Chapter 18

Assessment of Alternatives

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18. Assessment of Alternatives

Comprehensive Studies (CS) under Federal jurisdiction normally consider alternatives to a project and alternative means of carrying out a project. Under the *Canadian Environmental Assessment Act* (CEAA) they are listed as factors to be considered, and are both addressed within this chapter.

18.1 Assessment of Alternatives Methodology

This chapter presents the findings of the assessment of options and alternatives considered as part of the CS. Section 2 of this chapter details the assessment of alternatives to the project, such as upgrading existing facilities, modifying existing operations, upgrading other airports, or constructing a new airport. Section 3 details the assessment of alternative means of carrying out the PRP.

The following performance objectives have been used where appropriate:

- cost effectiveness;
- practicality: technical validity, reliability, and general suitability;
- minimal effects on the natural environment; and
- optimal socio-economic benefits.

Performance criteria for comparing alternatives have been classified as preferred, acceptable, or unacceptable, and are defined for each of the performance objectives as follows:

- Cost effectiveness applies to capital and operating costs:
  - **preferred** results in the maximum financial return
  - **acceptable** yields financial return less than maximum
  - **unacceptable** results in a return on investment that is too low to justify investment risk or would not cover the cost of capital and construction or would result in excessively high landing fees

- Practicality applies to the technical validity, reliability, and general suitability for the specific project situation:
  - **preferred** results in the optimal technical performance and reliability, with practical contingencies available
  - **acceptable** is less than optimum technical performance, tolerable reliability, and proven track record of application of the method or technique
  - **unacceptable** is low predicted performance or unproven application under similar circumstances

- Minimize effects to the natural environment:
  - **preferred** is negligible effects or optimal mitigation of possible adverse environmental effects
  - **acceptable** is less than optimum protection, but with potential tolerable mitigation and a proven track record
  - **unacceptable** is low predicted mitigation, with significant adverse effects likely and unproven reliability of mitigation, even if available

- Optimizing socio-economic benefits:
  - **preferred** is optimal mitigation of possible adverse socio-economic effects or provision of positive benefits
  - **acceptable** is less than optimum protection or provision of benefits, but with potential tolerable mitigation and a proven track record
  - **unacceptable** is low predicted mitigation with significant adverse effects likely and unproven reliability of mitigations, even if available

The general approach to using the criteria and objectives has been that:

- preferred or acceptable ratings must be achieved in each category for the alternative to be valid for the project;
- a high number of preferred ratings may not necessarily be the preferred overall choice; and
- all choices must meet health and safety requirements.

18.2 Alternatives to the Project

18.2.1 Do Nothing

A "do-nothing" scenario is the future projection of YYC operations if the new runway is not built (see Volume IV, Chapter 2).

Six scenarios were considered and compared in conducting the Effects Assessments (Volume III):

- pre-construction conditions;
- construction conditions;
- conditions in 2015 with the new runway in place;
- conditions in 2015 without the new runway;
- conditions in 2025 with the new runway in place; and
- conditions in 2025 without the new runway.

As a result, an assessment of the "do-nothing" scenario has been included within each Chapter of the Effects Assessment and is, therefore, not assessed as an alternative in this Chapter.

The outcome of the 2015 "do-nothing" scenario indicated that the existing airfield (complete with all planned taxiway enhancements) would be unable to accommodate the 2015 busy day demand, and that delays would thus be at levels that are unacceptable (15 minutes or more at certain times of the day). The simulation model demonstrated that the level of projected delays is well beyond the accepted criteria (Airbiz 2009). The simulation model suggested that, in 2015, without the parallel runway in place, average delays in the afternoon and evening periods could be over 60 minutes for arriving aircraft and 7 minutes for departing aircraft.

As the modelling showed significant delay at 2015 demand levels, the "do-nothing" scenario for 2025 was not modelled. However, delays in the airport system behave as queuing systems; whereas demand increases above a threshold, delays will increase at an exponential rate.

18.2.2 Upgrade Other Airports and Divert Air Traffic

18.2.2.1 Springbank Airport

Springbank Airport is a reliever airport for YYC and is operated by the Calgary Airport Authority under long term lease from the federal government. Located in Rocky View County, west of the City of Calgary, it is the closest certified aerodrome to Cochrane, Kananaskis Country, and Banff National Park. Springbank provides a wide range of commercial and private aircraft services, and has become home for all levels of flight training activity, charter activities, and private and recreational flying.

Springbank Airport is classified as a certified aerodrome by Transport Canada (TC) and currently has two operational runways:

- Runway 16/34 – 5,000’ x 100’ (asphalt); and
- Runway 07/25 – 3,423’ x 100’ (asphalt).

