

YVR Report & Action Plan

DECEMBER 2022 TRAVEL DISRUPTION

TABLE OF CONTENTS

03

Letter from
President & CEO

16

Action Plan

05

Executive
Summary

22

Conclusion

08

Detailed Report
& Findings

23

Appendix

Event Timeline Highlights	24
About Vancouver International Airport (YVR)	25
Key Statistics	27
YVR Operations	28
Weather at YVR in December 2022	29

APRIL 17, 2023

LETTER FROM PRESIDENT & CEO

At YVR the safety of our employees, passengers, and the public is our highest priority. Safe operations are something we plan for, test, and practice regularly at YVR - including in times of adverse weather.

And so, when snow hit the Metro Vancouver region on the evening of December 19th, our team ploughed runways and de-iced aircraft to ensure the safety of aircraft, crew, and passengers. However, even with those tireless efforts what happened next is by now well-known: flight cancellations, passengers kept on aircraft for hours, long line-ups to re-book trips and pick up luggage, passengers sleeping in the terminal, and all with insufficient information to decide what to do next.

I am not going to sugar-coat it. It was not our finest hour. Our safety promise was kept. Our customer service commitment was not.

Delivering a passenger and their bag safely and efficiently requires a complex combination of processes and people working together. At YVR an ecosystem of over 26,000

dedicated people from baggage handlers, airlines, transit and taxis, government agencies, and airport staff all contribute to get this job done. Even on the most normal of days this requires enhanced communication and coordination. When operations are disrupted this becomes even more important.

Given our collective experience over the week of December 19th, communication and coordination was insufficient to support and inform travellers and our broader community through the weather disruption. That is why we immediately launched an enhanced operational after-action review and, for the first time ever following a significant event at YVR, a public engagement process as well.

The following pages contain the insights of our comprehensive review of the events in December and our action plan to improve going forward. And while there is work to do, the review reinforces that passenger safety and security was not compromised. The findings also confirm many of the areas our team had already identified for improvement in the weeks immediately following the December disruption. These improvements were implemented in January – which improved our operational performance through two subsequent snowfalls that hit our region in February 2023.

The pandemic was tough on the aviation and travel industry and we are still recovering from it. Many things are different today than before. The labour market is different: where we once had many more applicants than we had job vacancies, we now have many more job vacancies than we have applicants. Our travellers have greater access to real-time information on the status of their flights and baggage – often provided to them by a third party other than an airline or airport.

And at YVR we are seeing a change in the type of aircraft serving our airport. While our passenger numbers continue to rebound closer to our 2019 levels, we have fewer widebody aircraft serving YVR and more narrowbody or single-aisle aircraft. Said another way, we have more aircraft to move the same number of passengers. This puts additional strain on our airside services including aprons, gates, and ground handling.

Accordingly, the systems and processes our airport community has historically relied on must be made more resilient and adaptable.

I want to thank the members of the public along with the hundreds of YVR employees, representatives from our airlines, ground handlers, agency partners, and so many others for sharing their valuable time and expertise through this process. We have much to be proud of at YVR and we have a bright future ahead. I am confident that with this action plan, we will continue moving forward.



Tamara Vrooman O.B.C
President and Chief Executive Officer
Vancouver Airport Authority

EXECUTIVE SUMMARY

INTRODUCTION AND EVENT RECAP

In December 2022, Vancouver International Airport (YVR) experienced severe winter weather over seven of the busiest days of the year leading to the cancellation of 1,300 flights and travel disruption that affected more than 180,000 passengers. This included passengers on 24 aircraft who waited for more than four hours on the tarmac due to a lack of available gates. The longest duration of these aircraft being delayed from deplaning passengers was just over 11 hours.

A deep dive to identify lessons learned post-event, is a fundamental step in supporting airport resilience and strengthened service for the passenger. As such, while Vancouver Airport Authority and its partners were able to identify and address a number of systemic or procedural gaps and failures immediately after the event, a formal After-Action Review was initiated to dig deeper into what happened and then develop an action plan for how to improve going forward.

ABOUT THIS REVIEW

Vancouver Airport Authority operates YVR in service of the community and the economy that supports it. The After-Action Review was conducted with the valuable assistance of noted aviation and engineering consulting firm, Arup, along with teams from Airports

Council International (ACI), KPMG and other experts and advisors both internal and external to YVR. The review sought extensive input from various stakeholders, including Airport Authority staff and contractors, airlines, airport businesses, government agencies, ground handlers and regional airports, with the goal of better understanding how events unfolded. The Airport Authority also conducted a public engagement program undertaken by public engagement consultants, Kirk & Co. to hear directly from passengers and the public.

THE WEATHER

The weather over the event period included a combination of snow, freezing rain, low temperatures, and fog. The snow and fog led to periods of reduced visibility while the cold temperatures over such a sustained period were seasonably unusual at YVR. Snowfall came in three waves, the first through December 18th which was followed by a much more significant snowfall over the night of December 19th. Finally, a third snowfall was observed on the morning of December 23rd.

OVERARCHING FINDINGS

There was no single root cause but rather a combination of complex factors that came together to contribute to the operational challenges over a busy travel week,

negatively affecting passengers. The heart of the event and the severe disruption that followed was essentially a case of passenger and aircraft demand exceeding processing capacity due to winter weather conditions at YVR. This led to a cycle of delays, cancellations, queues, and congestion which in turn further limited airport operations and even further limited options for travellers. The processing capacity, whether it was

gates, aircraft de-icing, snow clearance, or other areas of the operation was itself impacted by a range of factors, such as quality or accuracy of information, timely decision-making and communications across partners and agencies, and equipment availability and performance under the weather conditions.

KEY SERVICE ISSUES

- 1 Tarmac Delays** - Passengers experienced long tarmac delays on arriving aircraft as well as departing aircraft that were unable to take off and had to return to a gate.
- 2 Terminal Congestion and Passenger Information Availability** - The terminal became heavily congested with stranded passengers and the information available to those passengers was inaccurate and inconsistent.
- 3 Baggage Handling and Repatriation** - Arriving passengers and passengers whose flights had been cancelled experienced long wait times for their bags. Service for those with missing bags was inconsistent and information available was inadequate.
- 4 Public Communications** - The Airport Authority and its partners did not provide adequate public-facing communications to convey key information to travellers and others who needed it on a consistent and timely basis.

ACTION ITEMS

- 1 Enhance Winter and Irregular Operations Plan** – To bolster overall preparedness, the Airport Authority will work with its partners to improve procedures, increase available winter weather equipment and de-icing fluid storage, and add new real-time weather monitoring equipment. More employees will be hired and trained, improvements will be made to how we monitor and manage aircraft flow with new technologies and data, and new gate protocols will ensure arriving aircraft can deplane passengers within 30 minutes of taxiing off the runway. A new baggage system will also be implemented to allow the Airport Authority to provide passengers with timely, accurate information about the status of their baggage.

