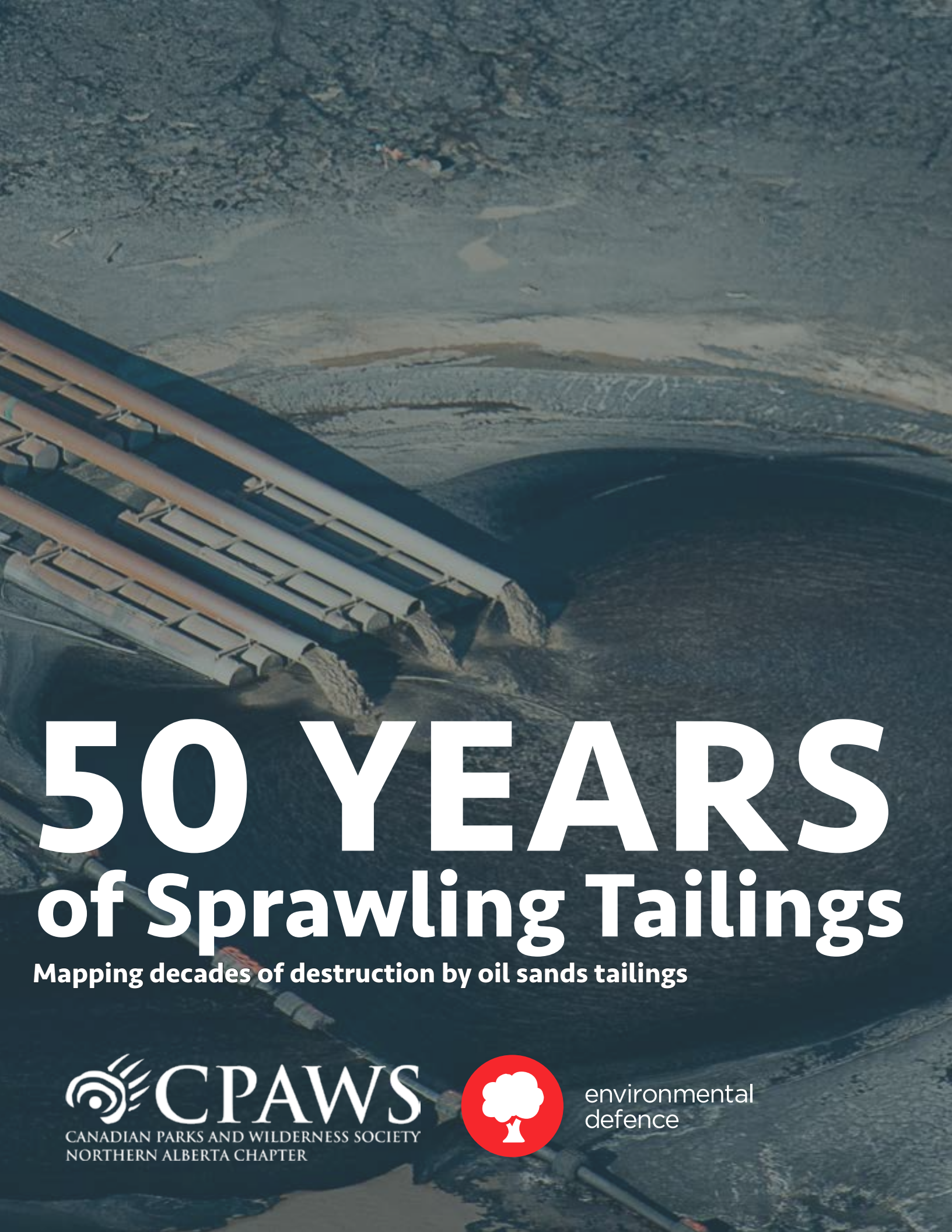

50 YEARS
of Sprawling Tailings

Mapping decades of destruction by oil sands tailings

CPAWS
CANADIAN PARKS AND WILDERNESS SOCIETY
NORTHERN ALBERTA CHAPTER

environmental
defence

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NORTHERN ALBERTA CHAPTER

About CPAWS Northern Alberta

Nationally, CPAWS' vision is to protect at least half of our public land and water so that future generations can experience Canada's irreplaceable wilderness. CPAWS uses a collaborative approach with crown and Indigenous governments, communities, progressive companies, and other environmental organizations to achieve conservation solutions. The CPAWS Northern Alberta Chapter (CPAWS NAB) was one of the society's first designated regional chapters, formed in 1968. CPAWS Northern Alberta's focus is on the northern two-thirds of the province.

environmental defence

About Environmental Defence Canada

Environmental Defence is a leading Canadian environmental advocacy organization that works with government, industry and individuals to defend clean water, a safe climate and healthy communities.

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Cover photo: Garth Lenz

Contents

Executive Summary

The oil sands region lies in northern Alberta, where decades of mining in the oil sands has left a pervasive legacy of harm to the environment and people.

The environmental impact of the oil sands is clear by the harmful effects caused by their waste fluids, disposed of in pits known as tailings "ponds." These massive human-made bodies of sand and fluids hold the toxic waste from the oil extraction process. And despite the small scale implied by their name, tailings "ponds" stretch as far as the eye can see - impacting healthy boreal systems, sprawling through Indigenous territories, leaking contaminants into groundwater and emitting greenhouse gasses.

The environmental, social, and cultural impacts of Canada's oil sands are immense.

The risks associated with the large volume of oil sands fluid tailings have been growing for decades. They are referred to in this report as tailings "ponds" for consistency with the term used by government and industry despite the fact that the volume of these human-made basins far surpasses what should be called a true pond. Since the first oil sands project in 1967, the increase in the number and size of tailings "ponds" has been momentous. As of 2020, there are 30 active tailings "ponds" across nine oil sands projects covering over 300 km^2 of the boreal forest. The tailings "ponds" are located dangerously close to the Athabasca River - one of Canada's major rivers that flows through Alberta and the Northwest Territories to eventually join the Mackenzie River, which empties into the Arctic Ocean.

In this report, we map the rapid growth of tailings "ponds" in the oil sands over 45 years from 1975 to 2020, using satellite imagery to identify tailings areas. We complement our analysis with a summary of known environmental and community impacts of tailings to provide current qualitative and quantitative data and expert knowledge.

Garth Lenz

Our analysis reveals:

In 2020, the total tailings area* was over 300 km², which would cover the city of Vancouver over two and half times.

Oil sands fluid tailings area* grew from nearly 1.5 km² in 1975 to about 120 km² in 2020 (a 7,833 per cent increase). Current fluid tailings area is over 240 times larger than the West Edmonton Mall, Canada's largest shopping centre.

If the widest portion of each tailings "ponds" were placed end-to-end, they would extend over 94 kilometers. This is roughly the equivalent of the distance from Calgary to Canmore, Alberta, or from Toronto to Barrie, Ontario!

From 1980 to 2005, the average 5-year growth rate of fluid tailings was 24 per cent. From 2005 onwards, the average 5-year tailings growth rate markedly increased to 38 per cent.

The largest tailings "pond", Syncrude's Southwest Sand Storage, is estimated to be just under 8-km long and 30 sq-km in total area. This is roughly the same size as McClelland Lake, which is the largest natural water body in the oil sands region.

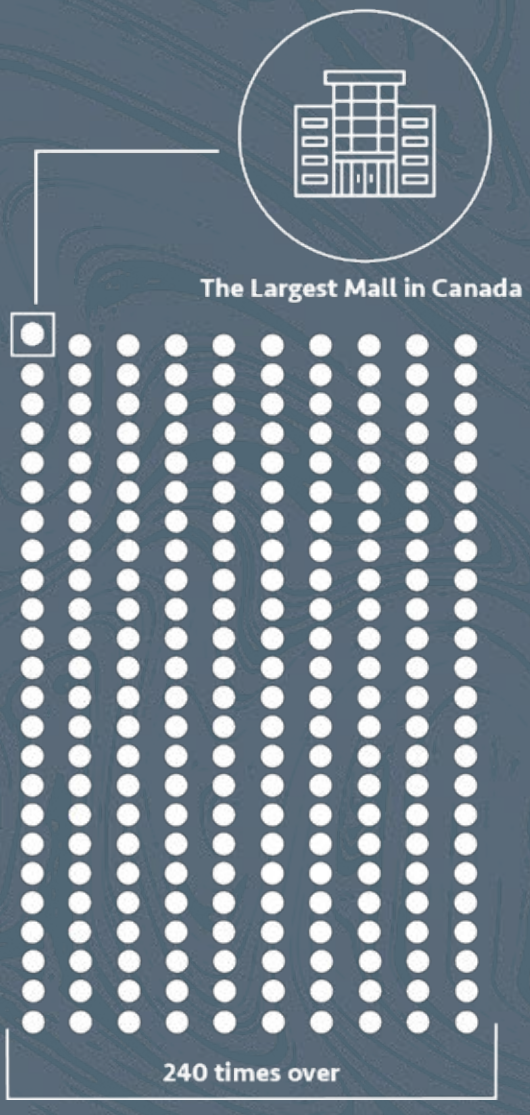
As of 2016, only one square kilometre of the oil sands had been certified as fully reclaimed by the regulator–roughly 0.1 per cent of the total disturbance in the oil sands.

Combined Fluid Tailings as of 2020

119.03 km²

*full map on page 21

equivalent to



* go to bottom of page 10 for more detail on fluid tailings area and total fluid tailings area.

Garth Lenz

The tailings maps produced in this report are publicly available. We make them available, as these types of maps or analyses can be typically challenging to access for the public, though they likely exist for industry and government. Our report's maps were created to show the public how large tailings "ponds" have become and provide downstream communities with the tools to defend and protect their waters, at a time when the risk posed by tailings is growing.

This report summarizes serious negative environmental and social impacts of the oil sands tailings. The tailings "ponds" store acutely toxic chemicals, including high concentrations of dangerous naphthenic acids, and are known to leak and evaporate their contents into the surrounding environment.

The tailings "ponds" also impact the boreal forest's biodiversity and are especially lethal to migratory birds who land and perish in the tailings "ponds" during migration season.

The oil industry has put aside only a small fraction of the officially estimated $28 billion it will cost to clean up the oil sands tailings. Experts believe the actual cost figure could be four times as large.

The report also weaves Indigenous Knowledge and shares the experiences of Indigenous experts from downstream communities who have been deeply impacted by the ever-growing oil sands industry. They share the many ways the upstream devastation has fractured the connection between community members, water, wildlife and their traditional practices.

Given the enormity of the environmental impacts on downstream and nearby, predominantly Indigenous, communities of the oil sands region, and the enormous risk held by the general public in clean-up costs for reclaiming tailings ponds, it is evident that any solutions for tailings management must be supported by downstream communities and the public.

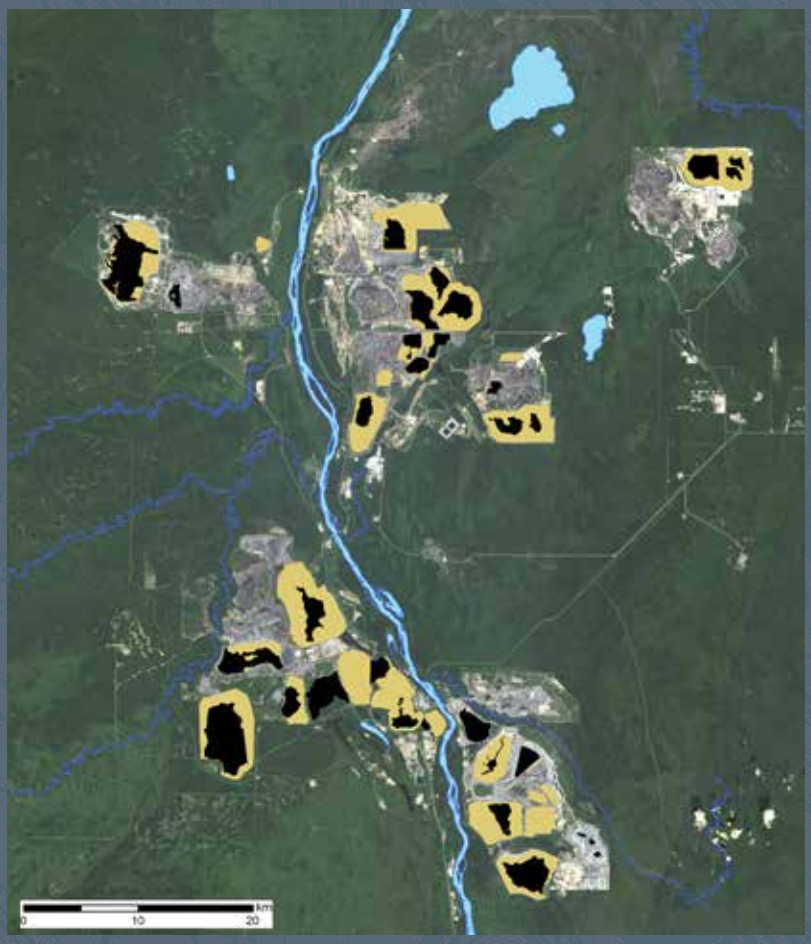
We make six key recommendations to improve the environmental outlook for tailings management in the oil sands region:

1. **Do not create any new tailings "ponds" and do not approve new oil sands mines.**
2. **Develop and implement a comprehensive tailings reclamation plan for the oil sands region, prioritizing environmental outcomes and the concerns of impacted downstream communities.**
3. **Require the collection and holding of the total funds that will be needed for oil sands mine clean up and rehabilitation.**
4. **Uphold the United Nations Declaration on the Rights of Indigenous Peoples and respect Indigenous sovereignty.**
5. **Strengthen cross-jurisdictional collaboration with all levels of government on the management of tailings.**
6. **Strengthen the oil sands bird monitoring program so it is a transparent, standardized and collaborative program.**

Tailings Growth Over Time

1975

2020



Fluid Tailings Area*
Total Tailings Area*

All maps from this report can be freely downloaded at https://bit.ly/3MBeFOa or by request to infonab@cpaws.org or info@environmentaldefence.ca

*** go to bottom of page 10 for more detail on fluid tailings area and total fluid tailings area.**

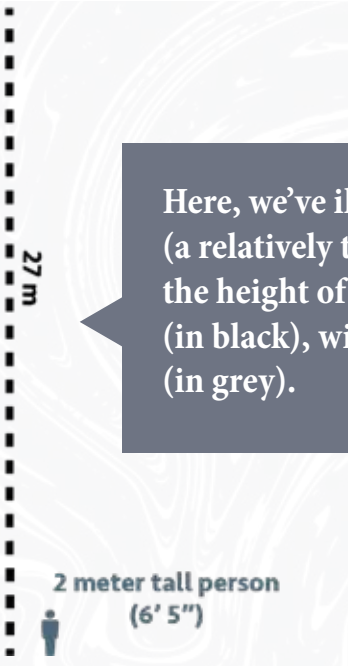
Mapping Out Decades of Toxic Takeover

Introduction: What are 'tailings'?

Tailings are the waste of the oil sands extraction process - a byproduct of separating bitumen from clay, sand and silt using high volumes of water and chemicals. They are stored as large reservoirs of fluids using dams and built-up walls, which industry calls "ponds". Oil sands tailings are acutely toxic[3]. Despite what the term tailings "ponds" might suggest, there are over 1.4 trillion litres of tailings perched in "ponds" on the shores of the Athabasca River near Fort McMurray, Alberta.

Tailings "ponds" are immense open-air reservoirs designed to allow solids to settle to the bottom of the ponds and separate from the water over long periods of time. After the water has separated from the solids, it can then be recycled in industrial operations. However, not all the solids easily settle. Instead, many remain suspended in the water and it is estimated that they can take up to 150 years to naturally settle and completely separate. This extremely slow settlement process is a problem because industry has not shown they can safely store tailings for that long without causing environmental harm.

The environmental impacts of tailings ponds on the landscape are pervasive. Tailings leak toxic substances, emit greenhouse gasses, require removal of carbon-storing peatlands and forests, and harm wildlife who mistake them for natural bodies of water.