Jet aircraft are permitted between 07:00 - 23:00 local time and must be Chapter 3 compliant. The airport pavement is restricted to a maximum of 30,000 lbs. The current plans for Springbank Airport anticipate upgrades to the existing airfield infrastructure, provision for a future 16R-34L parallel runway when required, and ongoing, incremental development of aviation-related business.

Springbank Airport acts as a reliever airport for YYC and has taken an increasing proportion of general aviation traffic from YYC over the years. A fundamental component of its role is to provide a base for smaller aircraft within the Calgary Region. In contrast, the role and future development of YYC is focused on supporting passenger, airline, air cargo, corporate, and other complementary aerospace activities and associated services (Springbank Master Plan 2009). The role statement states ‘the operations and development of Springbank Airport will be directed to supporting light aircraft flight activity including flight training, recreational flying, corporate and air charter activity, and compatible aircraft maintenance, manufacturing and support operations’ (Springbank Master Plan 2009).

18.2.2.2 Airdrie AirPark

The Airdrie AirPark is owned and operated by a privately held company comprising a group of primarily Calgary-based business interests (CAASS 2000), located approximately 5 km east of Airdrie on Yankee Valley Road, 33 km north of Calgary, at an elevation of 3,648 ft.

Airdrie AirPark is classified as a registered aerodrome by TC and has two runways:

- Runway 10/28 – 3,000’ x 100’ (asphalt); and
- Runway 13/31 – 4,520’ x 100’ (asphalt).

In addition to recreational flying, the Airdrie AirPark is an aircraft maintenance and overhaul facility. There is little room remaining for expansion on the existing airport property, with Yankee Valley Road to the north and limited development potential to the south restricting the runway length.

18.2.2.3 High River Regional Airport

High River Regional Airport is approximately 3.5 km to the south of the Town of High River, 66 km south of Downtown Calgary. High River is a full service town of approximately 10,000 people.

High River Regional Airport is classified as a registered aerodrome by TC and has two runways:

- Runway 06/24 – 3,000’ x 75’ (asphalt); and
- Runway 14/32 – 2,950’ x 75’ (gravel).

The High River Airport is used primarily for commercial business and pilot training, as well as for recreational flying. Future development potential for Runway 06/24 is limited to approximately 4,000 ft. due to the proximity of Highway 2 to the east. Availability of land to the south of Runway 14/32 suggests that there is some potential to extend the runway to approximately 6,000 ft. Approach and departure paths to the north are free of obstructions; however, the topography rises at the south end of Runway 14/32 on either side.

18.2.2.4 Okotoks Air Ranch

Okotoks Air Ranch is owned by Benicon Alta, Ltd. and is located within the Town of Okotoks, 3 km south of the Okotoks access road linking the Town with Highway 2.

Okotoks Air Ranch is classified as a registered aerodrome by TC and has one runway:

- Runway 16/34 – 3,025' x 75' (asphalt.gravel)

The Okotoks Air Ranch is an airport residential community, and recreational flying is the basic activity.

18.2.2.5 Red Deer Regional Airport

The Red Deer Regional Airport is a ten minute drive south of Red Deer on Highway 2A. The military built the training airfield at this site because of the predominantly good flying weather and the uncongested airspace. Both factors are still valid today. The Red Deer area boasts good flying weather over 95% of the year.

The City of Red Deer took over operation of the airport in 1965, and the Province extended the main runway 16/34 to 5,528 ft. in 1980, bringing it up to 737 standards. The ownership of the airport was taken over on 1 September, 1999 by the Red Deer Regional Airport Authority, which includes the City of Red Deer, Red Deer County, and the Red Deer Chamber of Commerce as stakeholders.

18.2.2.6 Lethbridge

The Lethbridge County Airport is approximately 5 km south of the City of Lethbridge and is owned and operated by the County of Lethbridge. The airport hosts the annual Alberta International Airshow.

The airport is a Canadian Air Transport Security Authority (CATSA) Designated Aerodrome; thus providing full passenger screening. It also serves as a regional airport, offering a number of on-site charter, maintenance, flight training, and speciality aviation services. There are roughly 40 aircraft based at the airport, including commercial, corporate, recreational, flight training, aerial spray, and rotary-wing.

18.2.2.7 Conclusion

These airports cannot be considered suitable alternatives for the diversion of scheduled international air traffic from YYC. Many of the airports do not meet the runway specifications or have appropriate security facilities to support the functions of an international airport. In particular, aircraft need longer runways at higher elevations because the density of the air is lower. Larger and heavier aircraft, such as the new Code F, require even longer runways. YYC and the regional airports mentioned above are all at relatively high elevations. A 14,000 ft. runway is necessary to accommodate the new aircraft and, within the region, YYC is the only realistic option for its location. For comparison, Denver Airport, at an even higher elevation, has a 16,000 ft. runway.