- 2 Enhance Cross-Team Collaboration** - To enhance service and supports for passengers, establish a dedicated team from across the Airport Authority and partners. This will provide more information and data sharing, collaboration, and decision-making between key members of the airport ecosystem.

- 3 Accelerate Investments in Technology and Data** – To allow the Airport Authority and its partners to make informed decisions based on reliable information, continue to invest in YVR’s Digital Twin platform to better monitor and capture data in real-time. This includes a digital apron management tool to better prioritize aircraft handling services as well as an improved ability to track delayed baggage.

- 4 Enhance In-Terminal Passenger Supports** - Increase levels of trained staff available to support passengers as well as improve the quality, frequency, and channels of communications directly to passengers in the terminal about resources available, including accessibility services. More staff will be trained to support travellers directly with better information.

- 5 Enhance Communications to Passengers and Public** – Strengthen communications to the public and travellers both from the Airport Authority and in coordination with our partners and other organizations. This includes implementing new ways to provide updates and information as well as adhering to new standards for how often and where the Airport Authority will share information. We will also make better use of our website and leverage stakeholders, partners, and other organizations to get people the updates they need in a more reliable and consistent way.

CONCLUSION

Overall, the severe winter weather that occurred at YVR in December 2022 had a significant impact on passengers, airlines, and airport staff. The After-Action Review conducted by the Airport Authority brought together input from various stakeholders to identify the root causes of the disruption and make recommendations for improving the airport's resilience and capability to react to future exceptional events.

The findings of the review, combined with feedback from the public and passengers, will help the airport ecosystem better anticipate, prepare for, and mitigate similar adverse circumstances. By implementing the Action Items and addressing the root causes of the service failures, the Airport Authority can deliver a better and more predictable service to passengers during future adverse weather events and unplanned disruption to travel.

DETAILED REPORTS & FINDINGS

REPORT INTRODUCTION

In December 2022, YVR experienced severe winter weather that led to the cancellation of 1,300 flights out of approximately 4,100 scheduled flights between December 18th to 24th. This disruption affected more than 180,000 passengers, causing them significant inconvenience at a key time of year for travel. The situation also impacted airline operations extending well beyond YVR, which was made worse by additional winter weather impacts at many other airports across Canada and the United States that also experienced significant disruptions during the same period. Airport Authority employees, as well as those of airport partners, airlines, ground handlers and agencies worked long hours under significant pressure and stress.

As such, in addition to the usual internal debriefs that occur after any event, Vancouver Airport Authority initiated a formal After-Action Review. This work was conducted with the valuable assistance of noted aviation and engineering consulting firm, Arup, along with teams from Airports Council International (ACI), KPMG and other experts and advisors both internal and external to YVR. The review sought extensive input from various stakeholders, including Airport Authority employees and contractors, airlines, airport businesses, government agencies, ground handlers, and regional airports, with the goal of better understanding how and why events unfolded as they did. The Airport Authority also conducted a public engagement program undertaken by public engagement consultants, Kirk & Co. to hear directly from passengers and the public.

The findings of these reviews have helped identify the root causes that led to the disrupted passenger experience and are enabling the Airport Authority and its partners to learn and transform operations and responses to better anticipate, prepare for, and mitigate similar adverse circumstances and ensure all are well equipped to respond, adapt, and recover in the interest of passengers.

Although this review arose from the events in December 2022, the ability for the Airport Authority and its partners to deal effectively during other future events is a measure of its organizational resilience. While the report focuses on winter weather response, there are wider lessons that will also enhance the organization's resilience and capability to react to other exceptional events.

EVENT CONTEXT AND WEATHER

On December 16th, a winter weather event briefing was held at YVR bringing together airlines, ground handlers, agencies, and airport contract partners. At a high level, the forecasts presented correctly identified a risk of severe snowfall and cold temperatures. However, those forecasts, and subsequent updates, significantly underestimated the snowfall intensity that would occur on December 20th and overestimated the intensity that would come later in the week. The weather during the event period included a combination of snow, freezing rain, low

temperatures, and fog. The snow and fog led to periods of much-reduced visibility, while the cold temperatures were seasonably unusual at YVR for such a sustained period. Snowfall came in three waves, the first through December 18th which was followed by a much more significant snowfall over the night of December 19th. The third wave was observed on the morning of December 23rd. A detailed analysis of the weather during the event period can be found in the appendix.

OVERARCHING FINDINGS OBSERVATIONS

There was no single root cause, but rather a combination of complex factors came together to contribute to the situation. The heart of the event and the severe disruption that followed was essentially a case of passenger and aircraft demand exceeding limited processing capacity due to severe winter weather conditions at YVR. This led to a cycle of delays, cancellations, queues, and congestion which in turn further limited airport operations. The processing capacity, whether it was at gates, aircraft de-icing, snow clearance, or other areas was itself impacted by a range of factors, such as quality or accuracy of information, decision-making and communications across partners, and equipment availability or performance under the weather conditions. Overall, the response of the Airport Authority and its partners as a system revealed a number of areas for improvement across a wide range of the operation.

SUMMARY OF KEY SERVICE ISSUES

The results of the review as well as the public and passenger engagement can be summarized into four key service issues:

- 1 Tarmac Delays** - Passengers experienced long tarmac delays on arriving aircraft and some on departing aircraft that were unable to take off.
- 2 Terminal Congestion and Passenger Information Availability** - The terminal became heavily congested with stranded passengers and the information available to those passengers was inaccurate and inconsistent.
- 3 Baggage Handling and Repatriation** - Arriving passengers and passengers whose flights had been cancelled experienced long wait times for their bags, and the bag repatriation service for those whose bags were missing was inconsistent and the information available was inadequate.
- 4 Public Communications** - The Airport Authority and its partners did not ensure adequate public-facing communications to provide key information to passengers and others who needed it on a consistent and timely basis.

1 KEY SERVICE ISSUE Tarmac Delays

Twenty-four passenger flights experienced wait times of more than four hours for passenger disembarkation due to a lack of gate availability. The longest of those wait times was 11 hours, 14 minutes. The adverse weather conditions made the use of

contingency disembarkation methods such as remote stand operations unsafe. As a result, passengers remained on aircraft while the Airport Authority and partners tried to de-congest the airfield and get aircraft moving onto gates.