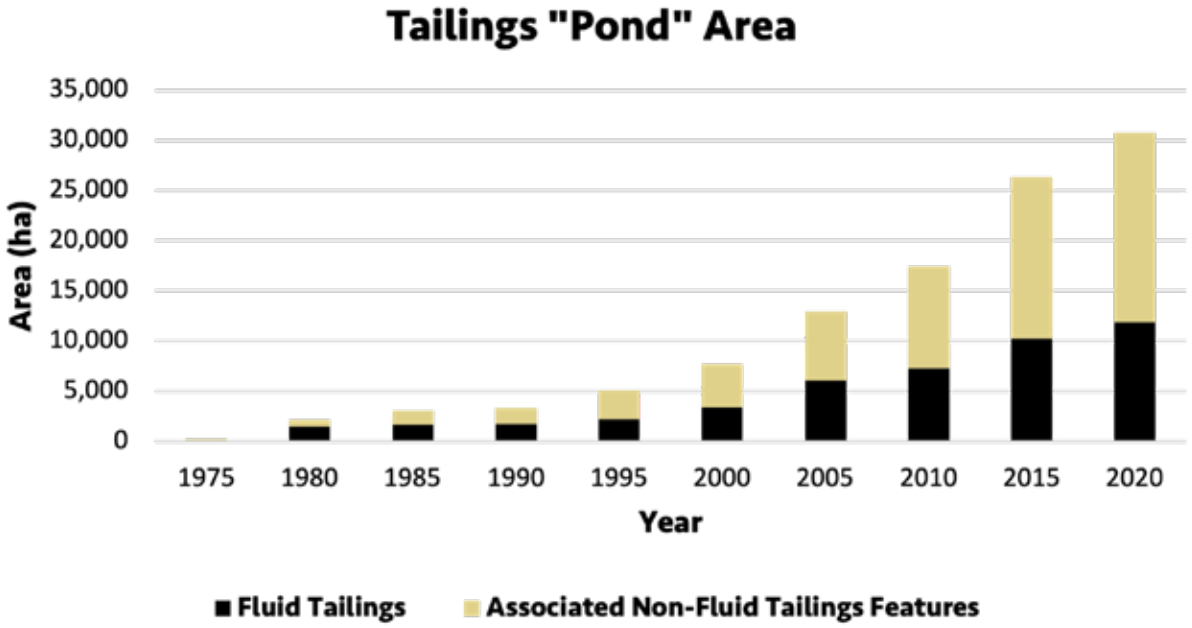


Here, we've illustrated a 6'5" person (a relatively tall person) standing beside the height of tailings fluid in a "pond" (in black), with the large retaining wall (in grey).

Beyond the footprint of the tailings fluids themselves, the storage of tailings additionally requires many associated structures and features on the landscape. For example, enormous dams are built to retain tailings ponds. Some dam walls reach heights of 100 meters[4] – as tall as a 30-story building!

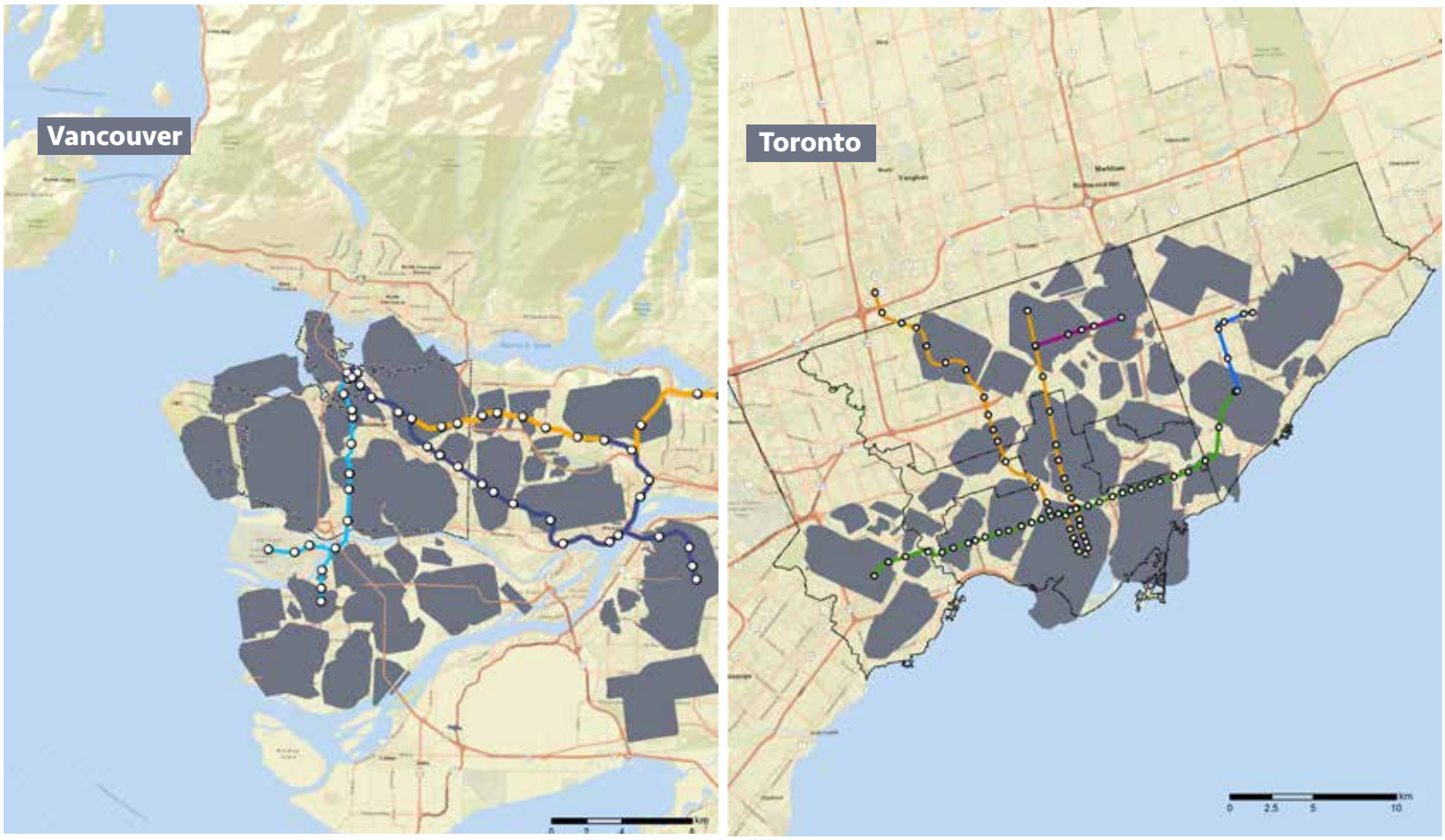
Despite the risks to environment and downstream communities from storing dangerous waste in tailings ponds, and the lack of meaningful reclamation success, the oil sands tailings volume and area was allowed to massively **balloon from 1975 to 2020:**

- In 2020, the total tailings area was just over 300 km^2, which would cover the city of Vancouver over two and half times (see map on next page).
- Tailings pond fluids cover about 120 km^2 in the oil sands region– roughly 240 times larger than the West Edmonton Mall, Canada's largest shopping centre.
- If tailings "ponds" were placed end-to-end, they would extend over 94 kilometers. This is the equivalent of the distance from Calgary to Canmore, Alberta, or from Toronto to Barrie, Ontario!
- From 1975 to 1980, fluid tailings area increased by over 900 per cent, reflecting the rapid expansion of the oil sands industry in the region from almost nothing at all. From 1980 to 2005 the average 5-year growth rate was 24 per cent. From 2005 onwards the average 5-year tailings growth rate dramatically increased to 38 per cent.



In this report, we map both fluid tailings and tailings features, which includes dams, berms, beaches, end pit lakes and areas with various reclamation treatments. It is important to note our report considers the 'tailings area' as a cumulative sum of all current tailings "ponds" and all areas previously used as tailings "ponds", as none of these areas are certified reclaimed. See Appendix 1 for detailed summary tables on yearly tailings area calculations.

- We examined tailings policies and regulations and found they did nothing to curb tailings growth. There were no regulations addressing tailings management or reclamation between 1975 and roughly 2010, when fluid tailings grew from 1.49 km^2 to 73.27 km^2. New tailings regulations were implemented in 2009, stating operators had five years to reduce their fluid tailings, but our analysis shows that the fluid tailings area still grew 40 per cent from 2010 to 2015 (from 73.37 km^2 to 102.39 km^2).
- As of 2016, only one square kilometre of the oil sands had been certified as fully reclaimed by the regulator–roughly 0.1 per cent of the total disturbance in the oil sands[5].
- The largest tailings "pond", Syncrude's Southwest Sand Storage, is estimated to be 7.9-km long and 30 km^2 in area (including the fluid tailings and pond walls). This is roughly the same size as McClelland Lake, which is the largest natural water body in the oil sands region.
- As of 2020, the total volume of tailings "ponds" was estimated at 1.4 trillion litres. This is the equivalent of over 560,000 Olympic-sized swimming pools.



As of 2020, the area of oil sands tailings "ponds" would cover the city of Vancouver, Burnaby & Richmond (left). To the right, the tailings "ponds" would cover most of the Toronto city boundary. For similar comparisons to other cities in Canada, see our Appendix #1 for maps.

1975

Fluid Tailings Area: 1.49 km²
Total Tailings Area: 2.44 km²
Oil sands mine(s): 1

1980

Fluid Tailings Area: 15.13 km²
Total Tailings Area: 21.46 km²
Oil sands mine(s): 2

1985

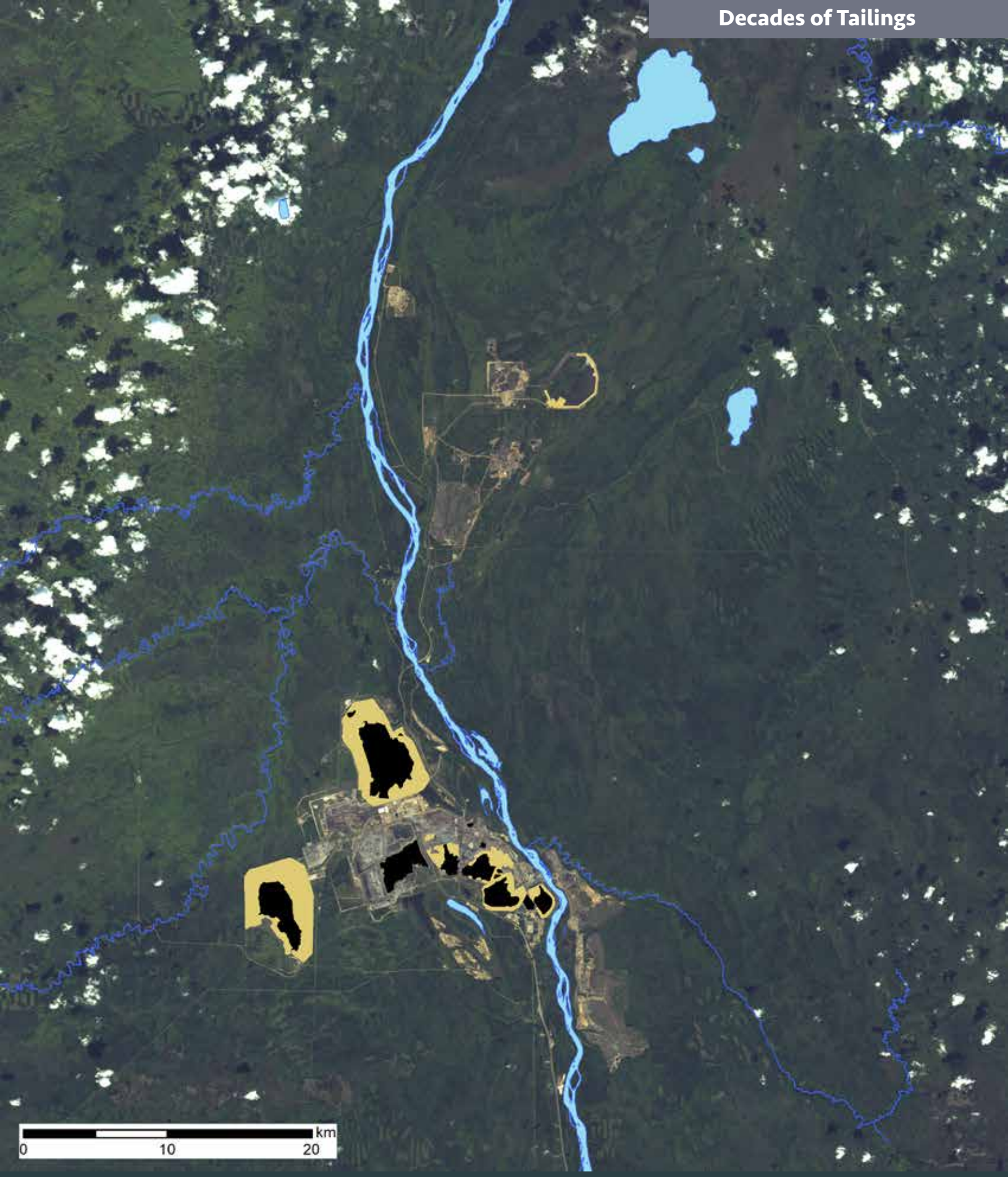
Fluid Tailings Area: 16.68 km²
Total Tailings Area: 30.71 km²
Oil sands mine(s): 2

1990

Fluid Tailings Area: 17.55 km²
Total Tailings Area: 33.18 km²
Oil sands mine(s): 2

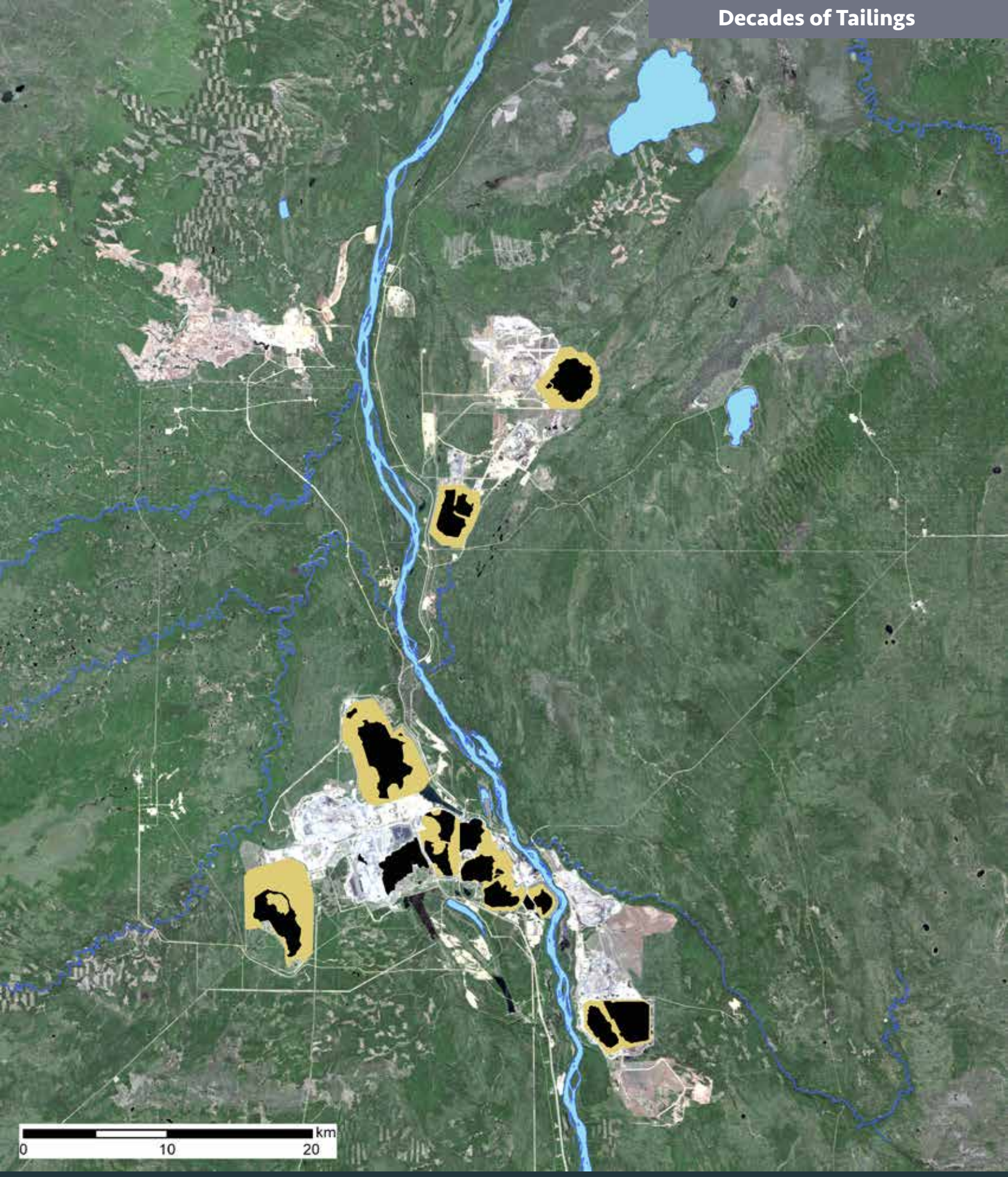
1995

Fluid Tailings Area: 22.75 km²
Total Tailings Area: 51.58 km²
Oil sands mine(s): 2