Many of the airports lack any form of effective public transport that would allow passengers wishing to travel to Calgary to use these airports as an alternate arrival point. As a result, diverting international traffic to these facilities would also require improvements to rail and roads to support the development, which would be a significant expense to the provincial and federal governments.

Diverting international traffic to airports that are primarily used for domestic, recreational, or commercial purposes would also require stakeholder and community consultation with the residents within the region. Diverting the traffic would change the role of each regional airport, which would, in turn, affect the local area. Increasing traffic at these regional airports and introducing international traffic is not consistent with the land use planning in the area. The regional airports discussed are primarily used for recreational and commercial purposes presently, and it is expected that increasing the frequency and size of aircraft arriving and departing would have adverse effects and be poorly supported by the local communities. The Airport Vicinity Protection Area around YYC has been in place since 1979 and is designed to incorporate the PRP.

The other regional airports described earlier are in rural locations, not within the boundaries of a large city. If one of the airports were expanded, effects of biophysical valued components (VCs) would almost certainly be more than they would be within a City location such as YYC. In addition, more surface travel would be necessary for users to travel to and from the airport, generating more emissions. Therefore, from an environmental perspective, expanding at YYC would be preferable. This would also be acceptable in terms of sustainability as environmental disturbance would be less and socio-economic benefits would be greater.

On this basis, diverting international and domestic scheduled airline traffic to alternate airports in southern Alberta is unacceptable in terms of cost effectiveness, practicality, minimal effects on the natural environment, and optimal socio-economic benefits.

18.2.3 Construct a New Airport

The 2004 Master Plan for YYC includes the future needs of a parallel runway to accommodate the forecasted increase in demand, and the land around YYC has been acquired to this end. Infrastructure and land use classifications have been developed assuming the presence of the PRP in the future. Land use classifications for commercial, retail, and light industrial purposes have been in place since 1979 and are consistent with the presence of the PRP.

The development of a second international airport near Calgary cannot be considered as a viable alternative to the PRP and, as such, a consideration would have substantial temporal, economic, and planning constraints.

The planning, design, approval, and construction of a second international airport near Calgary would take a substantially longer period of time than the timescale proposed for the PRP. Appropriate land would need to be acquired from private or public owners, planning and infrastructure would need to be adapted or improved, and significant stakeholder and public consultation would be required. It is anticipated, based on experience at other airports, that such a process would take between 5 and 10 years before commencement of construction. This process would also be substantially more expensive for the Authority, and it would likely have to involve City, provincial and federal funds.

The development would have a larger footprint and area of disturbance than the PRP. Infrastructure and roads would have to be built to support the planning and operation of two international airports servicing the same city. Transport corridors would need to be developed to ensure passengers could be transferred between sites effectively and that operations were not regularly disrupted.

Based on the size of YYC, a large parcel of land would have to be located. Although it is unlikely a suitable parcel would be able to be acquired, the only opportunities for large expanses of land exist outside the city in 'greenfield' sites. The development would thus have significant adverse effects on the environment. Essentially, all the operational effects of the existing YYC operations would be duplicated in a new location where no planning or infrastructure exists to support it.

From a sustainability perspective, constructing a new airport would cost more, have more adverse environmental effects, and fewer social benefits than expanding at YYC. The latter is, therefore, preferable.

In consideration of the significant constraints that this alternative would face both temporally and economically, and the substantial increase in adverse effects that would be associated with it, this approach is unacceptable in terms of cost effectiveness, practicality, minimal effects on the natural environment, and optimal socio-economic benefits.

18.2.4 Short Term Measures to Meet Demand

18.2.4.1 Upgrade Existing Facilities

The airfield capacity assessment conducted by the Authority in 1998 highlighted many operational enhancements that could be made that would improve the overall efficiency and capacity of the existing airfield system. These improvements fell into various categories, including:

- additional taxiway infrastructure to improve the flow of air traffic on the ground
- improved air traffic management by NAV CANADA
- implementing new air traffic control technology that would assist air traffic controllers in managing the operation of the airport's existing intersecting runway configuration
- rationalizing the mix of aircraft operating at YYC, given that small, "general aviation" aircraft mixed with larger, faster moving aircraft have an adverse effect on airfield capacity (NAPA 1999)

Both the Authority and NAV CANADA acted on the key recommendations coming out of this assessment, and an overall strategy evolved that focused on maximizing the efficiency of the existing airfield system, with the objective of deferring the need to construct the new runway for as long as possible. Various enhancements were made by both the Authority and NAV CANADA during subsequent years, some of which had significant and beneficial effects with regard to reducing delays and improving the efficiency of the existing airfield (see Volume II, Chapter 2, Section 2.1).