CONTRIBUTING FACTORS

- There was a lack of a singular picture of aircraft on the ground that would have informed the Airport Authority, airlines, and partners on how long passengers had been waiting. This made it difficult to prioritize aircraft disembarkation by wait time.
- The Airport Authority's Demand Management Plan (DMP) did not take into consideration the potential for extended periods of zero departures. The combination of tarmac delays for returning as well as arriving aircraft quickly led to full parking stands, which were made worse by communication breakdowns between partners.
- Periods of heavy snow resulted in safety-mandated periods of no departures due to loss of holdover time (HOT) for de-iced aircraft. The combination of sub-freezing temperatures and intense snowfall resulted in holdover time being too short for aircraft to taxi to a runway and safely get airborne based on Transport Canada regulations. There were also periods where extreme weather meant HOT were non-existent and aircraft de-icing fluid (ADF) was no longer effective against the severe weather conditions. These aircraft then had to return to gates, however there were no gates available.
- While runways and taxiways were kept clear, snow clearing efforts in other areas of the airfield such as access to airline hangars and aprons were sometimes delayed and inconsistent. Snow removal priority on Aprons was focused on clearing the lead in lines that pilots and ground crews rely on to properly position aircraft at gates. However, this did not prioritize clearing the service side (right side) of aircraft that ground handlers need to access the aircraft more easily for baggage loading/unloading. Additionally, snow clearing at gates was request-based.
- Aircraft demand management was a significant factor in the disruptions. Runways and taxiways were clear and in good condition, so aircraft continued to arrive, while at the same time, few aircraft were departing. This imbalance between arriving and departing aircraft lead to congestion on the airfield. This congestion was compounded due to the lack of a pre-determined contingency plan for remote parking of aircraft. The demand management team faced several cascading issues that impacted operations, including communication breakdown between airlines, ground handlers, and the Airport Authority. Despite demand management plans, a rolling ground stop, and the issuance of the Notice to Air Missions (NOTAM), there were still significant issues managing demand throughout this event.
- Gates were full of empty aircraft as there were not enough tow crews available to make way for incoming or returning aircraft. Airlines were continually asked by the Airport Authority to tow empty aircraft off gates to make room for arrivals and returning aircraft, however ground handler staffing (particularly on December 19th and 20th) was a challenge due to the weather and the ability of crews to get to the airport.
- Although not a contributing factor in overall tarmac delays, there was commentary both during and following the event pertaining to supply levels of Aircraft De-icing Fluid (ADF). The volume and type of snow accumulation on aircraft, particularly on December 21st meant ADF stock levels were being depleted quickly during the event. However, daily deliveries of ADF were received at YVR and at no time did the Airport Authority run out of ADF.

2 KEY SERVICE ISSUE

Terminal Congestion and Information Availability

The terminal became heavily congested with passengers remaining at the airport, and the information available to those passengers was inaccurate and inconsistent.

CONTRIBUTING FACTORS

- The weather conditions and resulting flight cancellations led to many passengers being effectively stranded in the terminal. The severity, scale and longevity of the event was not foreseen; therefore, the Airport Authority had to bring in additional supplies to support the wellbeing of stranded passengers, such as water, snacks, cots, blankets, baby formula and diapers. When it became clear that this event was going to last for some time over the holiday period, the Airport Authority assessed options to best care for those who had to spend the night in the terminal. The Airport Authority worked with the Red Cross to set up a designated 'Care and Comfort' rest area with approximately 600 cots. It also took the extraordinary step of booking more than 400 nearby hotel rooms to provide at no cost to passengers who would otherwise be waiting days for connecting flights to continue on their journey.
- The information available to passengers about their flights and next steps was inadequate, leading to confusion and frustration as evidenced by many reports that airlines were not keeping public-facing flight information up to date. If airlines did not manually inform the Airport Authority of updated departure cancellations, the Flight Information Displays (FIDS) within the terminal and on yvr.ca would indicate a flight was 'delayed' instead of 'cancelled'. Airport Authority staff were unclear on what to tell passengers given the confusion around information on the FIDS. Furthermore, when passengers could not connect with their airline by phone or their website, many thought the next best alternative was to rebook a flight at the airport, which added to in-terminal congestion and put further strain on airport resources.
- Road network conditions across Metro Vancouver were poor, making it difficult for taxis, rideshare and personal vehicles to access the airport. Therefore, many passengers who wanted to leave the airport were unable to do so, which compounded congestion in the terminal. For the most part, the Canada Line was operational albeit with some delays during the event as well as the fact trains do not operate during overnight hours.

3 KEY SERVICE ISSUE

Baggage Handling and Reunification

Passengers whose flights were cancelled or delayed experienced long wait times for their bags and the reunification service for missing bags was inconsistent. The information available to passengers about the status of their baggage was also inadequate.

CONTRIBUTING FACTORS

- Airline resources for baggage handling and offloading arriving aircraft were limited due to the high number of cancelled and delayed flights as evidenced by the reports that, given limited resources, the ground handlers' priority was getting outbound flights on their way.
- There was a lack of communication between all parties resulting in confusion about which bags should be offloaded from aircraft, as evidenced by reports from the Airport Authority Baggage team that they needed to communicate with both airlines and handlers, which took more time and inherently risked mixed messages. Other service providers offered to assist with inbound baggage, but contractual issues limited what they were permitted to do.
- Ground handlers experienced delays getting access to the aircraft due to snow accumulation at the gates. This added to passenger wait times for bags.
- The information available to passengers about the location of their baggage was inadequate, leading to frustration and confusion. Systems designed to provide information to both passengers and Airport Authority partners such as the Flight Information Displays (FIDS) were not regularly updated. Additionally, as has historically been the case, the Baggage Processed Message System (BPM) used by airlines and their handlers was not accessible to the Airport Authority. All of this meant the Airport Authority only had a partial view of the end-to-end baggage situation. This was further exacerbated by the fact that in an effort to get bags to passengers as quickly as possible, bags were put on any carousel with available space, so passengers did not know which carousel to go to. All of this meant ongoing baggage congestion and significant delays in baggage reunification with passengers.

4 KEY SERVICE ISSUE Public Communications

In order to capture the voice of the traveller, further to the After-Action Review, the Airport Authority initiated a public engagement process to hear directly from passengers and the public impacted by the travel disruption. The goal was to hear specifically how people were affected, and what actions the airport and its partners can take to better support and inform travellers during times of major travel disruption.

The public and traveler engagement (the “Public Engagement”), conducted by Kirk & Co. Consulting Ltd, a nationally-recognized public engagement firm, also included opinion research from Leger Marketing Inc. and a variety of engagement methods, including an online feedback form, a key stakeholder meeting, three focus groups and polling. The Public Engagement was conducted in two phases between January and March 2023 and included a total of 1547 participant interactions.

YVR KEY TAKEAWAYS

- 1 The public expects airports, airlines, and other relevant organizations to work seamlessly together and during times of major travel disruption — they do not care who is responsible for what.
- 2 Travellers want and expect to receive timely and accurate information. They look to the Airport Authority to help lead in bringing information together across the different organizations, so that people can be better supported and make informed decisions during significant travel disruptions.
- 3 Overall, a lack of effective and timely communications, excessive tarmac delays, extended airport stays, baggage issues, and a lack of adequate in-person supports were the biggest issues identified in the Public Engagement.

EXCERPTS FROM PUBLIC ENGAGEMENT SUMMARY REPORT

[Click here to read the full Kirk & Co. Public & Traveller Engagement Summary Report](#)

- 81% of those directly impacted by the situation found the performance of YVR on providing timely information updates less than or much less than acceptable.
- Impacted travellers and general public alike were largely critical of the performance of the airport and its partners during the extreme weather event with 69% indicating the holiday travel period had impacted their perception of YVR in a negative way.
- 86% of engagement participants want to receive information from a single source (where possible).