2000

Fluid Tailings Area: 34.44 km²
Total Tailings Area: 77.14 km²
Oil sands mine(s): 3

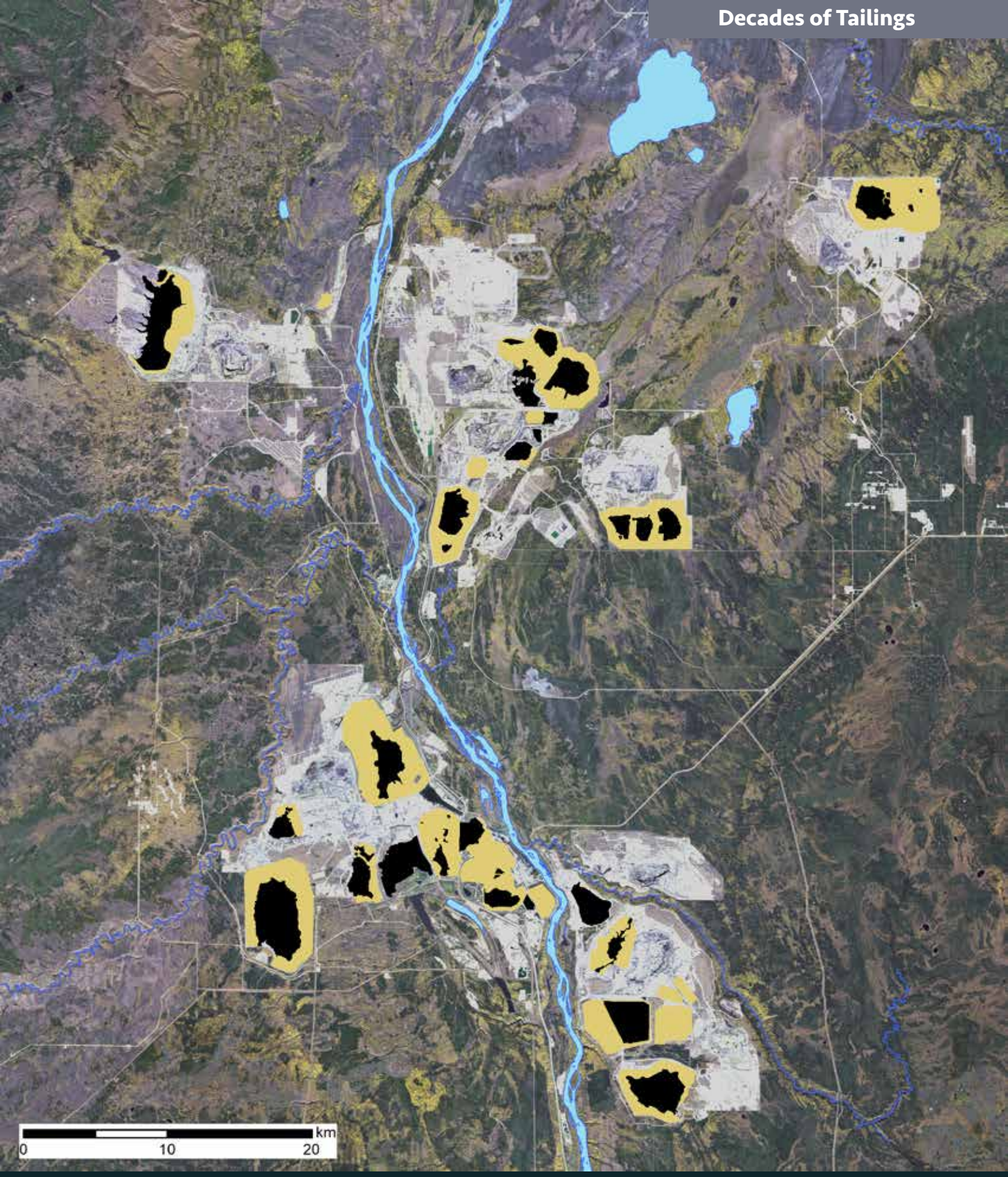


2005

Fluid Tailings Area: 60.73 km²
Total Tailings Area: 129.13 km²
Oil sands mine(s): 5

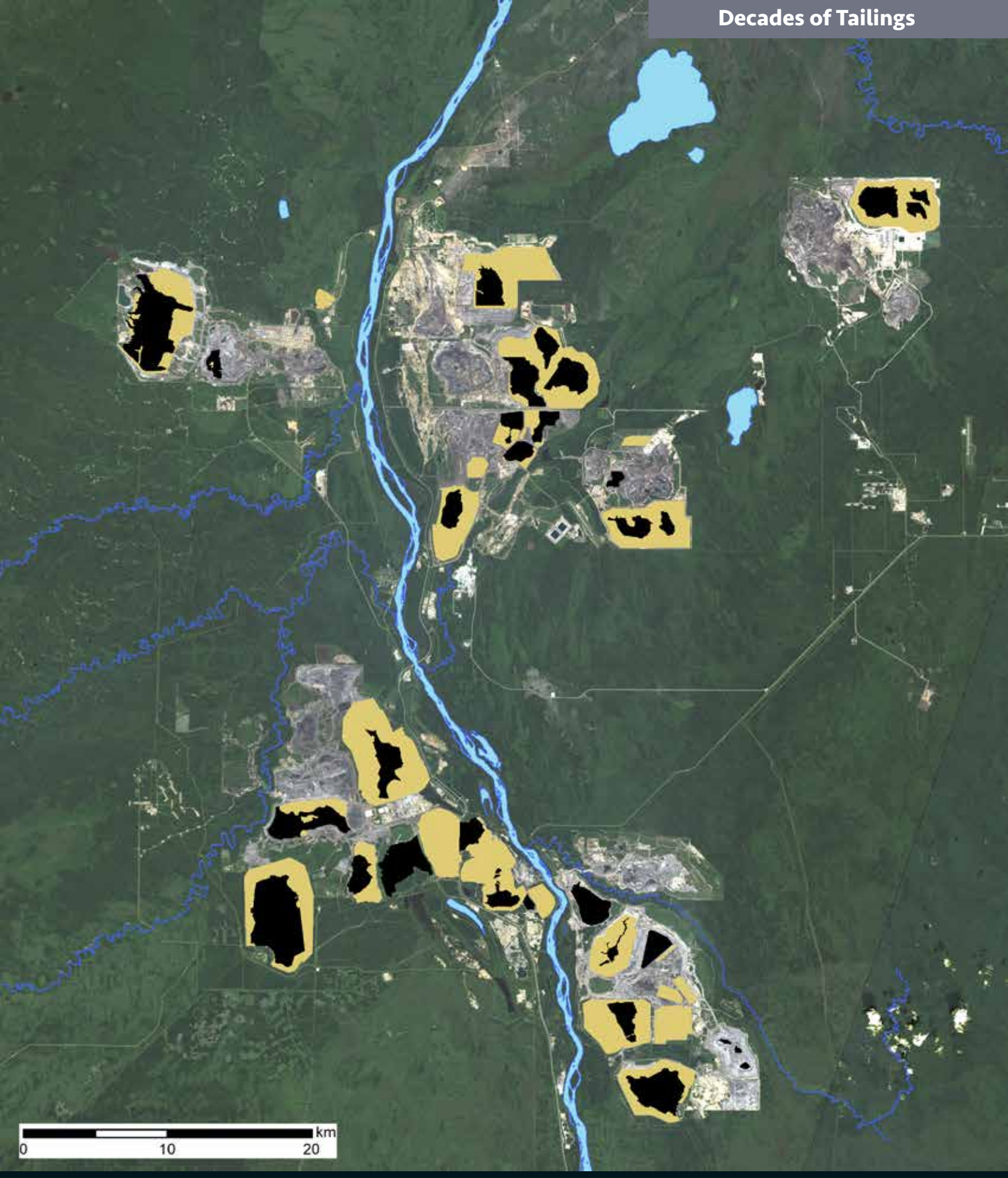
2010

Fluid Tailings Area: 73.27 km²
Total Tailings Area: 174.50 km²
Oil sands mine(s): 7



2015

Fluid Tailings Area: 102.39 km²
Total Tailings Area: 263.94 km²
Oil sands mine(s): 8



2020

Fluid Tailings Area: 119.03 km²
Total Tailings Area: 307.31 km²
Oil sands mine(s): 9

Indigenous Expertise About, and Experiences of, the Tailings

Indigenous communities that have been displaced and impacted by the oil sands warned of the devastation that would come from oil sands mining since the earliest memories of industrial operations. We are grateful to be able to share the knowledge and experiences of **two Indigenous experts, Jean L'Hommecourt and Mike Mercredi**, on their expertise and knowledge from living downstream of the oil sands and the ramifications posed by tailings "ponds". We weave their insight throughout this report, highlighting their expert Indigenous Knowledge.

Both experts emphasized how Indigenous communities are doing their part to protect the land and the water for generations to come. They asked how and when others would step up and do the same before it is too late and called upon non-Indigenous people to trust the knowledge and wisdom that Indigenous people are offering, rather than wait until Western science confirms what Elders have predicted long ago. This report reflects the authors' commitments to solidarity, mutual respect, and a greater understanding of all knowledge systems.

Meet The Experts

Jean L'Hommecourt

Denesuline woman
Lives just outside Fort McKay
On the Board of Keepers of the Water
Has Six grandchildren
Traditional land use specialist

Mike Mercredi

Denesuline
Member Athabasca Chipewyan First Nation, Fort Chipewyan
Land based instructor

Self describes not as an environmentalist or activist, but as "just a Denesuline, trying to remain a Denesuline, in a neo-world that doesn't know Denesuline".

when you see this icon throughout the report, this represents knowledge from Jean or Mike

A legacy of impacts

The development of the oil sands has dispossessed Indigenous people from their lands–a traumatic and destructive experience. The myriad of impacts from this dispossession and loss of cultural practices are pervasive and have completely altered the ways in which Indigenous peoples can–and cannot–use their lands and waters.

Today, there is ongoing harm that results in a loss of access to traditional lands by Indigenous communities, which disrupts their traditional ways of life. Land-based teaching, hunting and fishing, medicine harvesting, and community gatherings are all traditional practices fundamental to the Indigenous people in the area that are now nearly impossible to carry out. For example, gathering sites that once hosted many generations have become "no access zones" by industrial operators. The obstruction of access, and thus obstruction of traditional practices, is a direct attack on the Indigeneity of the communities surrounding and downstream of the oil sands.

> **"To fully understand the adverse effects you need to understand the history of the peoples there and the ways in which they used the land."**
>
> *- Mike Mercredi*

The federal government has a responsibility to enable access to such traditional ways by upholding Treaty Rights. The United Nations Declaration on the Rights of Indigenous People (UNDRIP), which Canada has committed to implementing, recognizes "Indigenous peoples have the right to practise and revitalize their cultural traditions and customs."[6]

Environmental devastation impacts on mental health of those that experience it firsthand

Connection to the land and the animals is a central part of Indigenous peoples' identity, and being separated from these deeply affects mental health. For example, Jean longs and mourns for access to food and fur like her ancestors did. After living many years in traditional ways further up North, Jean returned to Fort McKay to be close to her parents and describes a real "culture shock" upon witnessing the devastation and the lack of access.

Not only is access limited, but communities also describe themselves as being "fenced in" and "surrounded" by industry - an unambiguous way to express their lack of freedom in their own territories.

Language matters

Industry and governments are deliberate in the language they use, as it is a powerful tool to shape the way the public understands a situation. In order to provide clarity, it is important to understand the on-the-ground meanings of these industry terms as described by Indigenous experts, Jean and Mike.

Ponds: Industry's term to designate the man-made tailings storage water bodies, which are **immense dumps of toxic fluids** that span over kilometres. The use of the term "ponds" is a deliberate attempt to misrepresent the size of the tailings and create the false idea that they are much smaller in scale.

Industrial projects: The development of the oil sands is not merely another industrial project, despite what their permits and press releases say. For many, it is a takeover of Indigenous lands and territories, with all the **displacement, disruption and destruction** that comes with the development of the projects.

Overburden: Before industrial activities, the land was coated with a **rich life-giving soil**. The muskeg was critical for providing clean water and ideal for fur-bearing animals, enabling fur trapping. Industry calls it overburden, meaning the layer of soil that needs to be removed for mining operations. It is pushed to the side with little regard for the cascading effect this has on the ecosystem.

Reclamation: The return of an area to its pre-industrial state is known as Reclamation. However, it should not be described as such until **Indigenous people have regained access** to and full use of the area. Certain areas are getting certified as reclaimed, or ready to reclaim, by the Alberta Energy Regulator without meeting such criteria.

Resilience, strength, and hope are not going away

For millennia, Indigenous people stewarded the lands and waters where tailings ponds now sit. Their history and laws long preceded mining permits and colonial laws, and they will long outlive them.