All possible upgrades, as listed in Volume IV, Chapter 2, that will increase capacity of YYC will be complete by 2015 and have been factored into the Airbiz "do-nothing" scenario. As explained in Volume IV, Chapter 2, the outcome of this scenario indicated that the existing airfield (complete with all planned improvements) would be unable to accommodate the 2015 busy day demand, and that delays would be 15 minutes or more at certain times of the day.

As all feasible improvements will have been made by 2015, there is no alternative to assess.

18.2.4.2 Modify Existing Operations

Introduce Pricing Mechanisms
Introducing pricing mechanisms, such as peak period surcharging, has been considered to manage the demand for airport facilities. By increasing landing fees during peak hours, air traffic could be diverted to off-peak periods, which would assist in accommodating the forecast air passenger movements. Peak runway pricing has been implemented at international airports, such as London airports operated by the British Airports Authority and at JFK Airport, with varying degrees of effectiveness. In the present case, peak spreading might be feasible in the short term (2015), but increasing air traffic volume would render it ineffective by 2025.

Ultimately, the cost of congestion surcharging will affect passengers, either directly through higher fares or indirectly through delays and inconvenience. Flight frequencies would be limited during peak periods, and only the larger airlines would be able to afford to operate during these times. Implementing such a strategy would be in contradiction to the principles of the Strategic Operating Plan (SOP 2008), which quotes YYC strategies as ‘optimizing all sources of commercial revenue while maintaining reasonable aeronautical fees to air carriers‘. One of the Authority’s goals is to ‘create a productive balance which produces a quality level of service at the lowest practical cost and maintain aviation fees lower than the average of other major Canadian Airports’. In addition, increased landing charges would be passed on to passengers, resulting in an adverse socio-economic effect.

Theoretically, introducing pricing mechanisms and spreading the peak operating periods through the day would reduce the environmental effects that are associated with emission from engines running while aircraft wait for takeoff clearance on congested taxiways or circling the airport waiting to land. Introducing pricing mechanisms would, therefore, be preferred in terms of minimizing the effect on the natural environment in the short term; however, it is unacceptable in terms of cost effectiveness, practicality, optimizing socio-economic benefits, and minimizing the effects on the natural environmental in the long term.

Limit Access to YYC
YYC is a Level 2 (schedules facilitated) airport, i.e., one where there is potential for congestion at some periods of the day, week, or scheduling period, which is amenable to resolution by voluntary cooperation between airlines and where a schedules facilitator has been appointed to facilitate the operations of airlines conducting services or intending to conduct services at that airport.

The activities of the schedules facilitator must at all times be neutral, transparent, and non-discriminatory. The Worldwide Scheduling Guidelines (IATA 2010) states that:

> *‘For Level 2 airports to work effectively, it is in the interests of airlines themselves to cooperate fully with this process. It may be useful for airlines to discuss and agree on local guidelines. The early review of planned schedules may reveal periods of potential congestion. The airlines concerned must be willing to make schedule adjustments in order to avoid exceeding scheduling parameters thereby avoiding the need for coordination. Voluntary exchanges of timings between airlines are encouraged.’*

If access to YYC were to be limited by allocating slots to airlines at different times of the day, it would be considered a Level 3 (coordinated) airport. The Worldwide Scheduling Guidelines (IATA 2010) states that:

> *'A coordinated airport (Level 3) is one where the expansion of capacity, in the short term, is highly improbable and congestion is at such a high level that:*
>
> - *the demand for airport infrastructure exceeds the coordination parameters during the relevant period;*
> - *attempts to resolve problems through voluntary schedule changes have failed;*
> - *airlines must have been allocated slots before they can operate at that airport.*
>
> *Because slots at a coordinated airport may not be available at peak times, it is essential that airlines operating or planning to operate there should be prepared to develop alternative plans if they are unable to acquire the exact slots that they need. There are some airports where few or even no suitable slots are available. In this case, airlines should be aware of alternative airports, which could accommodate their planned services.'*

Further, the guidelines state that all critical sub-systems should be analyzed to consider the practicalities of removing scheduling constraints through infrastructure or operational changes to avoid the situation whereby a Level 2 airport is changed to a Level 3.

Theoretically, slot allocation and spreading the peak operating periods through the day would reduce the environmental effects that are associated with emissions from engines running while aircraft wait for takeoff clearance on congested taxiways. However, it would reduce the level of service to the public, resulting in an adverse socio-economic effect. Introducing slot allocation and limiting access to YYC would, therefore, be **preferred** in terms of minimizing the effect on the natural environment in the short term; however, it is considered **unacceptable** in terms of cost effectiveness, practicality, optimizing socio-economic benefits, and minimizing the effects on the natural environment in the long term. Both methods of modifying existing operations are undesirable from a socio-economic perspective. Although offering a short term reduction in emissions by reducing congestion in the longer term and avoiding the biophysical effects of building a new runway, YYC would still become congested and emissions would increase, unless an alternative airport service would need to be provided elsewhere in the region.

