Diameter  
Expected heat impact from a Full Surface Tank Fire or Dike Fire to ignite treed area
- Distance to Life Impact via Primary routes of travel from SFU and University  
20% Reduction Magnitude  
250' Distance  
1 ½ Tank Diameters  
Expected impact from a Full Surface Tank Fire or Dike Fire to require abandonment of all routes leaving Burnaby Mountain
- Distance to Event Escalation Potential of adjacent Hydrocarbon Storage Tank Farm  
11% Reduction Magnitude  
900' Distance  
4.5 Tank Diameters

## Conclusions

On 16 December 2013, Kinder Morgan submitted an application to the National Energy Board (NEB) for the expansion of the Trans Mountain Pipeline system, which includes the expansion of the Burnaby Mountain Terminal. The expansion involves the densification of storage tanks within the existing footprint of the site from 13 tanks to 26 tanks – a tripling of the subject terminal’s storage capacity from 1.7 million barrels to 5.6 million barrels. The findings of the fire safety and risk analysis within this paper, raises concerns over KMC selection of the Burnaby Mountain Terminal for the densification of storage tank use.

Based on the findings of the analysis, Burnaby Mountain Terminal is not the appropriate location for the expansion of the Burnaby Mountain Terminal and densification of petroleum storage, given the subject terminal topography, limited site area, limited site access, its close proximity to the Lochdale, Sperling-Duthie, Meadowood, Forest Grove neighbourhoods (the nearest residential property being 20 m away), Simon Fraser University, UniverCity as well as the immediate proximity to the highly sensitive and susceptible Burnaby Mountain Conservation Area. These factors pose significant constraints from an emergency/fire response perspective, including but not limited to safety of firefighters and effectiveness to combat fire; containment and extinguishment of fire/spill/release; evacuation of employees within the Burnaby Mountain Terminal facility; evacuation of adjacent neighbourhoods, as well as broader areas impacted by release of sulfur based gases and toxic smoke plumes; and, protection of adjacent properties, including conservation lands.

Additionally, the TMEP lacks appropriate consideration for original facility fire protection premises and industry best practices in petroleum storage and fire protection, as the proposal only seeks to comply with minimum federal and provincial code requirements.

These factors pose significant risks to lives and property arising from the densification of petroleum products on a sub-standard, ill-configured and under sized property located in proximity to urban residential and other populations.

This paper has analyzed and identified the impacts of the TMEP with regard to the *reduction in countermeasures* and resulting facility susceptibility to *consequences* resulting from *hazard event* occurrence.

## Countermeasures

The increased consequences arising from risk occurrence is a direct result of the facility configuration changes and additional storage tank locations which reduce the positive impact of the previously engineered fire and safety protection counter-measures. The Counter-measures which will be marginalized by the TMEP, include:

### ▪ Tank Spacing

A 33% reduction in the overall facility Tank Spacing

A 45% reduction in the proposed Tank Spacing versus existing Tank Spacing premise

Tank spacing is the fundamental premise in reducing fire event extension potential through designed isolation distances of hazards from adjacent risks.

### ▪ Application Positions

A 70% increase in the number of Storage Tanks that do not provide safe deployment positions for fire operations in all potential wind conditions, limiting the ability for fire events to be prevented from extending to adjacent Storage Tanks or Wildland areas.

100% of the proposed Storage Tanks do not provide safe deployment positions for fire operations in all wind conditions, limiting the ability for fire events to be prevented from extending to adjacent Storage Tanks or Wildland areas.

The proposed use of significantly greater storage tank density has impacts on the availability of appropriate application positions to control major fire events. The primary concerns created by the TMEP related to deployment positions are:

- Insufficient deployment positions to cool adjacent tanks to prevent event heat exposures from escalating into fire extension
- Insufficient roadway option to allow for safe access and egress of deployment positions to provide all necessary fire stream applications in all potential wind conditions

### ▪ Distance to Fenceline

A 30% reduction in the facility average Tank to Fenceline Distance

A 61% reduction in the average proposed Tank to Fenceline Distance

The TMEP expands the existing TMTF with high density storage tank configurations into the northern and eastern corners of the existing facility property. The proposed configuration changes the tank to fenceline distances of the facility. The tank to fenceline distance is critical as it directly impacts time elapse to hazard impacts to the community life, environmental health and property outside the TMTF facility.