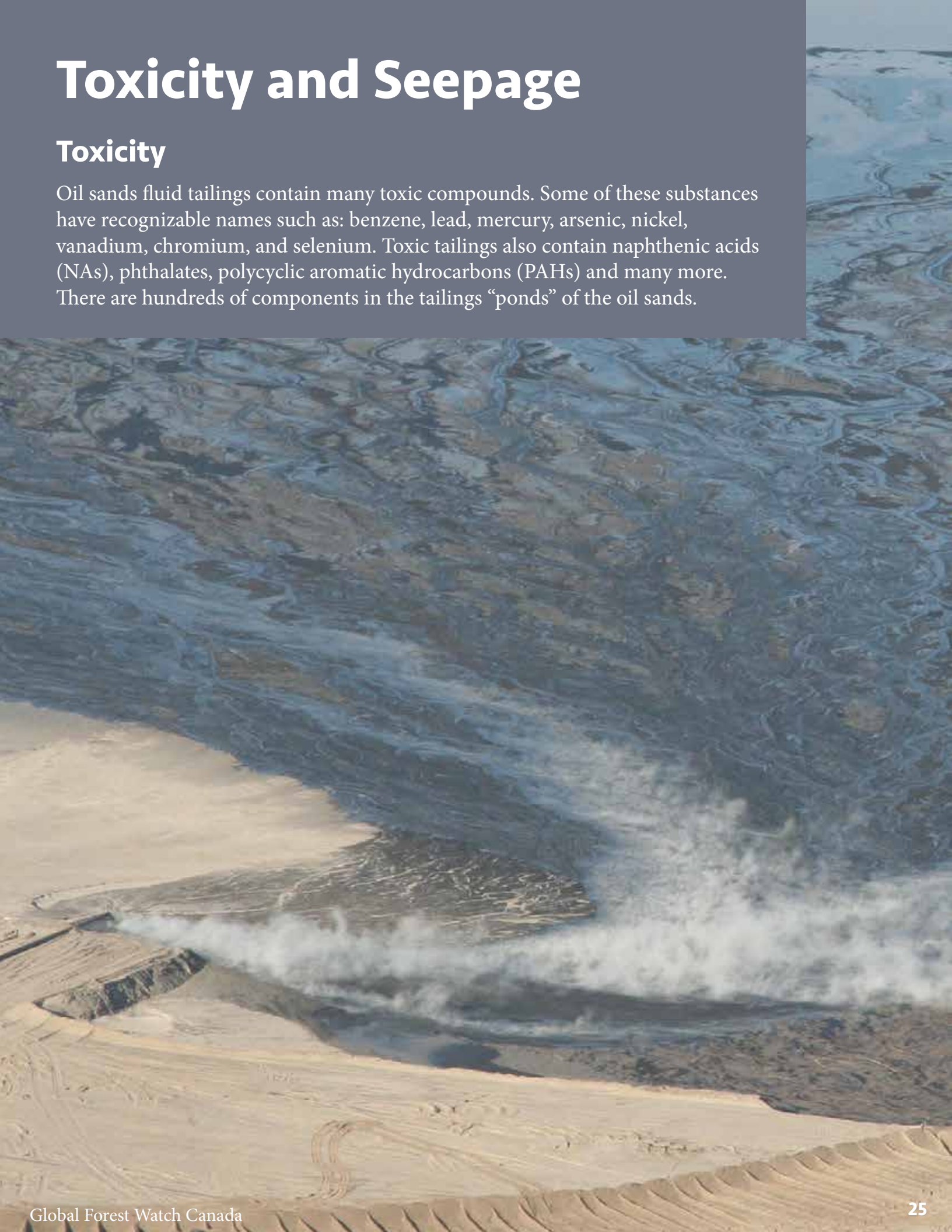
The resilience of Indigenous people is one best illustrated by Mike's own words: "As long as we do what we do, we win. There actually isn't much evidence that says we are losing, although there is evidence that there are parts being lost, like the birds, the lack of access, the challenge to harvest."

Despite the hardship and harm caused by industry, this will only be an episode in the much longer existence of Indigenous people on their lands. Mike predicts that the tension currently felt between industrial activities and Indigenous existence will continue until one of two stops, and he unequivocally places a bet on his people.

Toxicity and Seepage

Toxicity

Oil sands fluid tailings contain many toxic compounds. Some of these substances have recognizable names such as: benzene, lead, mercury, arsenic, nickel, vanadium, chromium, and selenium. Toxic tailings also contain naphthenic acids (NAs), phthalates, polycyclic aromatic hydrocarbons (PAHs) and many more. There are hundreds of components in the tailings "ponds" of the oil sands.



In total, there are about 100 components in the tailings "ponds" of the oil sands.

Let's get to know a few of these:

Naphthenic acids

What We Know: Naphthenic acids, or NAs, are the primary source of toxicity of the tailings ponds water[7].

They are found at extremely high concentrations in the tailings ponds, over 100mg/L, which is more than 100 times the concentration in the Athabasca River in that area[8]. Canada has not established limits for what the surrounding environment in the oil sands can receive, whether through intentional release or seepage[9].

Naphthenic acids are acutely toxic to aquatic organisms in low concentrations[10]. Moreover, older tailings fluids has been linked with reproductive and hormone disruption, as well as immune system dysfunction in fish[11,12,13]. Naphthenic acids are the primary suspects[14].

Although little is known about NAs' effects on humans, existing studies suggest that they could disrupt hormonal functions[15]. People are also indirectly affected when NAs harm fish, which communities rely on as a food source.

Arsenic, lead, mercury

What We Know: These heavy metals are known to be dangerous and appear on the World Health Organization's 10 Chemicals of Public Concern list. Although they are only found in low concentrations in the tailings, repeated or elevated exposures pose risks to humans and ecosystems through bioaccumulation. For example, if each organism along the food chain is exposed to a small amount of a heavy metal such as mercury, it would build up to a dangerous level by the time it reaches a human consumer at the end of the chain. Given the large volume of tailings, heavy metals are of concern despite their presence in low concentrations.

Salts

What We Know: Tailings fluids typically contains elevated levels of sodium and chloride. In some cases, chloride concentrations are 63 times greater than in the nearby Athabasca River[16]. The high sodicity in tailings deposits is a result of caustic soda (NaOH) addition during bitumen extraction. The mines go very deep to reach productive oil sands ore, resulting in higher saline content.[17].

Salts damage freshwater ecosystems and have significant negative impacts on aquatic organisms. Increasing the concentration of salts in the Athabasca River could greatly endanger the entire ecosystem of the river, including the fish, as well as the communities living downstream.

Bitumen

What We Know: Some bitumen (also referred to as natural asphalt) remains in the tailings fluid, even though most of it is separated during the oil production process.

Tailings fluid has been shown to contain bitumen levels 2.5- to 9-fold higher than Alberta's Environmental Protection and Enhancement Act maximum discharge limit of 10 mg/L[19].

Ammonia

What We Know: Ammonia is highly toxic to fish and other aquatic organisms in high concentrations. Tailings fluid contains ammonia at a concentration of 14 mg/L[20], which is higher than the United States Environmental Protection Agency's criteria of 0.8–1.3 mg/L for continuous concentration (the highest concentration of a toxin that an organism can be exposed to indefinitely before experiencing long term effects). [21]

Polycyclic aromatic hydrocarbons (PAHs)

What We Know: PAHs are a large family of chemicals, some of which are naturally occurring in oil. The impacts of PAHs specific to tailings water are not well known[22], but numerous PAHs have been shown to disrupt hormonal and immunological functions, cause cancer and even trigger genetic mutations in fish species[23]. Adverse effects of PAHs on human health have been better studied and demonstrated through pathways such as food or workplace exposure.[24]

The average concentration of 0.01 mg/L in oil sands process-affected water (OSPW) substantially exceeds 0.00001–0.00006 mg/L, Canada's surface water quality guidelines for the protection of aquatic life.[25]

Garth Lenz

Science's understanding of the danger and impact of tailings "ponds" on people and wildlife is still incomplete and there is a significant need for more research on their impact on human health and the environment[26]. In fact, there were no environmental impact assessments completed when tailings "ponds" were first approved that examined their potential impact.

The legacy of ignoring or underinvesting in the study of the impacts of the oil sands continues today.


Rankin1958 CC BY-SA 3.0

Research demonstrates that no community or ecosystem should be exposed to tailings. The existence of these immense reservoirs of toxic fluids poses environmental and human health risks that warrant immediate governmental attention and the development of a risk management plan.

Case study: Research on the exposure of fathead minnows to tailings waters

- Test group of fish exposed to waste water from the oil sands
- Control group of fish exposed to wetland water
- All fish exposed to wastewater died before the end of the study period
- At the reference wetland sites, all fish survived the entire study period

Farrell et al. (2004)[27]

Danger in every breath: Relentless air pollution from tailings

Downstream Indigenous communities have reminders of the toxic upwind oil sands development every day. Community members speak of the deteriorating local air quality. With every breath, community members feel the toxicity that enters their lungs: a pungent stench that irritates the eyes, throat and nose.

Jean speaks to the toll the air pollution has taken on her community. Historically, Indigenous people of the area had no asthma. Yet, children are now frequently born with severe asthma and other respiratory diseases. Jean's fear is that even if industrial activity stops, intergenerational health issues will persist.

While many of us look forward to hot summer nights, those in Fort McKay do not. "I know what summer brings," says Jean, referencing the dangerous lows in air quality during summer months. Evaporation during the day and then a sudden cooling at night leaves particles hanging in the air for long hours, during which time the air quality is at its absolute worst. Despite the heat, people close their windows to be safer.[28]

The air pollution is especially magnified during heat waves. As climate change makes the summers hotter and days of extreme heat more frequent, the health of the communities could be further endangered. It does not escape Jean that the oil sands industry is also a primary contributor to climate change, fueling the deterioration in air quality downwind.

Seepage

Industry has failed to design tailings "ponds" that do not leak and has known about the seepage since the start of the oil sands: Syncrude's own research dates as far back as 1973 on tailings seepage[29]. Tailings "ponds" are permeable; they are not lined to stop any natural seepage that occurs from the large volumes of fluid. This characteristic is supposed to provide "structural stability."[30] Operators instead place seepage collection ditches which are meant to re-collect what is leaking and return it to the "ponds".

These measures are clearly insufficient: Suncor and Syncrude data show that their tailings "ponds" are leaking toxic waste fluids into surrounding groundwater, with toxins detected at monitoring wells extremely close to surface waters.[31]

The exact volume of toxic waste fluids that has made its way from tailings "ponds" into the environment is unknown, however, estimates are available:

- Approximately 785,000,000 litres of toxic waste fluids have leaked from Syncrude's Aurora Settling Basin alone. This is roughly 39.25 million litres per year from a **single tailings pond** over its 20-year operation, so far.
- In 2008[32], Environmental Defence Canada used industry information to calculate the tailings were leaking roughly 11 million litres of fluid per day. A conservative estimate, it is the equivalent of over 4 billion litres per year – enough to fill the Toronto Skydome, Toronto's baseball team's stadium, two and a half times. Since the calculations were made, tailing "ponds" have increased more than 230 per cent[33] in volume and roughly 170 per cent in size, suggesting that the volumes of leaking waste fluids could be much higher.

Syncrude's Aurora Settling Basin is shown here. It is estimated it leaks over 39 million litres per year into the surrounding environment. The nearby Muskeg River is less than a kilometer away from the leaking "pond".

It is clear that tailings leak, but realized and potential harm have not been quantified. Significant knowledge gaps remain, as industry's self monitoring data and government's investigative data are not made avaliable to the public. Important questions remain unanswered: leaking rates across all tailings "ponds", impacts to surface waters and the Athabasca River, and impacts to the ecosystem from unmitigated impacts over decades.

Downstream communities have learned not to trust the waters

Tailings chemicals make their way into surrounding natural waters through seepage in the ground and through the natural water cycles, as evaporation from the ponds falls as rain or snow hundreds of kilometres away from the source.

For Fort McKay residents, there is an additional concern regarding the waste from the "man camps," the temporary housing where workers stay. It is unclear to Fort McKay residents where the domestic wastewater from man camps ends up.

The water is being harmed by industrial activities and results in the broken trust in the water, so local communities no longer drink it.

"We are being poisoned slowly by the toxic soup they make."
- Jean L'Hommecourt

Not only do tailings "ponds" leak contaminants, they also escape through atmospheric contamination, creating another source of exposure. Polycyclic Aromatic Hydrocarbons (PAHs), which are likely carcinogens , are evaporating from the ponds and depositing themselves in Alberta's water systems at a rate comparable to tailings seepage[34]. Researchers have found that compounds originating from Suncor Pond 2/3 alone made up more than half of the organic compounds in the air of downstream First Nations and Métis communities in Fort McKay, meaning a large portion of the air the communities breathe has compounds coming from toxic tailings![35]

Harm to Wildlife, Nature,and People

Garth Lenz

The boreal forest of northern Alberta is a natural collection of wetlands, rivers, streams, lakes, and ponds–even containing one of the world's largest inland freshwater deltas[36]. It is a highly interconnected water and wetland system, fundamentally impacted by tailings ponds that disrupt and alter the biodiversity of the watershed through habitat loss, fragmentation, water and air toxins, water withdrawals from the river, and more.

Oil production drives the erosion of connections between people and ecosystems

Oil production is responsible for the erosion of connection to culture and tradition, through the destruction of the relationship between people and ecosystems. Land-based teaching, hunting and fishing, medicine harvesting, and community gatherings are all traditional practices fundamental to the Indigenous people in the area, harmed by the industrial activities in the region. **These impacts include, but are not limited to, these examples:**

- Elders in the area recount a visible change in animal behaviour, both in the fish and in the fur-bearing species. Animals don't come anywhere close to the sites, making hunting almost impossible near industrial activity.
- In order to mine and store the wastewaters, operators dig up and remove rivers and creeks that are inland, disrupting the entire ecosystem and water system.
- Many animals, including moose, bears and ducks, get trapped or fall into the tailings and need to be pulled out.

- Elders in Fort McKay are struggling to find places to do land-based teachings to younger generations due the lack of access or lack of non-contaminated sites. Jean recounts the need to go to Moose Lake–nearly 500 km away–to go hunting and conduct teachings.
- Medicine harvesting and family outings to go berry picking, which had happened for many generations, is no longer possible for the communities closest to the oil sands.
- Around the tailings ponds, Mike describes a slimy tar deposit on the trees, while Jean notes the soil is drying out and vegetation dying. The poor habitat negatively affects harvesting opportunities and animal life.
- Traplines, which are a series of traps set out in a specific area, are often set aside by industrial operators to avoid destroying them. These narrow strips of undisturbed land end up being surrounded on all sides by mining activity. This drives away most wildlife from the area, meaning the traplines are barren of wildlife.
- Fishing in the Athabasca River used to be central to the communities, but net setting does not occur in most places now. In Fort McKay, many people also avoid eating ducks, as they are known to frequently land on tailings "ponds" and possibly ingest the toxins.

Deadly impacts of tailings on migratory birds

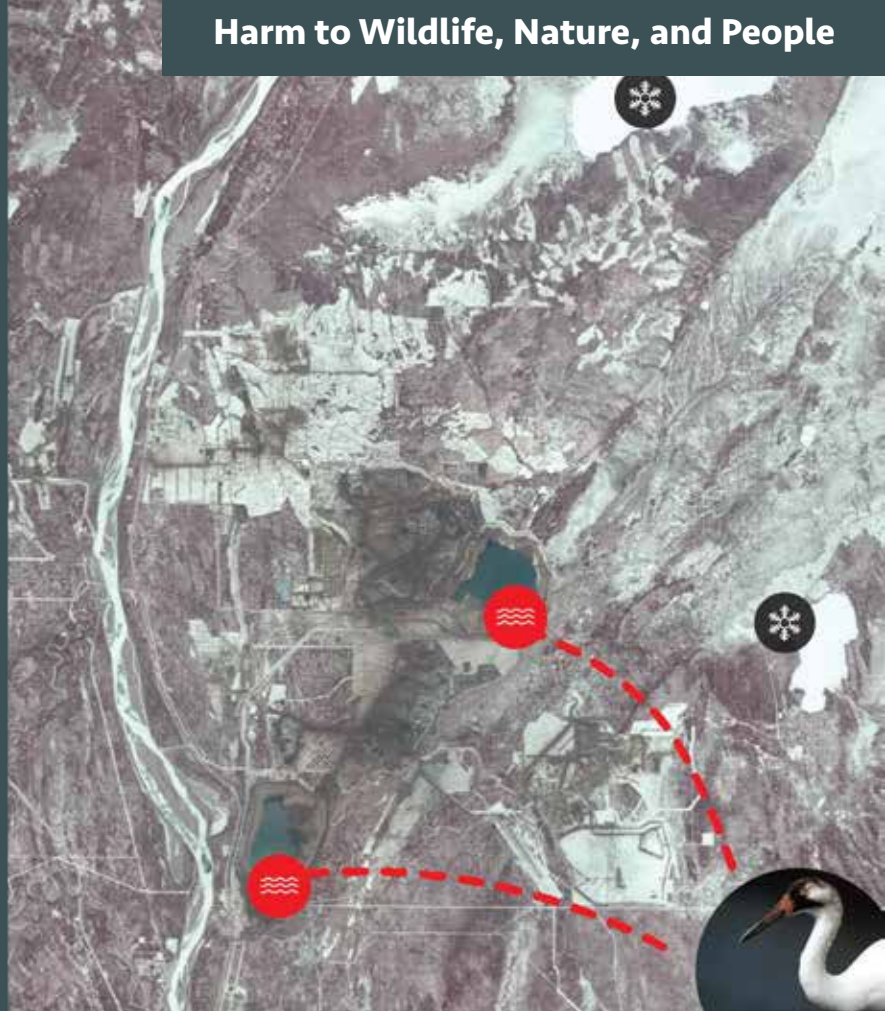
The impacts of tailings on wildlife are best exemplified by their threats to boreal birds and migratory birds that fly over the region. This area is a global hotspot for migratory birds that are converging from all over the continent and are at risk when they fly over the oil sands region: over one million migratory birds use four major flyways that cross over the oil sands region during their Spring and Fall migrations.[37]

USFWS Headquarters

Tailings pose a threat to migratory birds, who fly long distances in sometimes adverse weather conditions and need to land on water bodies to rest and feed. Birds can easily mistake the tailings "ponds" as safe short-term rest stops: they are large bodies of water, often ice-free because of the warmth and salinity of processed waters, with the added attraction of anthropogenic light sources.[38] During poor weather conditions, birds are particularly likely to become attracted to landing in tailings "ponds".