18.2.5 Conclusion

Table 18-1 Assessment of Alternatives to the Project Summary

Option	Upgrade Existing Facilities	Introduce Pricing Mechanisms	Limit Access to YYC	Upgrade Other Regional Airports	Construct a New Airport
Cost Effectiveness	All possible upgrades, as detailed in Volume IV, Chapter 2, will be complete by 2015 and have been factored into the Airbiz 'do-nothing' scenario. The resulting congestion and delays will result in a return on investment that would not cover the cost of capital and construction.	This would be in contradiction of the principles of the SOP. YYC strategies should optimize all sources of commercial revenue while maintaining reasonable aeronautical fees to carriers.	This would be in contradiction of The Worldwide Scheduling Guidelines (IATA 2010), which classify YYC as a Level 2 airport. The process of increasing this to Level 3 will result in a return on investment that is too low to justify investment risk.	The airports considered are not suitable alternatives for the diversion of scheduled international air traffic from YYC and do not meet the runway specifications or security facilities to support an international function. This alternative would, therefore, result in a return on investment that is too low to justify investment risk.	This would result in an intolerable financial return as there would be key significant additional costs associated with constructing a new airport and the associated infrastructure needed to support it.
	Unacceptable	**Unacceptable**	**Unacceptable**	**Unacceptable**	**Unacceptable**
Practicality	All possible upgrades will be complete by 2015 and have been factored into the Airbiz 'do-nothing' scenario. The resulting congestion and delays will result in low predicted performance.	This would be in contradiction of the Authority's goal to 'create a productive balance that produces a quality level of service at the lowest practical cost and maintain aviation fees lower than the average of other major Canadian Airports' and it has low predicted performance and unproven application under similar circumstances.	This would be in contradiction of The Worldwide Scheduling Guidelines (IATA 2010), which classify YYC as a Level 2 airport. All critical sub-systems should be analyzed to consider the practicalities of removing scheduling constraints through infrastructure or operational changes to avoid the situation whereby a Level 2 airport is changed to a Level 3.	Many of the airports lack any form of effective public transport that would allow passengers wishing to travel to Calgary to use these airports as an alternate arrival point. Diverting international traffic to these facilities would require improvements to rail and roads to support the development.	The development of a second international airport within/ around Calgary cannot be considered as a viable alternative to the PRP and, as such, a consideration would have substantial temporal, economic, and planning constraints.
	Unacceptable	**Unacceptable**	**Unacceptable**	**Unacceptable**	**Unacceptable**

Option	Upgrade Existing Facilities	Introduce Pricing Mechanisms	Limit Access to YYC	Upgrade Other Regional Airports	Construct a New Airport
Natural Environment	All possible upgrades will be complete by 2015 and have been factored into the Airbiz 'do-nothing' scenario. The resulting congestion and increase in emissions will result in less than optimum protection of the environment.	If successful in spreading peak operating periods through the day, this would reduce emissions and optimal mitigation of possible environmental effects in the short term only.	If successful in reducing peak operating periods through the day, this would reduce emissions and optimal mitigation of possible environmental effects in the short term only.	The scale of infrastructure development that would be required to upgrade the other airports in the Calgary area to the required standard would create significant adverse effects on the environment.	The development would have significant adverse effects on the environment. All the operational effects of the existing YYC operations would be duplicated in a new location where no planning or infrastructure exists to support it.
	Acceptable	**Unacceptable**	**Unacceptable**	**Unacceptable**	**Unacceptable**
Socio-economic	All possible upgrades will be complete by 2015 and have been factored into the Airbiz 'do-nothing' scenario. The resulting congestion will result in low predicted mitigation and significant adverse effects.	The cost of congestion charging will affect passengers, either directly through higher fares or indirectly through delays and inconvenience.	A lower level of service contradicts the YYC mandate, and there would be socio-economic and environmental costs of accommodating the displaced traffic elsewhere.	Diverting the traffic would change the role of each regional airport, which would, in turn, affect the local area. Increasing traffic at these regional airports and introducing international traffic is not consistent with the land use planning in the area.	The development of a second international airport within/ around Calgary would have significant adverse socio-economic effects. All the operational effects of the existing YYC operations would be duplicated in a new location where no planning or infrastructure exists to support it.
	Unacceptable	**Unacceptable**	**Unacceptable**	**Unacceptable**	**Unacceptable**
Overall rating	**Unacceptable**	**Unacceptable**	**Unacceptable**	**Unacceptable**	**Unacceptable**

All alternatives to constructing the parallel runway discussed above are unacceptable in terms of cost effectiveness, practicality, and socio-economic considerations. The “do-nothing” scenario and upgrading existing facilities would result in increases in greenhouse gas emissions, as the time that aircraft need to spend in holding patterns increases with the exponential increase in congestion and delays that are predicted by 2015. The preferred alternative for minimizing the effects on the natural environment would be to modify existing operations in order to reduce this congestion; however, these measures are unacceptable in all other respects and would only be effective in the short term if they were to be introduced.