80%

of engagement participants say the following types of information would have been “very useful”:

- More frequent flight information and airport operation updates
 - Amount of time anticipated until the next update on the status of a flight
 - Guidance on whether to come to the airport given ongoing uncertainty about flight departures and arrivals
 - Services and support available at the airport for the duration of travel disruptions (e.g., food, water, blankets, care and comfort areas, rest areas, etc.)
- More than three-quarters (78%) of engagement participants impacted by delayed or lost baggage rated YVR’s efforts to assist them in finding their bags as less than acceptable.
 - About 1-in-5 (21%) reported a transportation issue such as public transit, not being able to get a taxi/rideshare, or experienced a parking related issue.
 - Approximately 5% reported having accessibility issues and rated YVR’s efforts to support them as less than acceptable.



65% OF BRITISH COLUMBIANS

have a favourable overall perception of YVR and want to see YVR use this as an opportunity to improve.

ACTION PLAN

Based on the key service issues identified above, we, the Airport Authority, have developed a clear action plan designed to address the operational and communications issues outlined in this report.

1 ENHANCE WINTER AND IRREGULAR OPERATIONS PLAN

Despite today's overall passenger numbers remaining slightly behind 2019 figures, changing travel patterns means YVR now has busier peak periods during the day where the volume of passengers in terminal and the number of operating aircraft is greater than pre-pandemic. Additionally, extreme weather events such as those experienced in December 2022 are becoming more common. This requires us to improve airport infrastructure and work with our partners to enhance procedures, increase available equipment, bolster overall preparedness, and increase training, to help manage more effectively through severe weather events and irregular operations.

ACTIONS BEING TAKEN

- We are training more staff and creating designated teams to focus on key aspects of winter and irregular operations, including adding trained staff for snow clearing and a new team to monitor and actively manage the flow of aircraft arrivals and departures to balance demand against capacity.
- We are increasing infrastructure and equipment to manage the effects of winter weather, including de-icing and snow clearing equipment, and storage for de-icing fluids.
- We are implementing new processes and enhancing capabilities to ensure coordination and real-time insight into flight and gate scheduling:
 - Improving our Demand Management Plan to allow teams to manage arrivals and departures and mitigate airfield congestion more effectively.
 - Introducing gate protection protocols to maintain gate availability and ensure arriving aircraft can deplane passengers within 30 minutes from time of taxiing off the runway; and, in periods when flights are at risk of not being able to depart, to ensure there is a gate available for deplaning.
 - Improving weather monitoring and forecasting tools to provide additional data to activate and modify winter weather plans to match evolving conditions.
- We are introducing baggage disruption protocols that will be triggered when passengers arrive at YVR separate from their checked bags during a disruption event. This will transfer all affected bags into a new YVR-managed system and will allow us to provide passengers with timely, accurate information about the status of their bags at YVR.

2 ENHANCE CROSS-TEAM COLLABORATION ACROSS YVR AND PARTNERS

While delivering a passenger and their bag safely and efficiently requires complex processes and the alignment of many organizations and people, we recognize that passengers expect a seamless experience to, through and from YVR. This requires a collaborative and integrated approach to bring together all parts of the airport ecosystem and serve the passenger as “one YVR”.

ACTIONS BEING TAKEN

- We are establishing a dedicated cross-functional planning team focused on winter and irregular operations.
- We have enhanced our baggage support services, increasing support available for airlines to reunite passengers with their bags during service disruptions. This includes improved data sharing with major Canadian airports and adding trained staff to assist airlines and handlers with baggage processes.
- We are scheduling quarterly training exercises with involvement from our airline and agency partners as well as emergency response agencies to rehearse procedures and ensure better alignment.
- We will amend licensing and use agreements for third party service providers such as ground handlers to include key performance measures such as equipment availability and up-time, staffing levels, and operational resiliency plans.

3 ACCELERATE INVESTMENTS IN TECHNOLOGY AND DATA

In the fast-moving and highly complex environment of airport management, access to comprehensive, up-to-date, and reliable data is key to effective operations. Through our recently developed Digital Twin, a virtual replica of YVR's terminal and airfield, we are building the capability to capture and monitor real-time operational data and develop meaningful service-focused tools to drive a better passenger experience. However, there is more work to do to expand sensors, data feeds and access to create a single source of the truth to support the decisions made by all members of the YVR airport community - carriers, passengers, concessionaires, airport controllers, etc. Going forward we will better leverage this technology, particularly during significant service disruption periods.

ACTIONS BEING TAKEN

- We are accelerating investment in YVR's Digital Twin to link real-time flight radar, ground tracking (MLAT) and video monitoring data to track aircraft movements and on-time performance. This will allow us to accurately track and gate aircraft in real-time especially in the event of weather or other disruptions. Integration of real-time data on the Digital Twin platform will enable all parts of the airport community to use the same up-to-date data to make resource and operational decisions.
- We are accelerating the delivery and integration of our digital apron management center to actively manage aircraft and aircraft handling services by the Airport Authority and its partners. This will provide an additional real-time tool to accurately track and prioritize aircraft waiting for gates.
- We are accelerating the deployment of digital sensors to measure and track passenger flow at key points in the terminal such as pre-board screening (CATSA) to ensure passenger flow is maintained (85% of passengers being screened in 15 minutes or less). This can be used to make staffing adjustments and process improvements to ensure the efficient movement and flow of passengers – especially during peak hours and during weather events.
- We are augmenting our Flight Information Display System (FIDS) with additional publicly available data feeds such as Flight Aware so we are not reliant on manual updates of information.
- We are working with aviation industry stakeholders such as airlines, NAVCANADA and airports to create opportunities to share data and information across the ecosystem for the overall benefit of the passenger.

4 ENHANCE IN-TERMINAL PASSENGER SUPPORTS

YVR operates 24 hours a day, 365 days per year, which requires trained employees on shift at all times to ensure passengers get safely on their way. While we will be adding to the availability of digital and on-line information – in person service will also be enhanced. Additional staff are required to support passengers during weather events or irregular operations. We will increase levels of trained staff available to support passengers during weather events or irregular operations, as well as enhancing communications about the resources available, including accessibility services.

ACTIONS BEING TAKEN

- We are identifying and training 25% more employees to be available to support passengers in terminal. This will ensure all information counters and busy check points are fully staffed.
- YVR is already an accessible airport, and we are placing even greater emphasis on accessible services for passengers. We are adding to our Three-Year Accessibility Plan, including additional services, awareness of those services, and specific supports for accessibility needs during irregular operations or significant weather events.
- We are expanding the use of in-terminal digital displays, both to provide timely information updates and to ensure passengers are aware of services and supports available at the airport.

5 ENHANCE COMMUNICATIONS TO PASSENGERS AND PUBLIC

Passengers have access to many forms of information about their trip and flight. We recognize the need to strengthen not only our own communications, but also ensure much greater coordination across the entire airport ecosystem, in order to meet the information requirements of passengers and the public.