Tailings "ponds" from a bird's eye view

Aerial image of the Syncrude Aurora North mine and tailings "ponds" in the Spring of 2008, the same month 1,600 ducks would land and perish in their tailings "ponds". Surrounding natural water bodies are frozen, leaving the dangerous industrial "ponds" as the only features where birds can land during migration.



**** Red dotted lines show migratory birds flying towards fluid tailings "ponds".**

Whooping crane: USFWS Headquarters

Todd Powell, Alberta Fish & Wildlife

Landing in a tailings "pond" can be a deadly mistake for birds, as tailings waters may contain residual bitumen floating on the waters and beaches of the "ponds".[39] Oiled birds can sink and drown in the tailings water or become weighed down and unable to fly away. Problems persist even if oiled birds manage to fly away: they can ingest oil when cleaning themselves, lose their buoyancy and insulation in water[40], and can be toxic to developing embryos if bitumen is transferred to a nesting bird's eggs[41].

There are rarely publicly-accessible photos of oiled birds in Alberta's oil sands. Only very few photos are still in circulation for journalists to use on this issue (left), or photos are provided by researchers via scans of prints (next page). Researchers are generally prohibited from taking photos on site when collecting data on bird landings.


University of Alberta, 2003


University of Alberta, 2003

Deadly bird landings are a persistent issue that plagues industry operators. Syncrude, in particular, has had a dark history with lethal bird landings: In 2008, an estimated 1600 ducks died after landing in a Syncrude tailings "pond".[42] They were fined $3 million for their negligence. But only two years later, another 230 birds died in the exact same "pond"[43] and then another 30 in 2014[44]. Tragedy struck again in 2015, when Syncrude once again caused the death of thirty-one great blue herons, a protected migratory species, for which they were charged $2.7 million in fines[45].

In 2008, an estimated 1600 ducks died after landing in a Syncrude tailings "pond".

Who is responsible for tailings harm to migratory birds

These lethal impacts on migratory birds are a sorely overlooked aspect of tailings "ponds" management by industry, provincial and federal governments. The responsibility for monitoring and managing these man-made water bodies remains in the hands of industry and overseen by the provincial regulator, but the federal government still has a responsibility to protect species at risk and aquatic ecosystems.

Within the oil sands region, there are 14 species protected under Canada's *Species At Risk Act* (SARA), including 9 at-risk bird species[46]. All migratory birds are also protected under Canada's *Migratory Birds Convention Act*, which includes the objective of providing for and protecting habitat necessary for the conservation of migratory birds[47]. The impacts of tailings "ponds" should not be overlooked when considering Canada's responsibility to protect and conserve these species.

For example, the Whooping Crane is listed as Endangered and protected under both *SARA* and the *Migratory Birds Convention Act*. There is only one wild migratory flock left in the world that uses natural breeding grounds - roughly 500 individuals in size. They have to fly directly over the oil sands to reach their breeding grounds in Wood Buffalo National Park. Even one bad storm forcing landings on tailings "ponds" could jeopardize the survival of the species. The magnitude of the risk is high, but inadequately accounted for during the federal environmental assessment process because it is naively assumed operators can deploy effective bird deterrent systems.

Global Forest Watch Canada

Many companies use different kinds of deterrent systems in an attempt to reduce the tens of thousands of bird landings that occur every year, ranging from loud cannons to simple scarecrows, some even using lasers as visual deterrents[48]. The deterrent systems are poorly studied and lack adequate evidence of their efficacy[49]. Experts have also found the air cannons are negatively affecting nearby wildlife, boreal birds, and people regularly exposed to the sounds.

The bird monitoring programs carried out by industry to monitor and report bird data have also been strongly critiqued. In an independent review of the bird monitoring programs, the monitoring program is lambasted for its lack of transparency and standardization, its unwillingness to complete an inventory of the tailings ponds to determine the high-risk ponds, and an overall lack of regulatory oversight.[50]

Cannons in the battlefield

Noise cannons are used to scare migratory birds away from landing in tailings ponds, but they have harmful impacts on nearby communities. The air cannons fire off at set intervals. They are incessant, day and night.

Jean describes the heartbreaking phenomenon of children growing up in the area becoming desensitized to the booming cannons. They create a dystopian atmosphere to which community members have no choice but to live through, as the sounds irritate their senses and chip away at their feeling of safety.

Reclamation Strategies

Oil sands reclamation: A misleading promise

All oil sands projects are approved with conditions that the mine and tailings will be reclaimed to "equivalent land capability," meaning that the land can support land uses similar to those that existed before the industrial activities, "but that the individual land uses will not necessarily be identical"[51].

Companies detail their vision for "equivalent land capability" in their Conservation and Reclamation Plan and Mine Closure Plan. Every oil sands mine has an independent and varying plan for reclaiming their tailings and mine. There is no standardized measure of "equivalent land capability" for the oil sands region, meaning the vision of the end landscape is instead determined by the company and regulator during the approvals process[52].

The province's definition for reclamation is vague and incomplete. What the regulations fail to capture is that the primary purpose of reclamation should be to reduce and eliminate known environmental harms, return ecological function, and support Indigenous traditional practices.

The purposeful ambiguity in how Alberta measures "reclamation," and vagueness in what habitat needs to be returned, skirts around the obvious reality that destruction of the boreal forest, particularly peatlands, is often irreversible.

Peatlands are a special type of wetland that are especially good at storing carbon, minimizing flood risk, filtering drinking water, and sustaining biodiversity[53].

formulanone, CC BY-SA 2.0

We see the regulations in action at the Canadian Natural Resources Limited (CNRL) North Horizon open-pit mine: an approved Mine Closure Plan details a final post-reclamation landscape with a 100 per cent loss in bogs, fens, and swamps in the project area[54]. Another study calculates the impact of oil sands mines will result in a staggering irreversible loss of nearly 30,000 hectares of peatland[55].

The vague definition also avoids paying particular attention to restoration of Indigenous land uses to the area. This would mean addressing downstream environmental impacts on Indigenous communities, but also Indigenous access to restored areas, and the wildlife those areas sustain.

Reclamation for Indigenous people means that the land is used for traditional practices.

In the heart of the oil sands region and right next to the Athabasca River, the energy company, Suncor, has a small piece of 'reclaimed' land, as certified by the province's regulator. The company boasts about the area, showcasing it as a model for what they will be able to do with the rest of the lease area.

For Jean and her community, the land redesign is nothing close to reclamation.

"We don't have access to it," says Jean. "It's stuck between two huge tailings."

Garth Lenz

The definition of reclamation was not an Indigenous one: some remain inaccessible for traditional uses or in such poor conditions that they are not beneficial. It must be recognized that if the wildlife and ecological health of the area is still lost, then it remains unusable by Indigenous peoples.

"You don't see much bug life anymore," says Jean, explaining how the area does not have the same ecological function or levels of biodiversity compared to before the mine went in. For many of the tailings areas treated for reclamation, it can be as simple as planting trees on top of their 'overburden'.

In imagining a world post oil production, Jean paints a picture of rich biodiversity, and harmony. There will be birds, who will in turn feed the soil, so that bug life comes back. Fur bearing animals will return, including coyotes and foxes, indicating mice are back too. Muskrats, although they have not been around for decades, will be back on these lands where they belong.

The ecosystem will function once again.

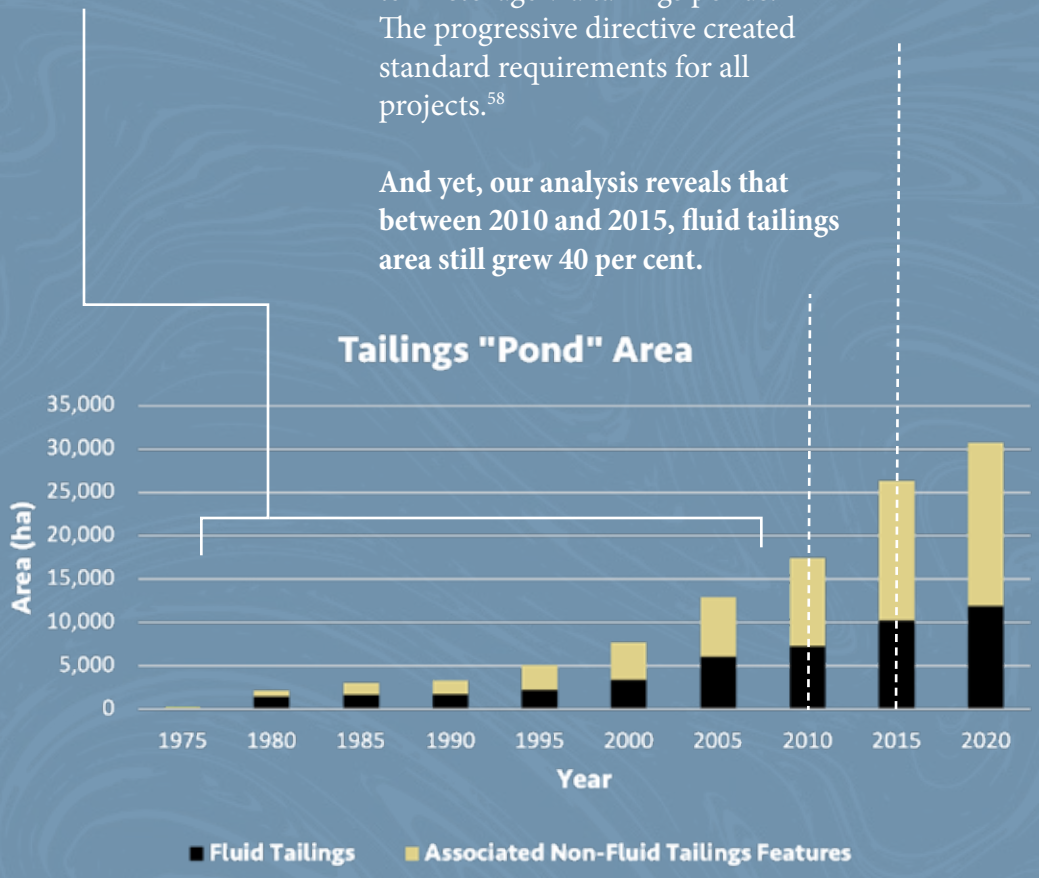
Tailings reclamation expectations:

Up until 2009, there were no regulations specific to managing or reclaiming oil sands tailings, meaning there were no mechanisms to control or limit how much tailings fluid, or how many tailings "ponds", were made and reclaimed by industry.[56]

In 2009, new direction was provided to regulate tailings, in part because it was known that oil sands operators were exceeding expected tailings volumes from their original project applications[57]**.** The requirements set forward aggressive reclamation expectations, focused on targets for slowing growth of tailings and moving away from long-term storage via tailings ponds. The progressive directive created standard requirements for all projects.[58]

And yet, our analysis reveals that between 2010 and 2015, fluid tailings area still grew 40 per cent.

This direction was entirely abandoned in 2015, just six years later, as it became clear most operators would not meet the targets and an updated direction on tailings was released in 2016 by the regulator. The new requirements no longer imposed standard requirements across all projects[59].



Simply put, the issue of how to suitably deal with the massive inventory of tailings on the landscape and the environmental risk of tailings ponds is fraught with inconsistencies.

We emphasize that this compels us to think about urgency in the oil sands in a different way: not one of urgency to push through industry-lobbied reclamation approach, but rather urgency for our governments to stop approving new oil sands projects and new tailings ponds while such a pervasive issue remains unresolved.

The pursuit of a solution to the pervasive problem of tailings ponds should not be solely for the sake of achieving continued, or increased, oil and gas production. A solution to the issue must be found that meaningfully addresses the human and ecological risks, but it should not justify a continuation of the problem.

Reclamation technologies for tailings: What we know, what we do not know

One of industry's most common approaches for tailings reclamation is to create an "end pit lake", done by refilling open-pit mines with tailings and capping them with freshwater. The idea is that the fine tailings will condense and settle to the bottom of the mine and create the lake bottom. They are permanent structures designed to drain into the Athabasca River and integrate within the watershed[60]. End pit lake technology has not been proven, though they are included in almost all Mine Closure Plans in the oil sands[61].

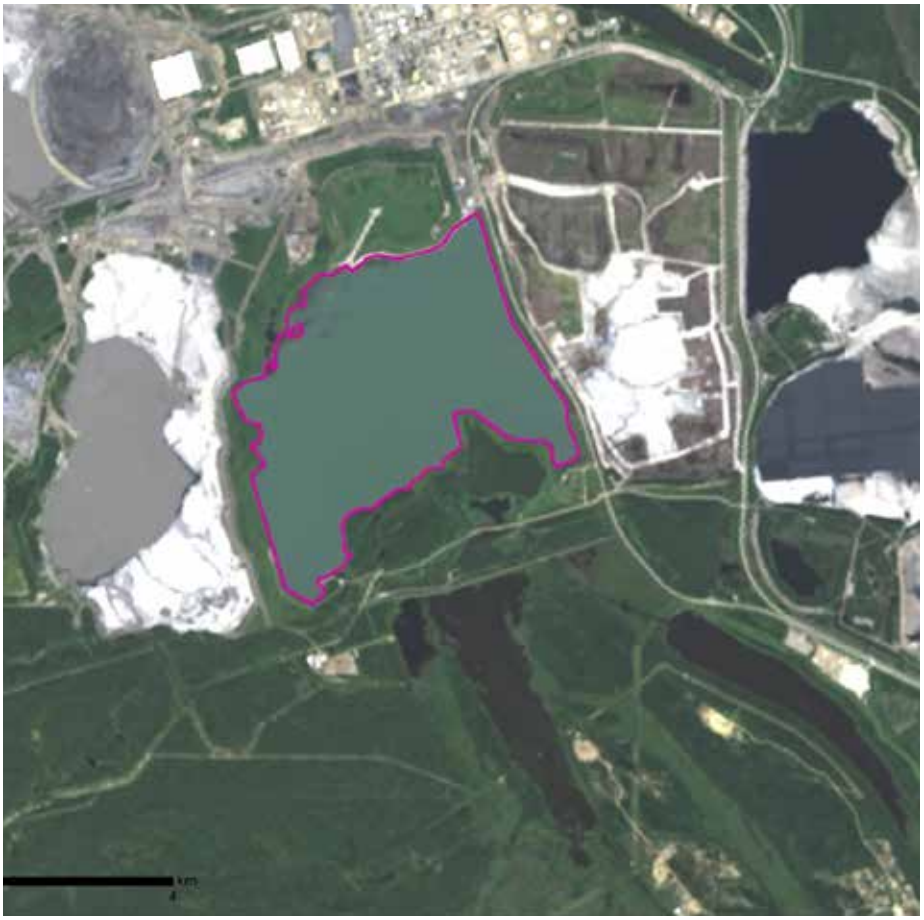
Alternative tailings reclamation technologies focus on solutions that will reduce industry's inventory of tailings, prioritizing approaches that will result in reducing the volume of tailings held by the company and potentially avoid the use of end pit lakes. For example, accelerating the dewatering process so the tailings turn from slurry into sludge, and sometimes further dried into "cakes" which can be transported elsewhere[62].