Constructing the parallel runway is the preferred solution to addressing the projected demand levels in 2015 and 2025 in terms of cost effectiveness, practicality, and socio-economic effects. Although there will be some residual adverse effects (Volume III: Effects Assessment), these are considered to be minor and, therefore, constructing the parallel runway project is considered acceptable in terms of minimizing the effects on the natural environment.

The methods used to assess alternatives to the PRP and alternative means of carrying out the PRP are consistent with the Authority’s policy relating to sustainability (refer to Volume III, Chapter 2, Section 2.1.2), Transport Canada’s Sustainable Development Strategy (refer to Volume III, Chapter 2, Section 2.1.1), and the City of Calgary’s Triple Bottom Line approach to sustainable decision-making.

18.2.6 Issues Raised by Stakeholders

Issue: Build the airport elsewhere

Response: The development of a second international airport near Calgary cannot be considered as a viable alternative to the PRP and, as such, a consideration would have substantial temporal, economic, and planning constraints. Based on the size of YYC, a large parcel of land would have to be located. Although it is unlikely a suitable parcel would be able to be acquired, the only opportunities for large expanses of land exist outside the city in ‘greenfield’ sites. The development would thus have significant adverse effects on the environment.

18.3 Alternative Means of Carrying out the Project

18.3.1 East-West Taxiway Alternatives

Preliminary airfield modelling analysis has revealed that a second cross-field taxiway is required in addition to Taxiway J in order to ease congestion in the vicinity of the terminal complex. It would create one-way taxi paths to eliminate head-to-head conflicts as aircraft move between the eastern and western sides of the airport. The project design team has developed project alternatives for a second cross-field taxiway with consideration of technical, functional, economic, and environmental issues. The alternatives discussed involved variations in the means by which potential designs may be carried out.

Table 18-2 Dual Taxiway Alternatives

Option/Methods	Advantages	Disadvantages
At-Grade Crossing (no dual taxiway)	• Lowest capital cost • No land required	• Airfield congestion and gridlock • Safety issues with head-to-head aircraft movements • Highest operating cost due to gridlock • Highest GHG emissions due to gridlock
New Parallel Taxiway Romeo	• No rare plants or other biophysical effects • Eliminates head-to-head conflicts for aircraft movement	• Additional land is required • Highest capital cost due to relocation of airfield infrastructure • Due to the presence of existing airfield infrastructure including the Air Canada hangar, the Aviation Fuel Tank Facility, and various cargo and aviation support facilities, construction of Taxiway R is not possible without a major redevelopment of the area
New Taxiway Foxtrot Extension	• Moderate cost • Lowest operating cost (i.e., least delays to operating aircraft) • No rare plants or other biophysical effects • Lowest GHG emissions • Eliminates head-to-head conflicts for aircraft movement	• Additional land is required • Extension of the existing Taxiway F to the east to connect the existing airfield to the new parallel runway system. The extension of Taxiway F will require the construction of a roadway underpass to allow continued public access to the McCall North Trade Park area via McCall Way

18.3.1.1 At-Grade Crossing

The performance criterion for this alternative is assessed as follows:

- Cost effectiveness is **unacceptable** because, although it has the lowest capital costs, there will be an increase in operating costs as a result of gridlock.
- Practicality is **unacceptable** because doing nothing would create airfield congestion and gridlock, which also creates concern with regards to safety issues.
- The effects on the natural environment are **unacceptable;** although there would be no land requirements, the congestion and gridlock that would ensue would create the highest level of GHG emissions.
- Optimizing socio-economic benefits is **unacceptable** as doing nothing would create delays by creating additional congestion and gridlock for both airlines and passengers.

18.3.1.2 New Parallel Taxiway Romeo

The performance criterion for this alternative is assessed as follows:

- Cost effectiveness is **unacceptable** because, despite mitigated risks associated with gridlock, the relocation of the airfield infrastructure would have the highest capital costs associated with the required redevelopment of the area to facilitate existing infrastructure.
- Practicality is **unacceptable** because the Romeo Taxiway would mitigate the potential for airfield congestion and gridlock, and the safety issues that may arise with head-to-head aircraft movements. However, the construction of Taxiway R is not possible without a major redevelopment of the area and would not be feasible to complete in time to support the PRP.

- The effects to the natural environment are **acceptable** as, although the extension would require more land, it has the benefit of operating at a lower emission of GHG by mitigating for congestion and gridlock.
- Optimizing socio-economic benefits is **acceptable** as the parallel taxiway would mitigate congestion and gridlock for both airlines and passengers.