ACTIONS BEING TAKEN

- We are creating an enhanced Irregular Operations Communications Group (IOCG). The IOCG will be activated during major events, and will include representatives from the Airport Authority, airlines, government agencies, emergency services, and other partners. The IOCG will work to establish agreed protocols for coordination of information sharing across group members, in order to provide accurate and systematically updated information to the public and passengers and coordinated amplification of that messaging across partner networks.

- We have established standard key performance indicators for communicating information. These KPIs outline requirements for how, when, and where we provide updates through established communications channels to keep passengers and the public informed of our current operating status. KPIs include posting an update to YVR.ca and social media at a minimum of every 90 minutes, 24 hours a day, seven days per week for the duration of a major event. Posts will include timing of the next update to ensure passengers and the public know they are seeing the latest information available.
- We are implementing a dedicated resource hub on YVR.ca that will be activated during major events and supported via social media. This dedicated site connected to YVR.ca will serve as a central hub bringing together key information for passengers in one easy-to-find online location. This will include the latest updates on operating status, information on getting to and from the airport, accessibility services available, relevant contact information, and answers to frequently asked questions.
- We will enhance information available at the airport. As mentioned in the previous section, this includes better leveraging digital screens throughout the terminal, at gates, at information counters and elsewhere to provide latest updates for passengers.
- To ensure people can better access information both through digital means and directly from employees in-person, we are also putting in place measures to ensure our Guest Experience team, Green Coat volunteers, and front-line staff from across the airport community have the latest information in order to better support passengers.
- Finally, we will regularly collect and report on key performance indicators for the airport including On-Time Performance (OTP), airport baggage system operations and processing times, and pre-board screening (CATSA) processing times.

YVR ACTION PLAN: TIMELINES

	COMPLETED	IN PROGRESS COMPLETION 2023
Enhance Winter and Irregular Operations Plan		
More trained staff		✓
Introduce designated winter and irregular operations teams		✓
Increase de-icing equipment and expanded storage		✓
Increase snow removal equipment		✓
Improve Demand Management Plan		✓
Introduce gate protection protocols	✓	
Improve weather monitoring and forecasting		✓
Introduce baggage disruption protocols	✓	
Enhance cross-team collaboration		
Establish cross-functional planning team		✓
Introduce baggage support services and data sharing	✓	
Introduce quarterly multi-agency training exercises		✓
Amend agreements with 3 rd party service providers to include key performance measures		✓
Accelerate investments in technology and data		
Accelerate use cases for YVR's digital twin to make real-time data-driven decisions across YVR operations		✓
Accelerate digital apron management program	✓	
Accelerate the connection of baggage data		✓
Use of digital sensors to enable more efficient passenger flow	✓	
Enhance support for passengers in terminal		
More trained staff available for passengers 24 hours per day		✓
Increase emphasis on available accessibility services	✓	
Bolster 3-year Accessibility Plan with additional services and supports		✓
Increase use of digital displays to highlight accessibility services	✓	
Increase communications to passengers and public		
Irregular Operations Communications Group (IOCG)		✓
Establish standard key performance indicators for more frequent information updates	✓	
Introduce new communications tools including dedicated online hub		✓
Enhance information available at the airport	✓	
Regular reporting of on-time, baggage, and passenger screening performance		✓

CONCLUSION

Overall, the severe winter weather that occurred at Vancouver International Airport in December 2022 had a significant impact on passengers, airlines, and Airport Authority employees. The cancellation and delay of over 1,300 flights led to disruption for over 180,000 passengers and had network implications beyond the airport. The After-Action Review conducted by the Airport Authority brought together input from various stakeholders to identify the root causes of the disruption and make recommendations for improving the airport's resilience and capability to react to future exceptional events.

The review identified four areas of key service issues: tarmac delays, baggage handling and reunification, terminal congestion and information availability, and public communications. Contributing factors to

these key service issues included a lack of shared information between all parties, inadequate contingency plans for extended periods of zero departures, a lack of tow crew availability, and poor communication and coordination between the Airport Authority, airlines, and ground handlers.

The findings of the review, combined with feedback from the public and passengers, will help the airport ecosystem to better anticipate, prepare for, and mitigate similar adverse circumstances. By implementing the recommendations and addressing the root causes of the service failures, the airport can deliver a better and more predictable service to passengers through any future adverse weather events and any other unplanned disruption to travel.

Appendix

EVENT TIMELINE HIGHLIGHTS



December 16th

- Winter weather briefing held with Vancouver Airport Authority team and partners

December 17th

- Departure Management Plan (DMP) issued

December 18th

- DMP not fully adhered to by airlines, leading to congestion airside and line-ups for deicing
- Thundersnow and lightning prompts safety-related operational pauses
- 77% of originally scheduled flights operated

December 19th

- Weather situation deteriorates, airfield congestion continues
- YVR Emergency Operations Center (EOC) officially activated
- Additional DMPs issued to reduce departures
- Worsening snowfall impacts ability of aircraft to depart due to de-icing holdover time (HOT) regulations
- YVR employees began distributing water and snacks to passengers in terminal
- 81% of originally scheduled flights operated



December 20th

- Passengers held on aircraft due to lack of available gates and inability to tow empty aircraft
- Full ground stop initiated overnight.
- 37% of originally scheduled flights operated

December 21st

- Notice to Air Missions (NOTAM) issued limiting international arrivals on non-Canadian-registered aircraft for 48 hours to restore balance between arriving and departing aircraft
- 74% of originally scheduled flights operated

December 22nd

- Airport terminal congestion improves.
- 80% of originally scheduled flights operated

December 23rd

- Third snowfall event along with freezing rain
- Additional DMP issued to reduce departures
- 44% of originally scheduled flights operated.

December 24th

- YVR's snow desk deactivated

December 25th

- EOC deactivated

ABOUT VANCOUVER INTERNATIONAL AIRPORT

Vancouver International Airport (YVR) first opened in 1931. It is located on Sea Island in Richmond, British Columbia 15 kilometres from downtown Vancouver. YVR is on lands traditionally occupied by the Musqueam People. The airport occupies approximately 1,340 hectares of federal property. Vancouver Airport Authority, which was first established in 1992, has an 80-year lease with Transport Canada to operate YVR.

YVR has two main runways that run parallel and oriented in an east-west direction, the North Runway (08L-26R) and South Runway (08R-26L). There is also a Crosswind Runway (13-31).

Made up of two terminals, the Main Terminal at YVR has five piers and supports the majority of airline services. The second terminal, the South Terminal, focuses on regional air traffic. YVR is designated as Level 3 coordinated airport under the IATA World Slot Guidelines, which allows them to allocate slots to airlines and other aircraft operators as a means of managing the declared capacity of the airport. The Airport Authority currently manages capacity based on aircraft stands and terminal asset availability (check-in counters and baggage

piers). Slot requests are processed by YVR using a specialized software (SCORE) and the approved flight schedule is then optimized in another software (AMS) which builds in airport configuration, stand capability and existing protocols related preferential or priority agreements. Slots are approved and aircraft are subsequently planned on specific stands. As airline schedules are always subject to change, actual gate assignments are planned for a rolling 48-hour period. There are several complexities to managing aircraft stands as the daily plan is based on adherence to planned arrival and departure time and not all stands are capable of all aircraft types. Some level of resilience in the planned schedule is required to allow for changes from originally planned schedules or availability of stands due to maintenance. As this is entirely dependent on adherence to planned schedule, real-time management of aircraft stands is active 24 hours a day, seven days a week in the Integrated Operations Centre (IOC).