## Hazard Events

The risk of spill and fire occurrence is well established within the hydrocarbon industry. Engineering initiatives and best practices have reduced the occurrence frequency, but the real potential of a fire event occurring has not been removed. Spill and fires that do occur can be prevented from spreading and growing into unmanageable public health and environmental disasters, only if the configuration of the tank farm facility supports the isolation of the spill or fire risk from the adjacent facility susceptibilities. The TMEP degrades the original fire protection premise of the facility and increases the likelihood of spill or fire extension exposing the community to the following hazard events.

- **Regional Seismic Event**

The consequences of a seismic event occurrence are increased due to the location of the facility. The TMTF is located, elevated immediately above residential communities and sensitive environmental areas, watercourses and eco-systems in close proximity, in the outfall downhill direction. The TMTF is located, immediately below a high density treed environmental conservation area, a highly populated university and high density residential community, in direct outfall uphill direction.

- **Flammable Gas Outfall**

Crude oil contains components that when released from the containment provided by piping and storage tanks causes the release of high volatile “Light Ends”. The lighter components of the crude oil when released form flammable outfalls with low ignition points and the significant potential to propagate explosion and fire events.

- **Release of Sulphur based Gases**

The loss of containment of crude oil products presents the potential for Hydrogen Sulfide and Sulphur Dioxide release. Hydrogen Sulfide is a poisonous, colorless, and heavier than air, highly flammable gas that has potential to create explosive mixtures with Oxygen. Exposure to 100 ppm of Sulfur Dioxide in air is considered immediately dangerous to life.

- **Watercourse Outfall of Liquid Crude Oil Release**

The release of Crude Oil to areas outside of lined secondary containment diking creates the potential of a crude oil introduction into watercourses exiting the TMTF facility. The release of crude oil to earthen surfaces outside secondary containment provisions, presents the expansion of the release to the subterranean water shed system of Burnaby Mountain. The natural water shed system off Burnaby Mountain would route collected crude oil to areas of downstream impact to Eagles Creek.

- **Tank Fire Burnout**

Tank Fire Burnout has historically been utilized as a contingency option for fire extinguishment when adverse environmental conditions exist, a lack of firefighting resources are present or when the facility design precludes safe offensive firefighting operations. Therefore the use of a Tank Burnout tactic exposes the community to the full

potential impact and duration of toxic smoke and heat discharge based upon the volume of crude oil present at the time of ignition. The operations associated with evacuating persons potentially impacted by a 4 day tank fire event from a facility with such tight proximity to high density residential communities would constitute an emergency activation of provincial scale. Even in the event that a tank is only being permitted to burn without extinguishment operations for short timeframes prior to mounting an offensive fire attack to extinguish, the emergency response will be forced to take immediate action in order to prevent incident escalation including fire spread to adjacent storage tanks and wildland areas such as the highly susceptible Burnaby Mountain Conservation Area.

▪ **Tank Fire Boilover**

The potential for Boilover exists in any wide boiling range hydrocarbon, such as a crude oil storage tank full surface fire. For a proposed 200' storage tank, a Boilover event can discharge heated and molten crude oil outwards to 2,000'. A Boilover event occurring from a Tank Fire in the TMTF, would result in large area life hazard and the potential for propagation of additional storage tank fires due to the mass discharge of molten crude oil over areas encompassing:

- The entire TMTF
- The Shellmont Tank Farm
- Forest Grove Community
- Meadowood Community
- Sperling-Duthie Community
- Closing Gaglardi Way
- Burnaby Mountain Parkway



## Consequences

The Kinder Morgan application for expansion at the Trans Mountain Tank Farm facility presents many uncontrollable and unacceptable safety risks to the City of Burnaby. The Trans Mountain Expansion Project (TMEP) will create elevated risk and consequences of risk occurrence to the community by increasing the number and size of hydrocarbon storage tanks within an already geographically challenged facility. Hydrocarbon storage tanks on Burnaby Mountain present several public safety risks, which include increased potential for, include:

- **Flammable Gas Outfall against the Fenceline**

The potential for flammable gas ignition outside the fenceline is based upon the use of the land areas in proximity to the fenceline. The highly populated areas around the TMEP present a high likelihood of ignition by the natural community activities.