18.3.1.3 New Taxiway Foxtrot Extension

The performance criterion for this alternative is assessed as follows:

- Cost effectiveness is **preferred** because it would mitigate the risks associated with gridlock of the at-grade crossing scenario, but its capital costs would be moderate in comparison to a parallel runway.
- Practicality is **preferred** because the Taxiway F extension would mitigate the potential for airfield congestion and gridlock, and the safety issues that may arise with head-to-head aircraft movements.
- The effects on the natural environment are **acceptable** as, although the extension would require more land, it has the benefit of operating at the lowest level of GHG emissions.
- Optimizing socio-economic benefits is **acceptable** as the taxiway extension would mitigate congestion and gridlock for both airlines and passengers.

Table 18-3 Dual Taxiway Alternatives - Conclusions

Option	Cost Effectiveness	Practicality	Natural Environment	Socio-economic
At-grade crossing	Unacceptable	Unacceptable	Unacceptable	Unacceptable
New Parallel Taxiway R	Unacceptable	Unacceptable	Acceptable	Acceptable
New Taxiway F Extension	Preferred	Preferred	Acceptable	Acceptable

An at-grade crossing alternative is not feasible due to airfield capacity constraints and delays that would create gridlock within the airfield. Therefore, it is not acceptable. Due to the presence of existing airfield infrastructure including the Air Canada hangar, the Aviation Fuel Tank Facility, and various cargo and aviation support facilities, the construction of Taxiway R is not possible without a major redevelopment of the area. Therefore, construction of Taxiway R would not be feasible in time to support the PRP.

The airfield modelling analysis revealed that a second cross-field taxiway is required in addition to Taxiway J in order to ease congestion in the vicinity of the terminal complex and facilitate circular movement of aircraft flow on the airfield. In order to address the potential air traffic congestion problem, an extension of the existing Taxiway F to the east is proposed to connect the existing airfield to the new parallel runway system. Although the extension of Taxiway F will require the construction of a roadway underpass to allow continued public access to the McCall North Trade Park area via McCall Way, it is considered to be both an acceptable and preferred alternative means for the dual taxiway. The underpass location depends on results of an ongoing study by Stantec regarding the McCall Central Development. The proposed realignment of McCall Way must be confirmed and an alignment must be established to allow the Taxiway F Underpass design to progress. The decision may also affect the vertical alignment for the Taxiway F extension.

18.3.2 Taxiway Juliet Underpass

The 2004 Master Plan recommended the construction of an airside road tunnel, referred to as the Aviation Support Precinct Tunnel (Taxiway J Underpass), to provide a direct north/south link between the proposed air cargo terminals at McCall North and South and the passenger aircraft aprons.

The project design team has developed project alternatives for the Taxiway J Underpass with consideration of technical, functional, economic, and environmental issues. The alternatives explored involved variations in the means by which potential designs may be carried out. A key factor in selecting an option for the Taxiway J Underpass is the evaluation of traffic volumes for ground handling and airport equipment. An assessment of typical ground handling and airport equipment, expected traffic volumes, lane capacity requirements, horizontal and vertical alignment, regulatory and safety requirements, and existing tunnel dimensions was carried out to rationalize the design inputs. Considerations for the options of the Taxiway J Underpass have been outlined in the table below.

Table 18-4 Taxiway J Underpass Alternatives

Options	Advantages	Disadvantages
At-Grade Crossing	• Lowest capital cost. • No land required.	• Increased delays and costs for aviation support services. • Does not reduce the potential for airport/vehicle conflict at this crossing point. • No direct access between the terminal and McCall North Trade Park. • Alternative routing would require aviation support service providers to cross an active controlled taxiway or they would be required to divert to alternative groundside routes to and from the terminal. • Highest operating cost due to alternate routing of service vehicles. • Highest GHG emissions due to alternate routing of service vehicles. • Severe delays for the transfer of air cargo between passenger aircraft and the cargo terminal. Taxiway J will have very limited gaps for crossing in peak periods of operation due to the frequency of aircraft movements in the area. • Aircraft would have priority over ground service equipment (GSE) and Taxiway J would be busier. As a result, GSE operators would need recertification, and increased tower control would be required. • Weather conditions would be a factor in causing crossing delays for GSE. Crossings would not be permitted in low visibility conditions. An at-grade crossing would be unusable during periods of low visibility or high traffic. • TC has identified the need to reduce the potential for airport/vehicle conflict at both controlled and uncontrolled airports and that every effort should be made to have airside service plans that do not cross runways or taxiways.
Underpass (approximately 200 m tunnel length or less)	• Provides connection between the air cargo terminals, the GSE area, and the passenger aircraft aprons. • Allows access of underground aviation service between the terminal and McCall North Trade Park. • Addresses the need to support increased development opportunities for aviation support and cargo development.	• Highest capital cost. • Increase in land disturbance. • Lay down area required for construction. • Closure of McCall Way NE. • Underpass would create the requirements for different security passes and additional training. • Carriers may be disappointed because they will not be able to use the underpass to transport staff to/from the terminal.