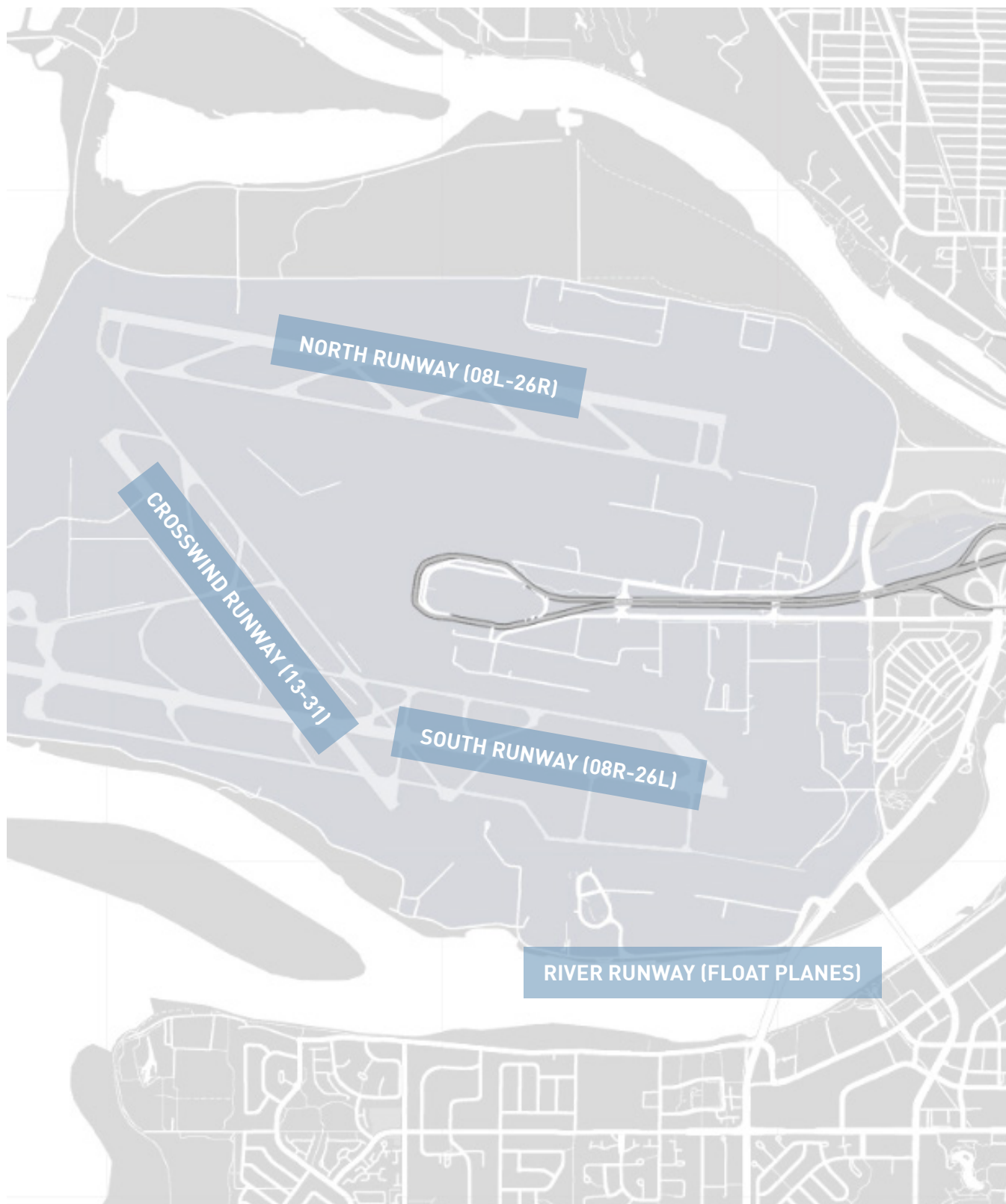


Figure 1 - YVR Runways

KEY STATISTICS

	2019	2022
Movement and Passengers		
Annual aircraft movements (runway)	289,533	230,162
Annual number of passengers (enplaned and deplaned)	26,379,870	19,013,416
Percentage of international passengers	27.6%	21.3%
Percentage of domestic passengers	48.1%	55.7%
Percentage of transborder passengers	24.3%	23%
Airside Infrastructure		
Number of aircraft stands ¹		
Domestic – contact		39
Domestic – non-contact		4
Domestic/International swing – contact		6
International – contact		13
International/Transborder swing – contact		6
International/Transborder swing – non-contact		11
Transborder – contact		17
Transborder – non-contact		13
De-icing stands		11 (dependent on mix of narrow/widebody aircraft)
Number of de-icing vehicles		22
De/anti-icing fluid storage		
Type I Concentrate		200,000 litres of fixed storage
Type IV		185,000 litres of fixed storage
Destinations and Airlines		
Number of airlines		44
Number of destinations		94

¹ Stand numbers pulled from Master Gate Capability Chart as of June 3, 2020

YVR OPERATIONS

Vancouver Airport Authority works closely with many other service providers connecting British Columbia proudly to the world. The Airport Authority's vision is "A world class sustainable airport" and its values are safety, teamwork, accountability, and innovation.

Approximately 400 different businesses, and numerous government agencies, work at YVR from the largest airline alliances to small, independent, indigenous businesses. In addition to carrying out its own responsibilities, the Airport Authority must ensure that all these organizations work together seamlessly in the interest of the safety, security and comfort of passengers and other customers. This section explains the role of each principal agent:

- Vancouver Airport Authority:** The Airport Authority is a community-based organization operating Vancouver International Airport under an 80-year lease (the Ground Lease) from the Government of Canada. The Ground Lease covers the airport infrastructure that enables airlines to operate their schedule and for passengers and cargo to arrive and depart. Specific accountabilities include:

Airbridges - The Airport Authority owns and maintains the airbridges linking aircraft to the terminal buildings. Airlines are responsible for maneuvering airbridges to the aircraft.

Airfield Maintenance – The Airport Authority is responsible for the safe and efficient operation and maintenance of runways, taxiways and aprons.

Airport Utilities – The Airport Authority manages the provision of electricity, heating, water, lighting, fire alarms,

etc. within the terminal. For tenants on leasehold lands this does not fall within the Airport Authorities responsibility.

Baggage – The Airport Authority is responsible for providing and maintaining airport terminal baggage systems. Airlines are responsible for checking in baggage and for transporting baggage between the baggage system and aircraft.