- **Release of Sulphur Based Gases against the Fenceline**

Highly toxic Hydrogen Sulfide (H<sub>2</sub>S) will very quickly, upon facility release, expose residential areas to conditions that are immediately dangerous to life. Smoke outfalls from fire event may contain Sulphur Dioxide (SO<sub>2</sub>), in which KMC analysis shows a potential health concern could be felt up to 5.2 km. downwind.

- **Release of Toxic Smoke Plumes against the Fenceline**

The risk to human life and the environment resulting from the release toxic smoke plumes from crude oil fires includes exposures to soot clouds, liquids, aerosols and gases, particulate matter, metals, sulfur compounds and nitrogen oxides. The potential health impacts of exposure to products of combustion from crude oil combustion are most notably likely to harm those with pre-existing chronic respiratory conditions, increase rates of asthma and cardiovascular illness, with potentially undetermined effects on longer term illness accumulations such as cancer. Considering that the required equipment mustering, organizational and planning work associated with mitigating an full surface tank fire can take several hours and the direct fire attack is likely to take nearly 2 hours if initially effective, KMC has stated it is expecting of a timeframe of toxic smoke discharge prior to possible extinguishment of 1 – 2 days. It is expected that the 1 – 2 day burn time would generate a sufficient toxic smoke plume discharge to significantly affect the entire Greater Vancouver Regional District, with specifically high concentration of exposure and respiratory health hazards to all Burnaby, Port Moody, Coquitlam and New Westminster residents at risk with pre-existing respiratory conditions.

- **Heat Discharge against the Fenceline**

The TMEP reduces the Heat Source distance to Wildland Impact and potential Wildfire exposure of the Burnaby Mountain Conservation Area by 66%.

The existing TMTF is designed with a set back or buffer distance of not less than 200' from the fenceline. The proposed TMEP massively decreases the distance The TMTF sits directly adjacent to the Burnaby residential communities of Lochdale, Sperling-

Duthie, Meadowood, Forest Grove (the nearest residential property being 20 m away), as well as in proximity to Simon Fraser University and UniverCity.

## Conclusions

The TMEP will increase the impacts associated with the risks of crude oil loss of containment or fire across all potential events types due to the increased proximity to residential population densities, highly susceptible conservation forest areas and downhill or downwind sensitivities. The time prior to life and environmental impact will be significantly reduced by the TMEP, as has many of the engineered in facility configuration countermeasures responsible for the minimization of event growth and corresponding impact escalation have been greatly reduced from original facility premises which fundamentally adhered to the intent of best practices, to the reduced performance of minimum code requirements.

The existing high consequence event potential of a regional seismic event will tax the TMTF facility as the tertiary containment system has not been proposed to be upgrade nor will the secondary containment provisions of existing storage tanks, creating a potential release of 40% of the volumetric crude oil from the facility or up to 2.24 Million Barrels of crude oil. The impact of this loss is not increased by frequency of event occurrence, but by the TMEP not incorporating site wide upgrades to maintain the countermeasure premises currently in place.

Fires occurring in this tank farm will have a potential to be severe in magnitude. Inherent in the layout of this tank farm is the potential of a fire event occurring in such close proximity to adjacent tanks, that subsequent ignition of additional storage tanks is a dangerous reality. A significant emergency management concern in a facility of this type is the escalation from a single tank fire to a multiple tank fire event. The resource requirements and the excessive complexity and risk to emergency responders, typically prevents the safe firefighting of a multiple tank fire event. The TMEP proposal includes the mass densification of the facility, adding many more and many larger product storage tanks. The addition of storage tanks decreases the distance between each tank. The distance between storage tanks is a key design and engineering feature provided to allow firefighters to effectively isolate an active tank fire, preventing a multiple tank fire event. The TMEP proposal effectively increases the risk associated with a multiple tank fire event due to the reduction in storage tank spacing.