These technologies are rarely verified by independent researchers outside of industry, and have so far yielded no clear winners for safely treating tailings. Outcomes of research projects are not always transparent. There are no requirements for project results, or project progress, to be publicly shared or published in peer-reviewed journals.

Access and trust in research on tailings reclamation approaches must increase in order to build public trust in safe and suitable solutions. The public, especially downstream communities, should be well-informed on reclamation options and their risks, and able to advocate for more research and development into preferred techniques that may need more resources to improve.

For example, the federal and provincial governments are currently developing regulations for treating and releasing tailings back into the Athabasca River. Downstream Indigenous communities have been vocal in their opposition to this treatment option that would shift environmental impacts off operators and onto downstream communities[63]. The treatment technology has also not yet been proven, with only Suncor's test facilities piloting the treatment[64].

The public, especially downstream communities, should be well-informed on reclamation options and their risks, and able to advocate for more research and development into preferred techniques that may need more resources to improve.



This is an example of one of Syncrude's end pit lake (outlined in purple) for the Mildred Lake mine project. End pit lakes are large artificial lakes with freshwater placed on top of untreated tailings fluids. The technology is not proven to safely store oil sands tailings.

This is an aerial image of Suncor's Millenium mine reclamation treatment area. They are dry stacks, which are "dewatered" fluid tailings. The dry stacks, or "cakes", take up large amounts of area for storage and treatment. We include this area in our estimates of total 'tailings area', as it will still require reclamation to return to pre-development state.

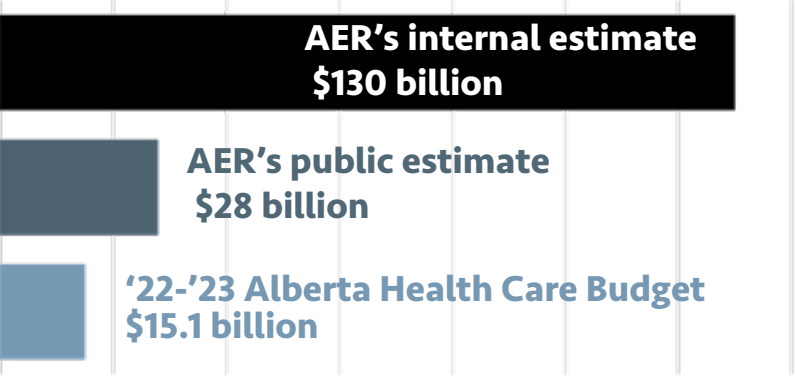
Cost of Clean Up

Clean-up and Liabilities

$130 Billion

That's one estimated cost to clean up tailings "ponds" based on an internal Alberta Energy Regulator (AER) document –and that's if they stopped growing.

Calculating the exact value of the total cost of clean up, or full reclamation, of oil sands mines is challenging because the cost can vary based on the various technologies that can be used for reclamation. But more broadly, it can be difficult to verify estimates as industry and regulators are not transparent about how numbers are calculated and provide inconsistent figures to the public. For example, in 2018, the Alberta Energy Regulator **publicly announced the clean up estimate for tailings was $28 billion.** Yet, an internal document obtained by the media through a freedom of information request showed that a senior member of the Alberta Energy Regulator estimated this clean up to be **closer to $130 billion**, with a note that the **"number is estimated to grow as more data becomes available."**[65]



Even the conservative estimate of $28 billion would be a significant burden for taxpayers: that is almost double Alberta's healthcare budget for 2022-23.[66] Meanwhile, companies have so far put aside **less than three per cent** of the necessary funds.

The lack of robust cost estimates presents a risk for taxpayers.

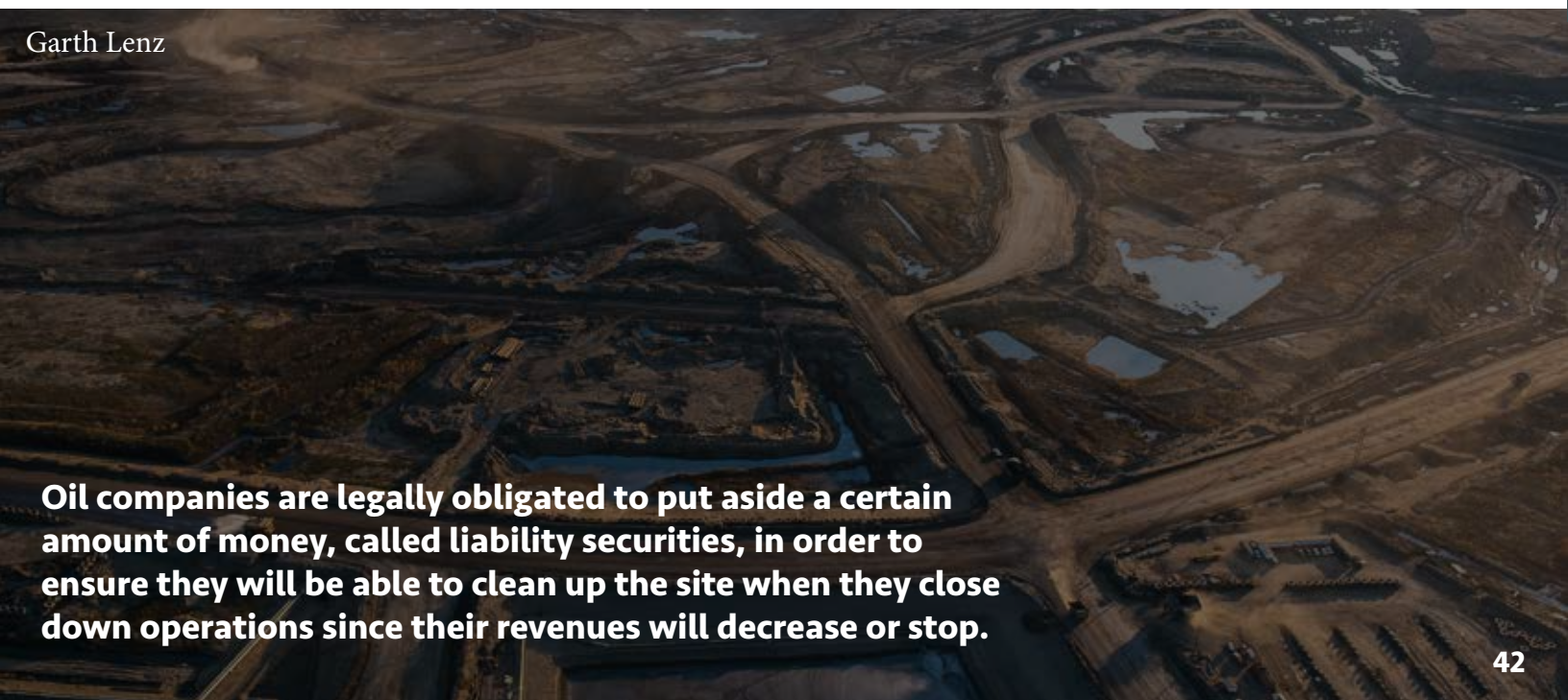
Oil companies are legally obligated to put aside a certain amount of money, called liability securities, in order to ensure they'll be able to clean up a mine when they close down operations since their revenue stream will decrease or stop. In short, it is meant to be a protective measure against a dine and dash situation, in which oil companies have dined for five decades!

The lack of robust cost estimates presents a risk for taxpayers. If the cost of clean up is underestimated, companies put less aside, which increases the risk that taxpayers will end up paying a large part of the bill.

The current system of liability securities under Alberta's Mine Financial Securities Program (MFSP) is extremely flawed. Environmental groups have been critical of the weaknesses of the MFSP[67]- with little faith in the program's ability to feasibly cover the costs of clean up. In comparison, Quebec and the Yukon amended their own programs, and their respective governments now hold the total estimated reclamation cost as security.[68,69]

Clean up must be paid for by companies. Given the history of non-enforcement that pervades the provincial agencies responsible for regulating the oil sands industry,[70] there is a significant risk that taxpayers may end up paying for the clean up. The fact that the federal government allocated $1.7 billion dollars to deal with oil and gas wells abandoned by industry in Alberta[71] should serve as a cautionary tale. To address these concerns, and in light of the historic profits made by oil companies in early 2022, the federal government could implement windfall profits tax, the revenue of which would be set aside as security to pay for clean up and reclamation.

Unfortunately, rather than putting more money aside, or making headway on the clean up, oil companies have announced plans to increase production in the oil sands in the upcoming years, which will inevitably increase the price tag of the clean up.



Garth Lenz

Oil companies are legally obligated to put aside a certain amount of money, called liability securities, in order to ensure they will be able to clean up the site when they close down operations since their revenues will decrease or stop.

Recommendations

We recommend six steps to governments for improving tailings management in the oils sands region and addressing their environmental harms:

1. Do not create any new tailings "ponds" and do not approve new oil sands mines.

Industry has created a problem for which they have no safe solution. We recommend against the approval of any new mine projects or new tailings "ponds".

One way of doing so is for the federal and provincial impact assessment processes to strongly account for the environmental harm of new tailings when considering approval recommendations for new project proposals. It is clear new tailings are not in the public's interest when their safe reclamation remains unresolved, and therefore, environmental impacts are not suitably mitigated and projects cannot be reasonably approved.

Alberta should not issue new permits under the *Alberta's Oil Sands Conservation Act*, *Water Act*, *Environmental Protections and Enhancement Act*, and *Public Land Act* for new mine projects and amendments or expansions to previously approved mine plans or Tailings Management Plans, if they include the construction of new tailings "ponds".

2. Develop and implement a comprehensive tailings reclamation plan for the oil sands region, prioritizing environmental outcomes and the concerns of impacted downstream communities.

We recommend that the government conduct an independent evaluation of all possible tailings reclamation options. The review should include a risk assessment of approaches, prioritizing those that minimize environmental and downstream impacts, over costs to industry. These findings should be made public.

Based on this recommended assessment, a body of experts should inform a process for standardizing criteria and outcomes of reclamation approaches for the oil sands region. The body should include experts and members of impacted communities – Traditional Knowledge keepers, independent scientists, conservation organizations, First Nations and Métis communities, downstream communities, and the Government of Northwest Territories – as well as decision-makers such as the Government of Alberta, Alberta Energy Regulator and Environment and Climate Change Canada.

3. Require the collection and holding of the total funds that will be needed for oil sands mine clean up and rehabilitation.

We recommend reforming Alberta's Mine Financial Security Program (MFSP) so the provincial government collects and holds 100 per cent of the current estimated costs of clean up, as contributed by industry. This means abandoning the asset-liability approach and developing policies such as those in Quebec and the Yukon[72]. We also recommend that the federal and Alberta governments give no additional subsidies to oil companies for clean-up related costs[73].

4. Uphold the United Nations Declaration on the Rights of Indigenous Peoples and respect Indigenous sovereignty.

Canada has committed to implementing UNDRIP, which states that "Indigenous peoples have the right to practise and revitalize their cultural traditions and customs,"[74] and so we recommend reclamation solutions must have the free, prior and informed consent of affected First Nations and Métis communities. The definition of reclamation must align with the standards set by these communities, meaning the requirements for reclamation outcomes must align with the ability of the land to support traditional practices and access by Indigenous Peoples.

Garth Lenz

5. Strengthen cross-jurisdictional collaboration with all levels of government on the management of tailings.

There is a need for stronger cross-jurisdictional collaboration between the governments of Canada, Alberta and the Northwest Territories, as there has traditionally been a history of inaction on responsible tailings management by Alberta, combined with several unfulfilled obligations by the federal government and hesitancy by the Government of Northwest Territories for certain reclamation approaches.[75]

We recommend that the federal government take the lead on this management approach, as Canada has several legal responsibilities and tools that are currently overlooked:

A The impacts of tailings "ponds" and their reclamation on Indigenous peoples warrant federal intervention, as a matter of upholding Treaty Rights, maintaining Crown-Indigenous relationships and supporting environmental justice.

B The risks associated with certain reclamation methods, such as the treat and release option currently being considered, will have transboundary impacts extending beyond Alberta and into the Northwest Territories.

C Federal laws meant to protect the environment and the health of Canadians, including the *Fisheries Act, Canadian Environmental Protection Act, Species At Risk Act*, and *Convention on Migratory Birds Act* necessitates action by the federal government.

D Still in its early stages, the Canada Water Agency should be involved in the ways in which the Athabasca River and its tributaries are impacted by tailings and their reclamation, especially if they involve releasing treated tailings into the River.[76]

E Activities in the oil sands impact Wood Buffalo National Park, the nation's largest national park and UNESCO World Heritage Site downstream of the oil sands. Canada is responsible for managing industrial impacts on the ecological health of the Park, which is known to be in decline.

6. Strengthen the oil sands bird monitoring program so it is a transparent, standardized and collaborative program.

The oil sands bird monitoring program should be a rigorous, standardized, and transparent monitoring program. The program should be led in collaboration with independent academic researchers, much like the Research on Avian Protection Project (RAPP), which ran from 2010 to 2014 and informed a standardized monitoring program that was implemented at the time, but has since been dismantled and no longer adheres to a standardized protocol. Significant gaps in the current program must be addressed, including releasing publicly-available data on bird landings and mortalities, completing a risk-based inventory of tailings, and increasing the understanding of the effectiveness of bird deterrent systems in the oil sands.

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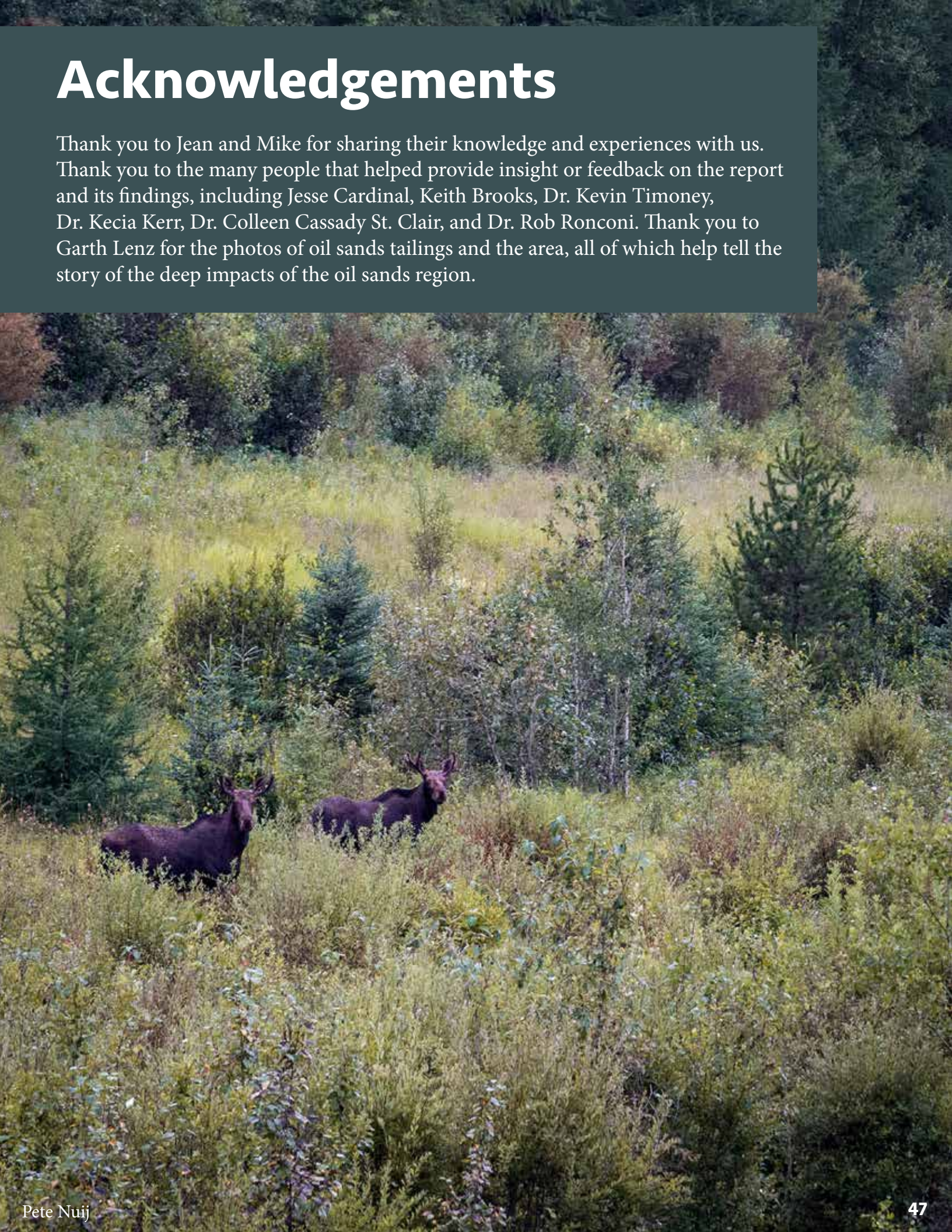

Pete Nuij

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Appendices

Appendix 1: Additional Maps and Figures

Table 1: Fluid tailings area (in hectares) in the oil sands in 5-year increments for all oil sands mine projects.