Fire Service – The Airport Authority has responsibility for aircraft rescue fire fighting services at the airport. Structural fire fighting is the responsibility of Richmond Fire Rescue, the local municipality's fire fighting service.

Flight information – The Airport Authority operates the Flight Information Display System (FIDS) in the terminals and online. Airlines are responsible for providing the data on their respective flight schedules that feeds the FIDS.

Property – contained within the Airport Authority's perimeter is a diverse range of property, including offices, airline lounges, business centres, warehouses, fuel facilities, crew reporting centres and aircraft hangars.

Retail – The Airport Authority develops, leases, and manages retail units, including car parks, shops, catering outlets, currency exchanges and car hire

Roads – The Airport Authority maintains the road network in and around the airport including two of four bridges providing access to the Sea Island.

- AERO MAG:** manages, operates, and maintains the Centralized De-icing Facility (CDF) at YVR as a single supplier

for all airlines including the positive control of aircraft and vehicles operating on the CDF, and recovery and disposal of glycol effluent.

- **Airlines:** are responsible for checking in passengers, delivering hold baggage and cargo to its destination, fueling aircraft, boarding passengers, passenger safety and on-board catering. Majority of airlines employ their ground handling agents to carry out above and below wing services including baggage, at gate maintenance, catering, and other tasks.
- **The Canadian Air Transport Security Agency (CATSA):** is responsible for security screening at designated Canadian airports and operates under provisions in the *Aeronautics Act*. CATSA is a Canadian Crown corporation created in 2002 under the *Canadian Air Transport Security Authority Act* and reports to the Government of Canada through the Minister of Transport. Screening staff are provided by a third-party provider operating under the standards set by CATSA.
- **Canadian Border Services Agency (CBSA):** manages the nation's borders by enforcing Canadian laws governing trade and travel, as well as international agreements and conventions. CBSA facilitates legitimate cross-border traffic and supports economic development while stopping people and goods that pose a potential threat to Canada.
- **Commercial Services:** individual businesses provide catering, shopping facilities, car hire, car parking and banking services.
- **NAV CANADA:** is a privately run, not-for-profit corporation that owns and operates Canada's civil air navigation system that is responsible delivering air traffic services, providing critical information, designing, and building technology, and maintaining the essential systems that help ensure the safe movement of aircraft in Canadian airspace.
- **Public Transit Operators:** TransLink is Metro Vancouver's transportation network operator, serving residents and visitors with public transit, major roads, bridges and Trip Planning. Public transit to YVR is predominantly provided by the Canada Line, a rapid transit line in Greater Vancouver that is part of the SkyTrain system connecting the airport to downtown Vancouver in under 30 minutes. Long distance busses are also provided by YVR SkyLynx. Taxis and ride app services are available from all terminals.
- **Richmond RCMP:** provides policing to YVR under contract to the Airport Authority and is also the police jurisdiction in the City of Richmond, British Columbia.
- **Transport Canada:** Transport Canada is the regulator of aviation in Canada. Its role is to develop transportation policies and legislation that provide for a high level of safety and security and support a successful, stable aviation sector in Canada.
- **U.S. Customs and Border Protection (USCBP):** Operates the pre-clearance facility at YVR providing immigration and customs services for people and goods travelling to the United States.

WEATHER AT YVR IN DECEMBER 2022

This section summarizes weather conditions observed at Vancouver International Airport between December 18th to December 25th. It examines publicly available weather station observation data by Environment Canada and NOAA (National Oceanic and Atmospheric Administration) at Vancouver International Airport. With some recordings spanning back to 1937, this data was used to determine historical weather trends at the airport location. Additionally, remote observations data by Visual Crossing in combination with the NAV CANADA METAR data provided an insight into hourly weather conditions experienced during the December 2022 event. This section also examines 5-day weather risk forecasts issued to the Airport Authority between December 13th and 22nd.

Observed temperatures were some of the lowest in recent history

December 2022 experienced the fifth coldest day in the last 50 winters, with the daily average temperature dropping below -10°C on December 22nd. The month had two cold spells. The first began on November 28th and lasted for a week and was relatively mild with daily temperatures fluctuating between -5°C and +5°C. The second began on December 18th when temperatures dropped to -6°C and continued to fall to a low of -13°C in the early morning of December 22nd. Temperatures remained below zero until the afternoon of December 23rd. This sustained period of low temperatures was unusual but not unprecedented – since 1937 there have been four other winters where temperatures have remained below -5°C for four or more days.

Snowfall came in three waves reaching approximately 4.5cm per hour

There were three separate snowstorms between December 18th and 24th. The first occurred through December 18th with the snowfall rates reaching 1cm per hour and accumulating 5cm of snow on the ground. This was followed by a much more significant snowfall over the night of December 19th, when the snowfall rate exceeded 4cm per hour producing 24cm of snow. Finally, the third snowfall was observed in the morning of December 23rd with the snowfall rates up to 1.5cm per hour and the total snow precipitation of around 8cm. A graph of precipitation is provided in Figure 5.

Freezing rain might have amplified the disruption

Such snowfalls are not particularly rare at Vancouver International Airport, with an average return period of approximately 1 in 6 years. The return period is an estimate of the likelihood of an event – a return period of 1 in 6 implies this has an estimated 17% chance of happening in any given year. However, on December 23rd, snowfall was followed by the heavy freezing rain as the temperatures rose towards 0°C. Together with the record low temperatures, this mix of significant snowfall and freezing rain might have presented an additional challenge for airport operators.

Visibility dropped to below 1 statute mile (SM) during the snowfalls

As the first snowstorm approached, visibility began to drop from 24km down to 1km in the morning of December 18th. It continued to stay low, ranging between 1km and 5km, before returning to 24–32km as the

snow subsided around 6pm on that day. Visibility once again reduced to 4km as foggy conditions were observed prior to the second snowstorm in the evening of December 19th. It further dropped to below 2km, reaching 0km at times, as the snowfall intensified overnight. Visibility stayed low for approximately 12 hours and improved to 24–48km throughout the next day. Similar drop in visibility was observed during the final snowstorm in the early hours of December 23rd. It ranged between 2–5km during snowfall and stayed below 15km until December 25th as rainy and foggy conditions continued.

Severe snowfall was forecasted prior to the event

A weather risk forecast was sourced daily from a company called 'The Weather Company' between December 13th and 22nd. The forecast included a 5-day risk outlook and a summary of any potential weather events that could impact operations of YVR. Additionally, frequent weather alerts were sent out to inform about more immediate conditions, such as visibility and snowfall warnings. A moderate snowfall of up to 2cm was initially predicted to occur on December 18th. This prediction was later revised to 1–4cm of snowfall, thereby aligning reasonably well with the observed conditions. Similarly, early forecasts identified severe snowfall to develop in the late morning of December 20th, with the potential for significant snow accumulation of up to 5cm. In the forecast issued one day before the event, the expected snowfall was significantly increased to up to 15cm; nonetheless, it still fell short from more than 20cm of snow precipitation observed on that day. Finally, a severe snowfall was predicted to occur

late on December 22nd and to continue through the morning of the next day, with the potential for up to 20cm of total snow accumulation. At a high-level, forecasts correctly identified the risk of severe snowfall and cold temperatures early on; however, forecasts significantly underestimated the snowfall intensity on December 20th and overestimated the intensity on December 22nd and 23rd. Additionally, minimum temperatures were forecasted to be -10°C, about 3°C warmer than the recorded lows during that period. It is also notable that no impact due to ice was predicted for December 23rd until the risk forecast issued two days prior, which identified freezing rain conditions following the snowstorm.