The TMEP proposes the increasing of the tank farm storage tank density, by decreasing engineered tank isolation distances, which in turn increases the potential for fire event escalation through extension, in a facility that has reduced its internal fire protection capability without approval. Notable by its absence from the TMEP application to the NEB is a detailed analysis of the effect of the tank spacing reduction on the requirements of mobile and fixed fire protection countermeasures, and the subsequent changes to the fire protection premises currently utilized. Weaknesses in the design of a facility can create fire event situations that cannot be safely or effectively mitigated without allowing a storage tank or several tanks to burnout.

The TMTF was originally approved based on the provision of a 2 tank diameter spacing. In subsequent years the addition of Tank 88 marginally reduced the overall facility tank spacing to 1.86 tank diameters (average), but maintained the original premise of tank spacing to provide tank isolation and reduce escalation and extension potentials. The TMEP massively deviates

from the original safety premise and approval basis of providing storage tank isolation for proposed tanks at a proximity distance of 0.5 tank diameters.

The addition of storage tanks into the existing TMTF changes the risk control premises with regard to storage tank isolation by facility design. In order to achieve the desired storage tank volume, KMC is proposing a significant replacement of designed isolation of each storage tank. In essence, the TMEP shifts the control of hazard from an engineered approach of tank isolation, to an emergency response approach. As the authority having jurisdiction for fire protection approval within the City of Burnaby, the Burnaby Fire Department has recently been advised by KMC on May 30, 2014, that the facility no longer has the emergency response ability to extinguish fire events with internal facility resources, and that additional hydrocarbon specialized firefighting resources from regional facilities are no longer available.

To complicate the emergency control activities, because of the tighter tank spacing, many heat exposure cooling operations are not possible due to insufficient firefighting deployment positions. The TMEP proposed to group many tanks with common diking separated only by small intermediate dike segregation. These larger dike areas reduce the available access and deployment roadway positions to facilitate safe, efficient and effective firefighting stream applications.

The decreased tank spacing within the tank farm has additional significant consequences. Many of the potential tank fire scenarios within the Trans Mountain Tank Farm facility would be inextinguishable due to lack of safe firefighting positions. The general configuration proposed by Kinder Morgan provides insufficient safe access routes and operating positions from which firefighters could apply protective streams to isolate or extinguish fire events. The elevation changes within the Trans Mountain Tank Farm do not provide multiple firefighting positions or consideration for approach elevations to enable safe and effective operations for all potential wind directions. In order to extinguish a tank fire within the Tran Mountain Tank Farm emergency responders could be forced to significantly risk their personal safety in order to overcome the design inadequacies of the facility. Specifically, the configuration of the tank farm on a hillside in such a tight footprint would require firefighting personnel to operate in elevated positions above the tank, exposing them to potentially excessive heat and smoke outfalls. In these instances emergency responders would likely be forced to allow the tank fire to burn out while adjacent tanks are protected.

The TMEP presents a significantly larger fire control risk within the TMTF. The identified increase in events with potential to escalate and extend to adjacent storage tank exposures due to insufficient firefighting deployment positions increases the likelihood of a multiple tank fire (including the potential of having to allow one or several storage tanks to burnout over 2-4 days), toxic smoke plume discharge (including long term chemical exposure to adjacent communities), and heat discharge to areas outside the facility (including high probability of fire extension to the forest areas of the Burnaby Mountain Conservation Area. The risk of community impacts outside of the facility from a TMTF fire event are increased by 70%.

The reality of employing a Burnout tactic for a Tank Fire event within the proposed TMEP configuration is that success associated with preventing fire extension throughout the TMTF and the adjacent community would by no means be assured. Significant potential exists that due to

the proposed configuration, density, complexity and proximity to the community impacts and fire spread potentials that would create scenarios where fire containment is not possible.