	Year									
Company - Project	**1975**	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Suncor Energy Inc. – Base Mine	149	334	459	531	621	788	1,129	644	581	552
Syncrude Canada Limited – Mildred Lake Mine		1,179	1,210	1,224	1,645	2,656	2,809	2,859	3,468	3,983
Syncrude Canada Limited – Aurora Mine North							612	541	1,106	1,256
Canadian Natural Upgrading Limited – Muskeg River Mine							512	562	759	880
Suncor Energy Inc. – Millenium Mine							1,011	2,015	2,129	2,050
Canadian Natural Upgrading Limited – Jackpine Mine									583	466
Canadian Natural Resources Limited – Horizon Mine								707	1,149	1,619
Imperial Oil Resources Ventures Limited – Kearl Mine									464	684
Fort Hills Energy Corporation – Fort Hills Mine										412
Total:	149	1,513	1,668	1,755	2,275	3,444	6,073	7,327	10,239	11,903

Table 2: Difference in growth of fluid tailings area within 5-year increments, with corresponding percentage increase.

	1975-1980	**1980-1985**	**1985-1990**	**1990-1995**	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Fluid Difference (hectares)	1,363	156	86	520	1,169	2,629	1,254	2,912	1,663
Per cent Increase (%)	912.89	10.30	5.16	29.65	51.41	76.33	20.66	39.75	16.24

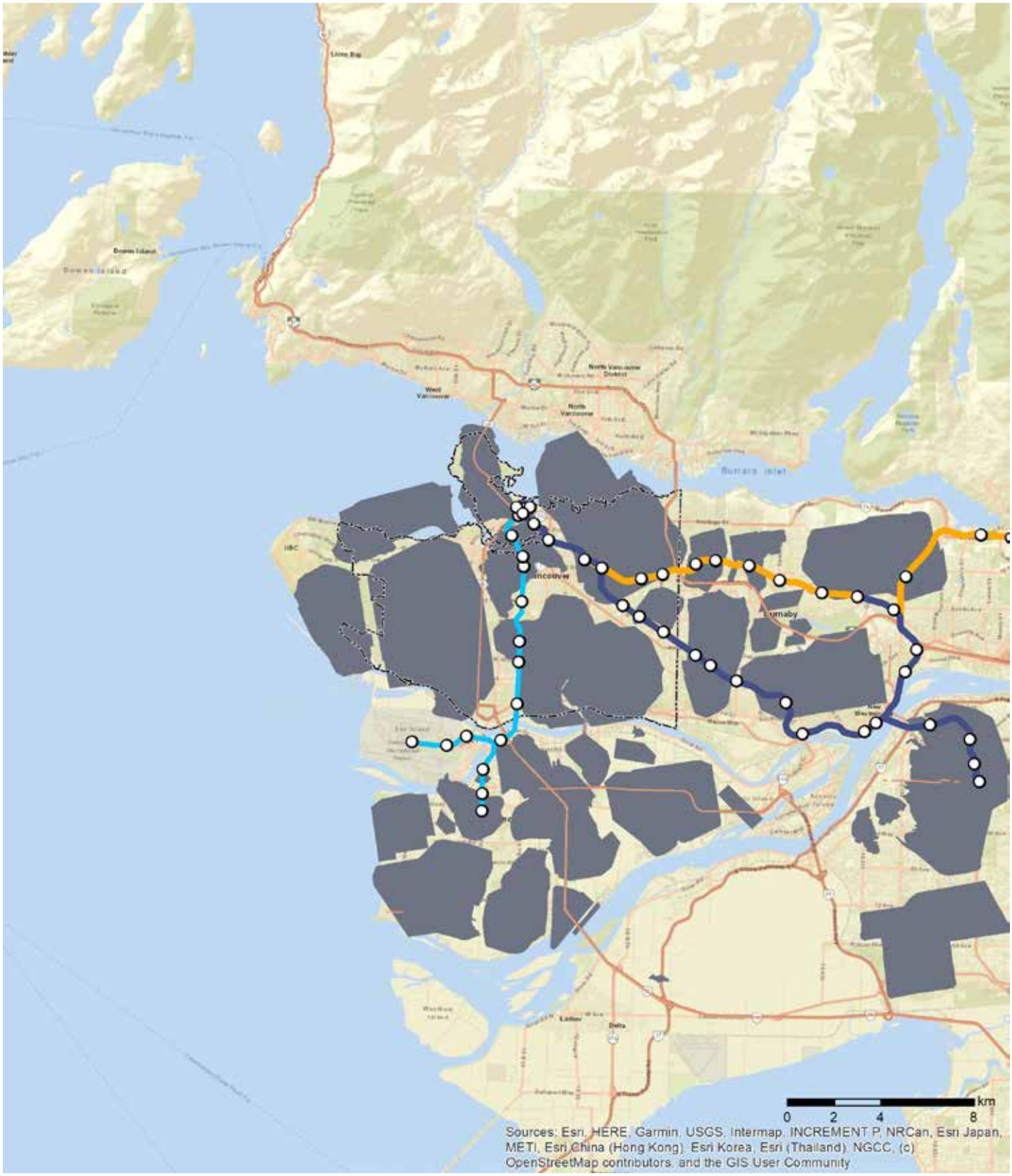
Table 3: Total tailings area (in hectares) in the oil sands in 5-year increments for all oil sands mine projects (total tailings area includes fluid tailings area and all associated tailings features, including beaches, berms, dykes, and areas treated for reclamation)

	Year									
Company – Project	**1975**	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Suncor Energy Inc. – Base Mine	244	527	698	840	1,068	1,447	1,989	2,061	2,082	2,093
Syncrude Canada Limited – Mildred Lake		1,619	2,373	2,478	4,090	6,102	6,948	7,684	8,718	9,491
Syncrude Canada Limited – Aurora Mine North						165	1,377	1,378	2,653	2,835
Canadian Natural Upgrading Limited – Muskeg River Mine							1,143	1,495	1,919	2,318
Suncor Energy Inc. – Millenium Mine							1,455	3,252	5,157	5,674
Canadian Natural Upgrading Limited – Jackpine Mine								645	1,778	1,849
Canadian Natural Resources Limited – Horizon Mine								934	1,966	2,788
Imperial Oil Resources Ventures Limited – Kearl Mine									2,123	1,866
Fort Hills Energy Corporation – Fort Hills Mine										1,817
Total:	244	2,146	3,071	3,318	5,158	7,714	12,913	17,450	26,394	30,731

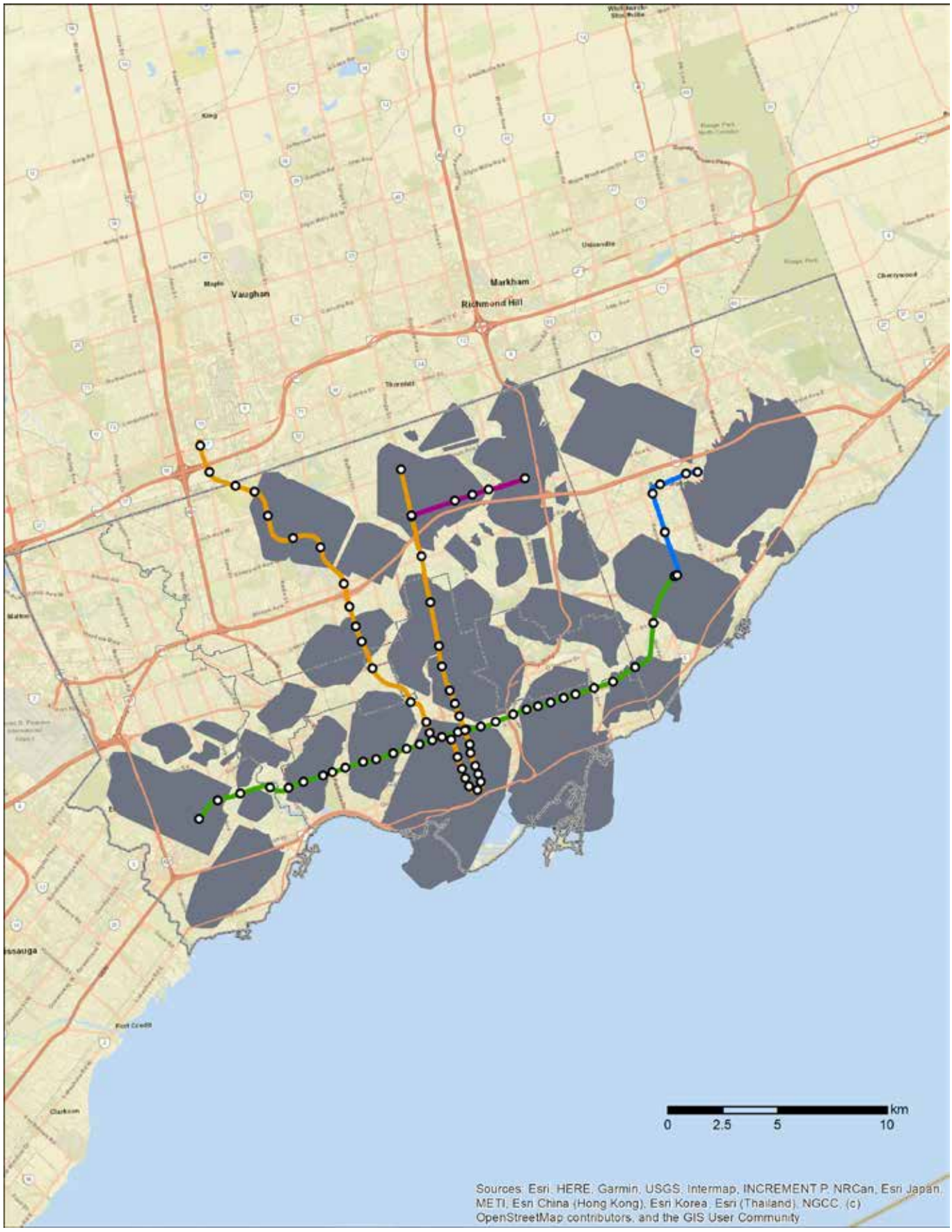
Table 4: Difference in growth of total tailings area within 5-year increments, with corresponding percentage increase.

	1975-1980	**1980-1985**	**1985-1990**	**1990-1995**	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Total Tailings Difference (hectares)	1,902	925	247	1,840	2,556	5,199	4,537	8,944	4,337
Per cent Increase (%)	779.96	43.09	8.04	55.46	49.56	67.39	35.13	51.26	16.43

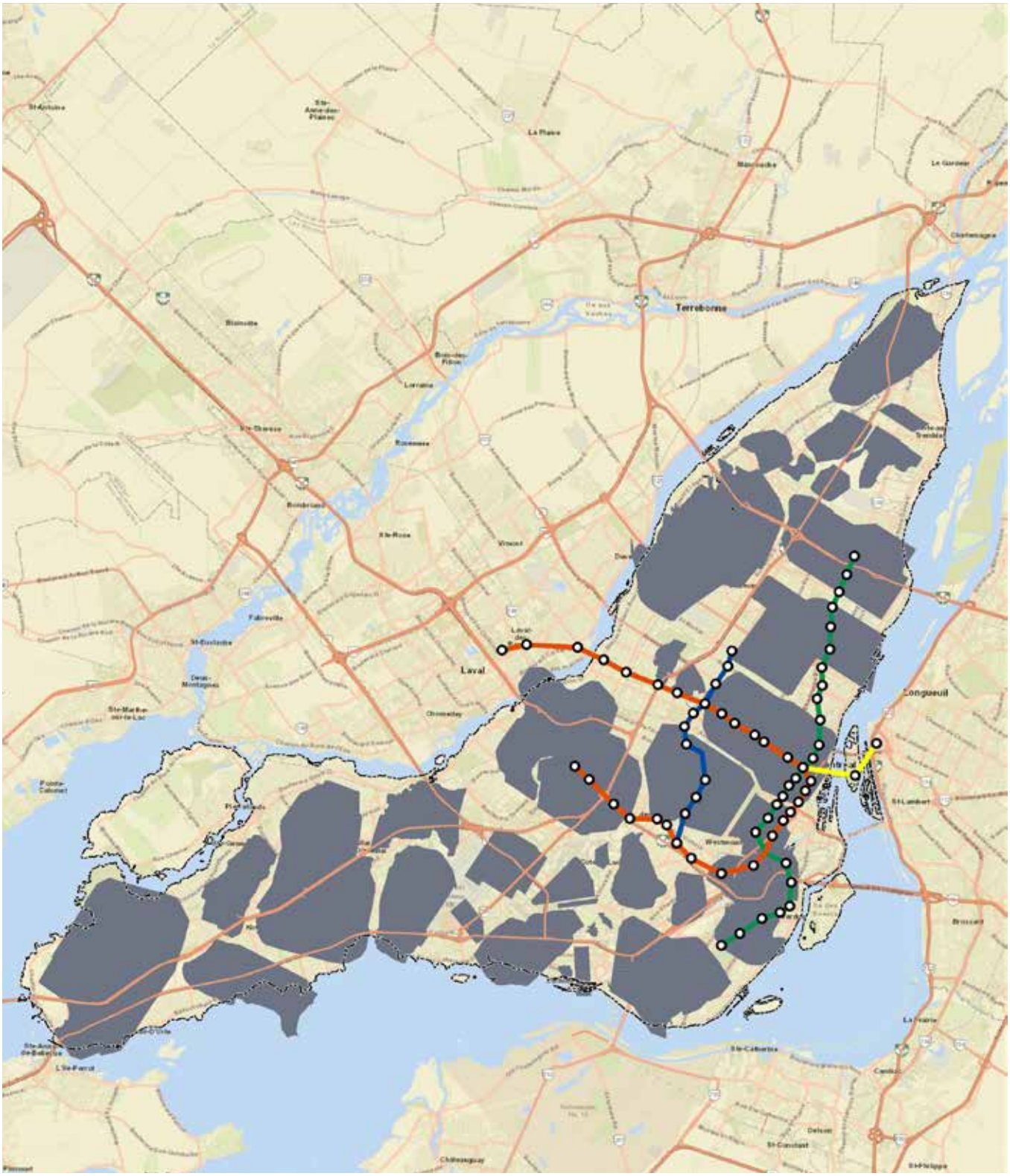
Oil sands tailings “ponds” over the Vancouver, Burnaby, and Richmond city boundaries with major SkyTrain lines.