Future events and the impact of climate change

The weather conditions at Vancouver International Airport between December 18th to December 25th were characterized by sustained freezing temperatures and periods of heavy precipitation in the form of snow. While these conditions are not common, they are also not rare and currently have a 10–15% likelihood of occurring each winter. Climate change has caused and will continue to cause an increase the amount of thermal energy in the atmosphere. This results in two broad trends: an increase in mean annual air temperature and an increase in total annual precipitation. Higher mean annual temperatures produce milder winters on average; however, those winters will also experience more intense precipitation events. The combination of these two factors is projected to result in wetter winters combined with less frequent but more severe snowstorms that have the potential to cause widespread disruption.

Figure 5 - Precipitation during the period December 18th – 24th 1

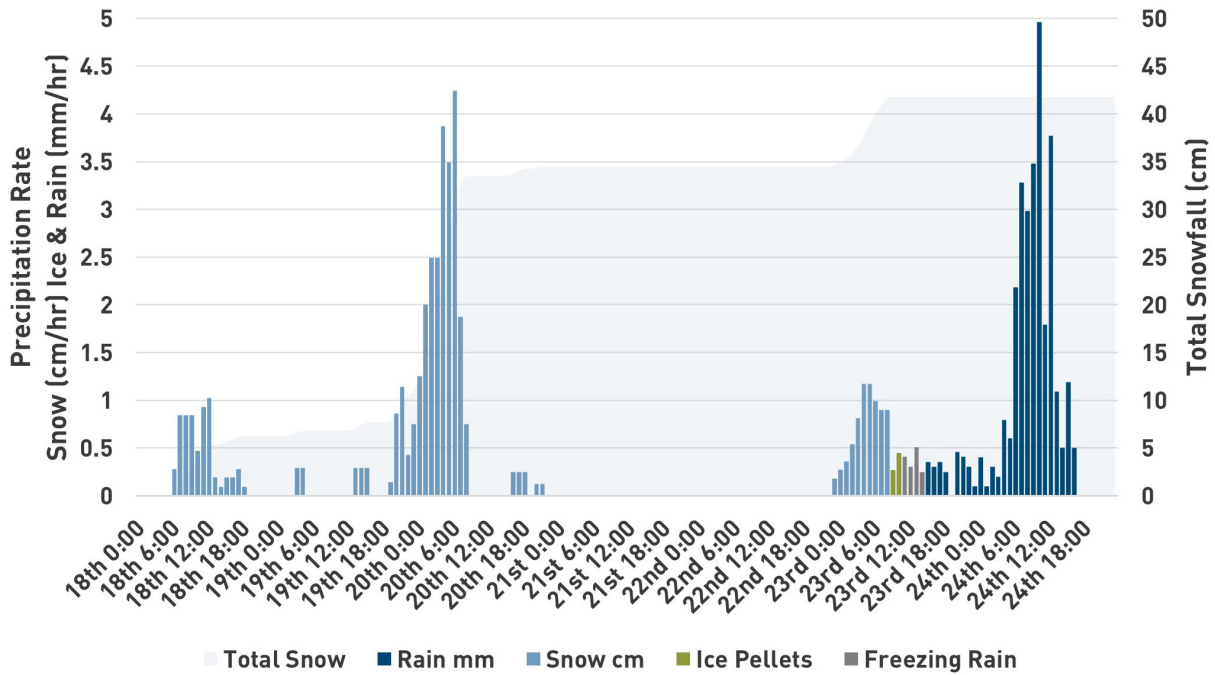
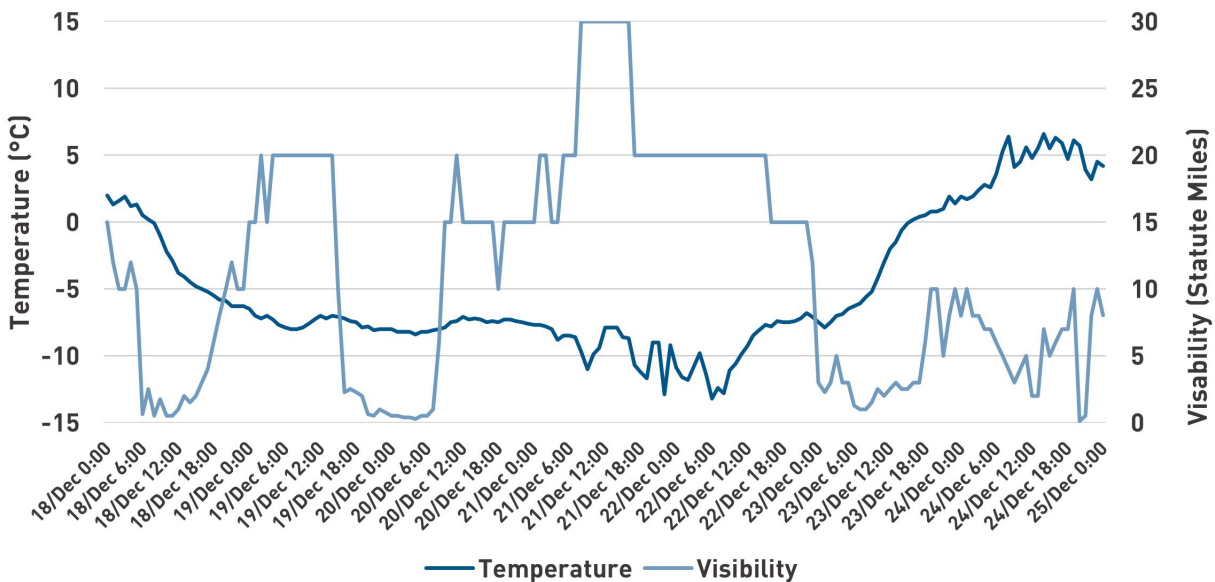


Figure 6 - Temperature and visibility during the period December 18th – 24th 2



¹ Data is based on daily snowfall and rainfall amounts reported by Environment and Climate Change Canada (ECCC) for Vancouver International Airport (Station Climate ID: 1108395). Hourly values were estimated based on ECCC hourly description of weather conditions, METAR weather reports, and remote observations (radar imagery). Total snowfall is a simple summation of hourly snowfall amounts. It does not represent ground snow depths which are impacted by snow compaction, snow melt, and snow drift.

² Data is based on hourly reported temperature and visibility values by Environment and Climate Change Canada (ECCC) for Vancouver International Airport (Station Climate ID: 1108395).