The cost of this risk potential assumed by the community is not in line with the safety and risk management premises initially utilized for original facility approval by the City of Burnaby. The specific driver of the increased risk is the reduction in the effective of the facility design to limit fire event growth and restrict hazardous impacts to an immediately controllable area of impact during a short emergency response timeframe. It is critical for public safety that design configuration utilized support the protection of life, the environment and property. The TMEP does not provide the basic engineered safety provisions standard in high-impact potential facility design.

The potential for Boilover exists in any wide boiling range hydrocarbon, such as crude oil. For a proposed 200' storage tank, a Boilover event can discharge heated and molten crude oil outwards to 2,000'. A Boilover event occurring from a Tank Fire in the TMTF, the high hazard expected to receive the discharged heated and molten crude oil would encompass the entire TMTF, the Shellmont Tank Farm, the Forest Grove, Meadowood, and Sperling-Duthie Communities, closing Gaglardi Way and the Burnaby Mountain Parkway. It is anticipated that the consequences of Boilover exposure within the areas identified would include human injuries to emergency responders and unevaluated civilians, mass tree top based wildland fire initiation, structural fire initiation to many residential buildings, potential tank fire initiation within the TMTF and the Shellmont Tank Farm and significant isolation of the SFU and UniverCity communities.

The TMEP proposes a reduction in the tank to fenceline spacing of 30% on a facility wide comparison, and utilizes a new tank positioning premise which reduces the tank to fenceline distance by 61%. The decreased tank to fenceline distance and consequential impact potentials to the community presents the higher requirement and increased priority of evacuation operations conducted simultaneously with fire control activities. This response requirement significantly increases the emergency response resource requirements associated with identifiable emergency event potentials.

The TMEP significantly increases the urgency and expedience required to prevent community life and environmental impact outside the facility fenceline in the event of a product release or storage tank fire. The positioning of storage tanks in such close proximity creates a greater potential for citizen exposure within the adjacent communities to the hazardous effects of flammable gas outfalls and sulphur based gases. Additionally, the close proximity of storage tanks to the fenceline dramatically increases the risk of wildland fire to the Burnaby Mountain Conservation Area.

## **Appendix A**

# **Tank Spacing Analysis**

## **Appendix B**

# **Deployment Position Analysis**

## **Appendix C**

### **Tank Distance to Fenceline Analysis**

*Subject: Trans Mountain Tank Farm*

*Tactical Risk Analysis*

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## **Appendix D**

# **Burnaby Fire Department General Tank Fire Protocol**



## **Appendix E**

# **Emergency Management Evaluation**

## **Appendix F**

### **Industry Related Emergency Incident Occurrence - Timeline**

*Subject: Trans Mountain Tank Farm*

*Tactical Risk Analysis*

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## **Appendix G**

### **Information Request Round 1 – NEB Application**

*Subject: Trans Mountain Tank Farm*

*Tactical Risk Analysis*

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## **Appendix H**

### **Trans Mountain Tank Farm Fire Protection Meeting**

**2014.05.30**

*Subject: Trans Mountain Tank Farm*

*Tactical Risk Analysis*

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**Appendix I**  
**Fire & Safety Risks Associated with TMEP**  
**Burnaby City Council Memo**

## CPE Letter of Comment to NEB regarding TMX

### **Who we are**

Concerned Professional Engineers (CPE) is a group of Registered Professional Engineers. We have extensive experience in the design, operation and maintenance of resource export terminals, design of escort tugs, handling of ships and navigation. We are not unconditionally opposed to the shipment of resources overseas, as we believe that we have an ample supply in Canada. We also believe that export of resources is a vital part of our economy and that we have been generally responsible at exporting resources in an environmentally sensitive manner. We feel nevertheless, that Canada should emphasize the export of value-added products rather than just the shipping of the raw resource.