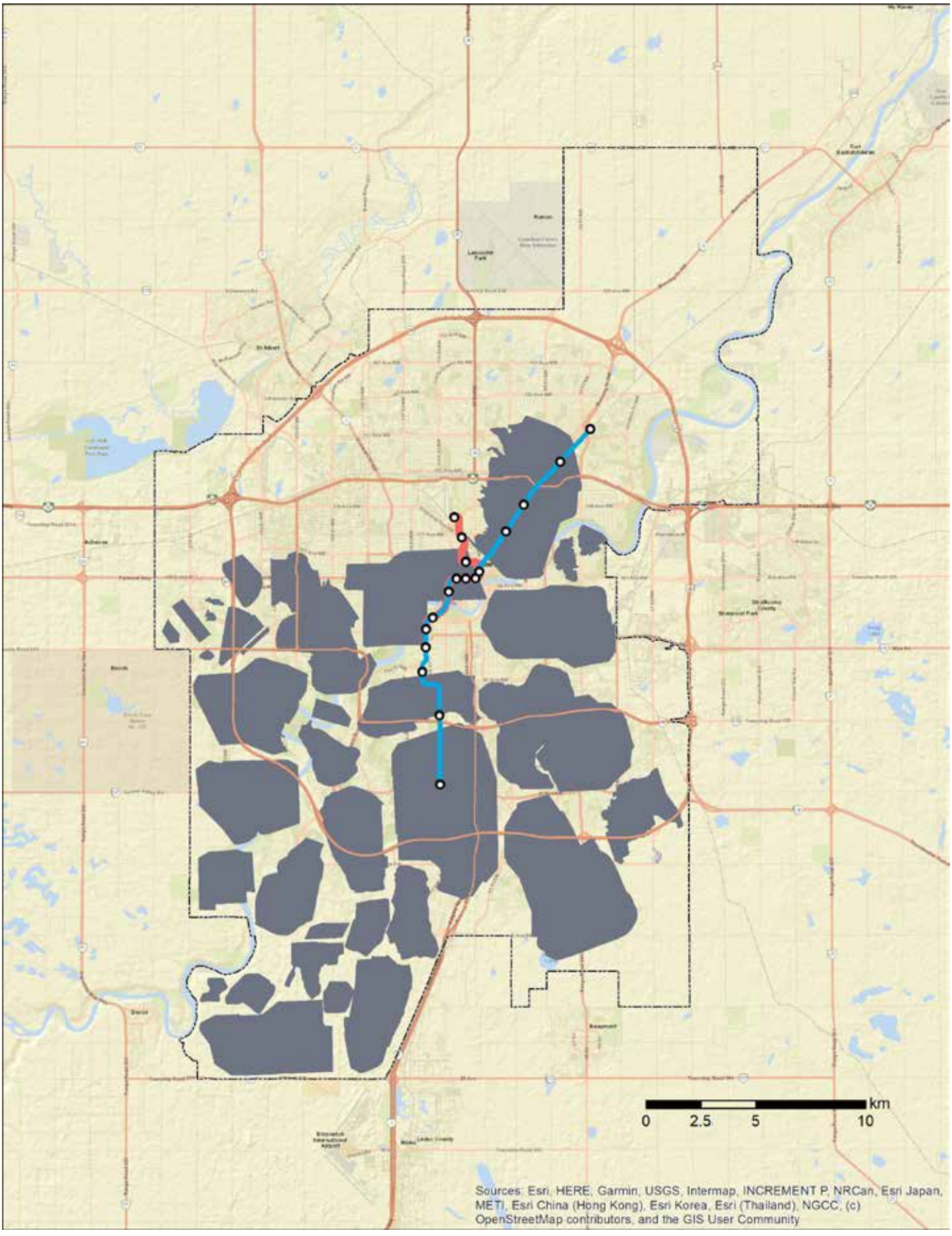
Oil sands tailings “ponds” overlaid on top of the city of Toronto with all major subway lines.



Oil sands tailings “ponds” over the Montreal city boundaries with major Metro lines.



Oil sands tailings “ponds” over the Edmonton city boundaries with major Light Rail Transit lines.



Appendix 2: Mapping Methods and Definitions

Tailing ponds were digitized at 1:20,000 scale based on Landsat imagery using false colour band combinations. The "Fluid tailings" category represents pixels seen on Landsat imagery where the tailings ponds predominantly appear as a fluid, and includes tailings pond water areas and end pit lakes. All other components of the tailings ponds, including beaches, berms and dykes were classified as "other". In addition to tailings structures, this category also includes disturbed and previously disturbed areas (for example, areas which have been revegetated), areas that were previously used for tailings storage but are currently mined and areas where tailings reclamations technologies are being utilized (coke placement and dedicated drying areas / dry stacks).

The classification of fluid tailings area and associated tailings structures was compared against the publicly-available oil sands disturbance dataset "Shapefiles for Land Disturbance due to Oil Sands Projects: 2015"[77] for consistency once mapping was completed. We compared the identification of tailings features and the overall area estimates. We note that the total disturbance associated with tailings in this Alberta Environment and Parks 2015 dataset (AEP 2015) is 246 km^2 compared with our mapped value of 264 km^2 in 2015. This difference can be mainly attributed to our inclusion of areas previously cleared as tailings areas (28 km^2) which were subsequently revegetated, and not including portions labeled as tailings dykes (9 km^2) at the Syncrude Mildred Lake site. These areas included in the AEP (2015) at the Mildred Lake site were not apparent as tailings features on Landsat imagery and were not mapped. Therefore, we feel this is a strong comparison and adds credibility to our identification throughout the entire dataset for tailings area. Area calculations are based on the Alberta 10TM map projection and city overlays are projected to Canada Albers Equal Area Conic.

We note that our mapping addresses gaps in existing public government datasets on oil sands footprint, much of which is industry-reported. Specifically, the AEP Shapefiles for Land Disturbance due to Oil Sands Projects, which spans from 2010-2017, with data points from 1980, 1998 and 2007 and the ABMI Enhanced Human Footprint for the Oil Sands Monitoring Region (2019)[78] with tailings ponds updated to 2016. The Alberta Energy Regulator (AER) reports on State of Fluid Tailings Management, but only provides volumes of tailings and not the size of the tailings areas, as management targets are for tailings volume.

Our dataset fills the gap of a dataset that focuses on theextent of the oil sands tailings footprint over time. Other datasets have intermittent temporal coverage (AEP) or are instead designed to monitor overall disturbance (ABMI).

The following Landsat image scenes were used for this analysis[79]:

Date	Landsat Satellite	Path / Row
September 20, 1975	Landsat 1	46 / 20
July 28, 1980	Landsat 2	46 / 20
July 10, 1985	Landsat 5	42 / 20
July 24, 1990	Landsat 5	42 / 20
September 24, 1995	Landsat 5	42 / 20
September 13, 2000	Landsat 7	42 / 20
May 30, 2005	Landsat 5	42 / 20
July 22, 2010	Landsat 5	43 / 20
October 1, 2015	Landsat 8	42 / 20
August 18, 2020	Landsat 8	43 / 20

Appendix 3: Full interviews with Indigenous Knowledge experts

The following is an unabridged summary of interviews with Indigenous experts, Jean L'Hommecourt and Mike Mercredi, represented as ten lessons they shared from their experience and knowledge living downstream of the oil sands.

Ten lessons from Indigenous Knowledge holders:

1. Artificial silos and examining impacts one-by-one mean nothing on the ground.

While this report focuses on industry's toxic tailings, nature does not work in silos. People and wildlife on the frontlines do not feel the effects of each company's activity or each part of the supply chain of oil production separately. Governments and industry often set standards and measure impact using a siloed approach, where everything is examined individually. Yet, oil sands mining, wastewater storage, and all industrial activities associated with oil production such as deforestation, trucking, landscape modifications, large numbers of workers present on the land and more, are affecting people and ecosystems simultaneously.

Impact is felt not merely as the sum of one after the other, but as the accumulation of harm which compounds to create a whole much larger than its parts.

Treating each project, company or even industry as separate is a Western practice that denies the reality on the ground, however, Western science's concept of "cumulative impacts" best approximates this compounding of harm.

2. Oil sands development eliminates access, which increases harm to communities.

For communities closest to the extraction sites and the tailings, harm happens much before long-term health impacts kick in. Through sprawling mines, tailings, roads and workers' temporary housing, oil production in the oil sands pushes Indigenous people off their lands - an extremely traumatic and destructive experience.

"To fully understand the adverse effects you need to understand the history of the peoples there and the ways in which they used the land," says Mike Mercredi.

Gathering sites that hosted many generations have become "no access zones".

The sprawl of the tailings, demonstrated by the maps above, translate into a gradual fencing in of the communities, which see their growing population share the same fraction of the land.

The communities describe themselves as being "fenced in" and "surrounded", an unambiguous

way to describe their lack of actual freedom on their own territories.

Traplines, which are a series of traps set out on a specific trail, frequently get surrounded on all sides by mining activity so as to leave only a narrow strip of land, driving away most wildlife from the area.

These stories only represent a sample of the ongoing harm oil production and tailings storage do to Indigenous people as their access to land is taken away from them.

3. Traditional ways are disrupted, which increases harm to communities.

Land-based teaching, hunting and fishing, medicine harvesting, and community gatherings are all traditional practices fundamental to the Indigenous people in the area. The United Nations Declaration on the Rights of Indigenous People recognizes "Indigenous peoples have the right to practise and revitalize their cultural traditions and customs," and the state has a responsibility to enable access to such traditional ways.

Oil production in Canada has been disrupting, often even entirely blocking, the practice of these traditions for decades:

Elders in Fort McKay are struggling to find places to do land-based teachings to younger generations due to the lack of access, or lack of non-contaminated sites. Jean recounts the need to drive, or fly during the summer, to Moose Lake (1,000km away) to go hunting and conduct such teachings.

Medicine harvesting and family outings to go berry picking, which had happened for many generations, are no longer possible for the communities closest to oil production.

As the following sections describe, relationships to non-human relatives are disrupted, challenging people's deep connections to their territories.

To obstruct access to traditional ways is to directly attack the Indigeneity of the communities surrounding and downstream of oil production.

4. What affects animals and plants, ends up affecting people.

Plants and animals are affected in numerous ways by the intense water extraction used to separate the oil from the oil sands, as well as the high level of toxic exposure through leaks and air transportation.

Around the Canadian Natural Resources Limited (CNRL) pond, Mike describes a slimy tar deposit on the trees, while Jean notices an extremely dried-up soil and vegetation. This in turn affects harvesting and animal life.

Elders in the area recount a visible change in animal behaviour, both in the fish and in the fur bearing species. Animals don't come anywhere close to the sites, making hunting close to impossible in the sites closest to industrial activity.

Fishing in the Athabasca used to be central to the communities, but net setting does not take place in most places now. In Fort McKay, many also avoid eating ducks, as they are known to frequently land on tailings, an ongoing problem the world woke up to during the 2008 Syncrude Bird landing.

This broken trust between people and their ecosystems is a health and nutrition issue, but also an ongoing erosion of the connection to culture and tradition, for which oil production is directly responsible.

5. The water is hurting.

Local and downstream residents know that the chemicals from tailings "ponds" are making their way into different bodies of water and that the water is hurting due to oil production. In order to mine and create the tailings, oil companies also dug out and removed inland rivers and creeks further disrupting the ecosystem.

Tailings "ponds" chemicals make their way into the water through seepage in the ground and through aerial travel via the water cycle. As evaporation from the "ponds" becomes rain or snow tailings pollution is sometimes spread hundreds of kilometres away from the source. For Fort McKay residents, there is an additional concern regarding the waste from the "man camps" - the temporary housing where workers stay, as it is unclear to them where their domestic wastewater ends up.

As a result, the trust with the water is broken, and local populations no longer drink it. "We are being poisoned slowly by the toxic soup they make," says Jean.

6. There is danger in every breath from the air pollution caused by oil sands development.

The toxic tailings "ponds" are immense open air pits of toxic water, where the air comes into contact with chemicals for kilometres. Air quality in the surrounding communities is extremely poor, and an ongoing stench serves as a daily reminder to the population about the danger they breathe in.

The stench irritates most senses, and hurts your eyes, throat and nose if you live nearby or towards where the wind blows.

Historically, the Indigenous people of the area had no asthma. Yet, children are now frequently

born with asthma, several other respiratory diseases, and skin diseases. Jean's fear is that even if industry activity stops, many generations will suffer from these, as what mothers breathe in now will be passed onto future generations.

While most of us look forward to hot summer nights, those in Fort McKay do not. "I know what summer brings," says Jean. Evaporation during the day and then a sudden cooling at night leaves particules hanging in the air for long hours, during which the air quality is at its absolute worst. Despite the heat, people close their windows to stay safe.

Jean describes a vicious cycle of air pollution, the development that produces the pollution, and the climate change that worsens the effects. Jean called for a stop to production because of this feedback system:

Tailings air pollution is worst in the summer, and locals dread heat waves as they bring air quality to dangerous lows
The production and consumption of the oil produced in the area is a leading cause of climate change, which will make summers hotter and days of extreme heat more frequent
As production continues or increases, air pollution from the tailings worsens, and tailings grow large to store more waste.

7. There are adverse effects on spirituality and mental health from the environmental harms.

Connection to the land and animals is a central part of Indigenous peoples' identity, and being separated from these, as the previous section describes, deeply affects their mental health.

For example, access to foods and to fur like her ancestors did is something Jean longs and mourns. After living many years of living in a more traditional lifestyle further up North, Jean returned to Fort McKay to be closer to her parents. She describes a real "culture shock" witnessing the devastation caused by industry and the lack of access.

Canon bombs are incessant, day and night. They are set up to deter bird landings, yet they create a dystopian atmosphere to which locals have no choice but to live through, as the sounds irritate their senses and chip away at their sense of safety.

Children growing up in the area become desensitized to the stench and the canon booms, a phenomenon Jean describes as heartbreaking.

8. Communities are fenced in, yet unsafe.

While fences are up to protect the industries infrastructure, the people and animals are far from safe near tailings. While access to the tailings "ponds" is forbidden, locals know better than to approach anyways:

Moose, bears and ducks regularly get trapped or fall into the tailings, and need to be pulled out.

Impunity is almost assumed in the area: community monitoring programs frequently flag high levels of toxicity, or worrisome air or water quality, yet enforcement is unseen. One of our interviewees stated that "Ever since our communities signed benefit agreements, it feels like it doesn't matter what the companies do anymore."

Man camps, ranging from 500 to 3,000 men depending on the season and the projects, come onto the land. Their trucks and activity disrupt animals and add to the air and noise pollution. More worrisome, is the danger this presents to the Indigenous women of the area: "You never know who you'll run into" when being on the land, testifies Jean.

The Missing and Murdered Indigenous Women, Girls and 2-Spirit People crisis in Canada is closely linked to these man camps and to extraction on Indigenous lands. Far from an isolated anecdote, Jean's experience with man camps is a peak into a country-wide issue of gendered, colonial violence.

9. Resilience, strength and hope are not going away.

Indigenous people have been on the territories where the tailings "ponds" sit for millenia. Their history and laws long precede the mining permits and colonial laws, and they will long outlive them.

The incredible resilience is one best illustrated by Mike's own words: "As long as we do what we do, we win. There actually isn't much evidence that says we are losing, although there is evidence that there are parts being lost, like the birds, the lack of access, the challenge to harvest."

Despite the hardship and harm caused by industry, this will only be an episode in the much longer existence of Indigenous people on their lands. In Mike words, the tension currently felt will continue until one of two stops, and "I would put a bet on us".

So, what would the area look like post-tailings and post-oil production?

Jean painted a picture of rich biodiversity, and harmony. There will be birds, who will in turn feed the soil, so that bug life comes back. Fur bearing animals will return, including coyotes and foxes, indicating mice are back too. Muskrats, although they have not been around for decades, will be back on these lands where they belong. The ecosystem will function once again.

10. A call for unity.

Neither the intensity of the activity nor the sprawl of the tailings "ponds" seems to be slowing down, despite repeated commitments by industry to work towards sustainability. Both experts highlighted Indigenous communities doing their part in protecting the land and the water, for generations to come. Mike asks, "Will your people do yours?"

Will we trust and use the knowledge and wisdom that Indigenous people are offering, or will we continue waiting until Western science confirms what their elders predicted long before, sometimes waiting until it is too late?

Solidarity, mutual respect, and a greater understanding of each other will be necessary. Mike, in sharing the teachings of the medicine wheel pertaining to the four colours of people on the earth, highlighted that if Indigenous peoples disappear, the circle will be broken. At the very end of our conversation, he said "if the rest of the world doesn't ensure that we survive, everyone else is going down with us."