We have examined the marine aspects of the TMX project and found that increasing their transport of Diluted Bitumen (Dilbit) from their existing terminal in Burnaby, through the straits of Georgia and Juan de Fuca to the Pacific Ocean, presents a high risk to the environment and to structures located along these routes.

### **Project risk**

Our main purpose of getting involved in writing this Letter of Comment on the Trans Mountain Project is to point out that the risks of an accident and a bad spill from the increased traffic are considerable. Based on Trans Mountain's own experts' estimations, as submitted with their TERMPOL Report 3.15 (Table 34), of November 25, 2013, there is a ten percent (10%) probability that a spill of 8.25 million litres or more will occur in a 50 year operating period, even with all the proposed mitigation strategies. This is considerably greater than the mitigated spill risk of 9% for a 5.0 million litres spill estimated for the Northern Gateway project out of Kitimat. The probability of at least one spill in 50 years increases to 19% when spills of any size are considered. CPE does not have access to the model that KM's experts (DNV) used to predict the probability of spills. This model should be made available and a completely independent analysis of the spill risk should be carried out.

We also believe that there has not been a proper analysis of the potential for a collision of a fully loaded or an empty Aframax-type tanker with either the First or the Second Narrows bridges, particularly with the present Second Narrows railway bridge. Aframax is a medium-sized crude tanker with a dead weight tonnage (DWT) ranging between 80,000 and 120,000 Tonnes and a length of 245 metres. The regional economic consequences of bridge damage (or collapse) following a collision accident cannot be over-emphasized. The history of collisions of vessels with these bridges needs to be carefully analyzed and re-evaluated with regard to the proposed TMX traffic. This review should include the number of times the railway bridge has been knocked out of service for a considerable amount of time and the number of times that it has had to be completely replaced. We believe that when this analysis is done the risks will probably be considerably higher than those stated by Kinder Morgan's experts.

In our opinion, an analysis as to what would happen if there is a collision of a loaded Aframax vessel with the railway bridge or the highway bridge at the Second Narrows is required. What forces would be exerted on the bridges' structures or foundations and what would be the expected damage to these bridges? Also, would the forces exerted by the vessel in striking the foundations of the bridge be sufficient to damage or ripping a double-hulled vessel, resulting in a release of its oil cargo? It is also important to assess the risk of collision of a tanker with the superstructure of the bridges. In this regard, the document "Second Narrows Movement Restriction Area Procedures" (Vancouver Fraser Port Authority, April 2010), provides available clearances both for the highway and for the railroad bridge. It should be required that the proponent provide a detailed study of how the tankers will meet these clearances, when attached to the tugboats, assuming either normal navigation under all weather conditions or under the possibility of mechanical/control failures.

We would like to refer you to a study by Dr. Ricardo Foschi, P.Eng and Emeritus Professor of Civil Engineering at the University of British Columbia. He considered these vessel collision probabilities and prepared a set of questions that need to be answered by the project proponent. This preliminary analysis, based on requirements of the Canadian Highway Bridge Design Code (CAN/CSA S6), is attached to this letter as Appendix I entitled 'Evaluation of Risks Associated with the Kinder-Morgan Project'. The analysis shows that the probability of collision with the bridges is very much dependent on the effectiveness of the tugboat assistance in case a tanker is out of control.

We think that a detailed modelling of the interaction dynamics of the system tanker-tugboats must be shown, and that this model should be used to estimate the degree of control that the tugboats can achieve. We are aware for example, that similar studies have been carried out by the city of Seattle for tanker traffic in Puget Sound and by San Francisco for similar traffic in Northern San Francisco Bay. We find that the proponent has not offered a similarly detailed modelling of the effectiveness of tugboat aid in relation to the existing infrastructure along Burrard Inlet.

We believe that increasing Kinder Morgan (KM) tanker traffic through the heart of the Port of Vancouver should be seriously evaluated vis-à-vis other alternatives. For example, Roberts Bank Superport was built for the purpose for handling large cargo ships and we believe it would be a much safer alternative for shipping Trans Mountain's export Dilbit. Roberts Bank is safer because it is much closer to the open ocean, and does not have the obstacle course presented by the First and Second Narrows bridges.

The question needs to be asked: why is the product not proposed to be shipped through Roberts Bank? This question needs to be asked of the Port of Vancouver as well. It also seems that restricting vessel size to Aframax class is unnecessarily constraining, when VLCC-class tankers could be used at Roberts Bank offering three times the capacity or requiring one third the number of ships. The pipeline transportation corridor to Roberts Bank could also be available along the Roberts Bank Coal Traffic rail right-of-way.

## **The product being shipped**

The behaviour of Dilbit in seawater as has been the subject of much debate. There is no clear evidence that should a spill occur, and depending on the sea conditions, the product will stay on the surface long enough for it to be cleaned up. It can be safely said however, that cleanup costs of a Dilbit spill will be very large. The cleanup and compensation cost of \$7 billion, attributed to the Exxon Valdez Alaska incident 25 years ago, may be a low approximation to the requirements for a spill in the Kinder Morgan project. It is even possible to speculate that Kinder Morgan may want the oil that is being spilled to sink, so that it is out of sight and out of mind.

The project proponent must be asked to produce scientific evidence on the behaviour of Dilbit under all sea conditions and produce a realistic clean-up response strategy. The company needs also to produce a scientific assessment of any spill consequence related to the toxicity of the product.

## **Liability for cost**

It is clear that of the owner of the tanker, not Kinder Morgan, is liable for spill cleanup and compensation costs. We believe that the funds available according to the latest estimates of the Federal Government are \$1.3 billion, which would fall vastly short of cleaning up and compensation for a 8.5 million litre (or greater) spill. It is likely that the Dilbit will separate from the condensate that enables it to float, and that it will then sink and form tar balls which, over the years, will make their way to the shores of Greater Vancouver, triggering a continuous clean up and compensation mess. It is our view that the product should be upgraded in Alberta then shipped as light crude.

The liability fund estimated by the Federal Government is a long way from covering the actual costs for cleanup and compensation. In our view, Kinder Morgan should require that all the vessels that come to pick up the product should have unlimited liability insurance. If this were the case, the insurance company would do a realistic assessment of the risks and would increase the premiums. These premiums would then be added to the cost of the barrel of oil and we would see a more realistic cost of the price of oil.

We urge you to consider these matters very carefully, and thank you for allowing us the opportunity to submit a Letter of Comment on this very important project.

Yours sincerely,

Brian Gunn  
Spokesperson for Concerned Professional Engineers.  
[www.concernedengineers.org](http://www.concernedengineers.org)



## EVALUATION OF RISKS ASSOCIATED WITH THE KINDER-MORGAN PROJECT

By

Ricardo O. Foschi, P.Eng

October 2014

## 1. OIL SPILL PROBABILITIES

Kinder Morgan presents calculated return periods (in years) for oil spills of different volumes. These are given in Table 34 of their TERMPOL Report 3.15. The oil spills result from marine accidents or incidents.

By definition, the return period is an estimation of the average time elapsed between spills of a given volume. As such, approximately 50% of the spills would occur before the return period and 50% would occur after that time; therefore, the return period is not a good statistic to communicate probability of a spill. Of importance is the probability that at least one spill, of a given volume, would occur within the operating life of the project. The calculation of such a probability is straightforward given the return period and the operating life.

Table 1 below shows the results of this calculation, starting from the Kinder Morgan estimations.

Oil spill volume (m3)	Return Periods (in years)			Probability of at least one spill in 50 years		
	No project	Project with no mitigations	Project with all mitigations	No project	Project with no mitigations	Project with all mitigations
>16,500	3,093	456	2,366	0.016	0.100	0.020
>8,250	619	91	473	0.080	0.420	0.100
>0.0 (any)	309	46	237	0.150	0.660	0.190

The above Table permits the following conclusions:

- With no mitigations the probabilities of at least one oil spill in 50 years are too high. Thus, mitigations are **essential and must be enforced**.
- Even with mitigations, probability of at least one oil spill in 50 years, greater than 8,250 cubic meters, is deemed to be too high (0.10 or 10%). This is comparable to the probability for a spill greater than 5,000 m3 calculated for Northern Gateway (9%). The probability for a large spill of 16,500 m3 is more tolerable (0.02 or 2%), but even a more moderate spill would cause very substantial damage.
- Even with mitigations, there is a 19% probability of an oil spill, regardless of volume. This is also too high.

## 2. COLLISION PROBABILITIES WITH SECOND NARROWS BRIDGE

The methodologies for the determination of the probability of collision of a vessel with a bridge pier are specified both in the American AASHTO Code (1991) as well as in the Canadian CSA-S6-00 (2000). Both Codes essentially contain the same provisions, differing in the system of units used in the prescribed equations. The methodology followed here agrees with that which is specified in the Canadian Code CSA-S6-00. This methodology has been used to evaluate the risk of collisions with several new bridges across the Fraser River: Golden Ears, Pitt River, Port Mann and the Skytrain Canada Line.

The methodology is based on the estimation of:

Appendix I

$P_A$  = probability of aberrancy, or the probability that a vessel will be out of control or likely to be involved in a collision incident;

$P_G$  = conditional, geometric probability that a vessel will collide with a pier, given that the vessel is out of control or likely to be involved in a collision.

The product  $P_E = P_A P_G$  gives the probability that a collision will take place, which has to be modified according to the number  $N$  of vessels transiting per year or in any interval  $T$ . From historical accident data in US waterways, the Code gives the value  $P_A = 0.6 \times 10^{-4}$ , applicable to ships.

The geometric probability is calculated considering that the position of the ship in distress is randomly located, with a mean equal to 0.0 (the centerline of the navigation channel) and a standard deviation equal to the length  $L_s$  of the vessel. This random position  $s$  is assumed to obey a Normal distribution. If mitigation aids from tugs were present, then the standard deviation of the position  $s$  would be smaller. For perfect mitigation, the tugs would keep the vessel along the centerline of the channel. In the calculations shown here it is assumed that the standard deviation could be a value  $(L_s / r)$ , with  $r$  being a factor either 1, 2, 4 or 6. Thus,  $r = 6$  would imply a more effective mitigation by the intervention of tugs.

The probability  $P_E$  is finally corrected for the number of vessels transiting the bridge location per year (here assumed to be 600), and then for the period of operations  $T = 50$  years.

The vessel considered is an Aframax tanker, with a length of 245m and a beam of 34m. The opening of the central span of the highway Second Narrows Bridge is 350m.

Results are show in the following Table 2:

Factor $r$	$P_G$	$P_E$	$P_{\text{Annual (600 vessels/y)}}$	$P_{\text{at least one collision in 50y}}$
$r = 1$ (no tugs)	0.304	$1.9152 \times 10^{-5}$	0.0114	0.437
$r = 2$	0.155	$9.7650 \times 10^{-6}$	0.0058	0.254
$r = 4$	0.027	$1.7010 \times 10^{-6}$	0.0010	0.050
$r = 6$	0.004	$2.5200 \times 10^{-7}$	0.0002	0.008

It can be concluded from these results, that the probability of at least one collision with the bridge, over 50 years of operation and at 600 vessels per year, **must be mitigated by the use of tugs**. This is **essential and must be enforced**. **With proper and effective mitigation, it would appear that collision with the bridge could have a low probability of occurrence.**

Collision with the bridge does not necessarily mean major damage or collapse of the structure, nor an oil spill. However, damage to the bridge would result in interruptions of traffic flow with associated economic consequences. Collapse of the bridge or substantial damage could be studied, but it would require a detailed structural analysis of the bridge and its footings.

- A more comprehensive model should be studied to relate the factor  $r$  to the tug intervention policy.
- These results apply to the highway Second Narrows or Ironworkers Memorial Bridge. The situation for the railroad bridge would be more risky, given that the channel between the bridge towers is much smaller than 350m. For this bridge it would be even more essential to provide an effective mitigation policy.