Options	Advantages	Disadvantages
	• Will make transfer of air cargo between passenger aircraft and cargo terminals easier. • Lowest operating cost. • Will minimize the risks of delays and their associated costs. • Lowest GHG alternate when compared to the 'do-nothing'. • Relatively small cost expenditure in relation to the overall investments to be made as a part of the Master Plan. • For security purposes, taxiway crossings and underpass usage can be controlled with passes and pass levels. • Low visibility conditions will not cause delays for GSE as an at-grade crossing would. • The underpass will allow YYC to maintain a safe uninterrupted connection under all weather conditions. • An underpass will reduce the potential for runway and taxiway conflicts and/or incidents.	• The necessity of dewatering and consequent effects. • Proximity to the fuel tank farm may require special construction techniques and assessment of the potential for managing contamination. • Increased security protocols and monitoring for safety within the underpass.

Past studies have identified the need for a Taxiway J Underpass to connect the infield area with the main terminal area. A needs study was undertaken as part of the Runway Development Project (RDP) Preliminary Design in order to evaluate the Taxiway J Underpass. The decision process involves elements of computational assessments (delay and capital costs), as well as other more objective issues such as risk, safety, and operational reliability. Given the Authority's objective of developing the McCall North Trade Park (and McCall Central) into an aviation support facility, the need for a strong north/south connection between the McCall Trade Park and the terminal apron will increase in importance as YYC expands. The McCall Trade Park is recognized as a critical part of overall airport operations based on its favourable location for aviation support and that it is also the future home of the proposed new air traffic control tower.

18.3.2.1 At-Grade Crossing

The performance criterion for this alternative is assessed as follows:

- Cost effectiveness is **unacceptable** because, although no capital costs will be incurred, there will be significant costs in the long term due to severe delays for the transfer of air cargo between passenger aircraft and the cargo terminal.
- Practicality is **unacceptable** because an at-grade crossing would not meet TC's agenda to ensure that every effort should be made to have airside service plans that do not cross runways or taxiways.
- The effects to the natural environment are **unacceptable**; although no construction is required, the long term effects from GHGs would be higher as a result of increased congestion and alternative routing of service vehicles.
- Optimizing socio-economic benefits is **unacceptable** as there would be severe delays for the transfer of air cargo between passenger aircraft and the cargo terminal.

18.3.2.2 Construct an Underpass for Taxiway J

The performance criterion for this alternative is assessed as follows:

- Cost effectiveness is **preferred** because, although there are initial capital costs incurred with construction of the underpass, there will be significant cost savings in the long term operating costs due to optimized services/routing efficiency.
- Practicality is **preferred** because TC has identified the need to reduce the potential for airport/vehicle conflict at both controlled and uncontrolled airports, and that every effort should be made to have airside service plans that do not cross runways or taxiways.
- The effects to the natural environment are **acceptable** as the footprint required is mostly under the surface and GHG emissions will be less than would be the case with an at-grade crossing.
- Optimizing socio-economic benefits is **preferred** as, not only does the underpass have a positive effect on the safety of both passengers and employees, there are positive benefits to efficient operations of the transfer of air cargo between passenger aircraft and the cargo terminal for both airlines and passengers.

Table 18-5 Taxiway J Underpass Alternatives - Conclusions

Option	Cost Effectiveness	Practicality	Natural Environment	Socio-economic
At-grade crossing	Unacceptable	Unacceptable	Unacceptable	Unacceptable
Underpass	Preferred	Preferred	Acceptable	Preferred

The assessment concludes that the long term development plans for YYC would be better supported by the underpass. The at-grade crossing scenario of Taxiway J may be able to accommodate the conflicting traffic in the short term; however, with the forecasted growth in aircraft movements and aviation support movements, the underpass would provide more functionality and control. The underpass is evaluated as the most favourable means for the taxiway based on its operating costs, its GHG emissions, and its operational functionality. The use of an underpass will be less difficult for groundwork and traffic operations. The environmental effects of additional land disturbance to construct the underpass are considered to be less significant than the long term environmental effects related to GHGs, should alternate routing be required. If the underpass is constructed, it would be most advantageous to construct it at the same time as the Taxiway J.

18.3.3 Pavements – Rigid vs. Flexible Pavement

Pavement design is based on a combination of geotechnical site investigations and TC's historical pavement-bearing values from existing airside pavements at YYC. In addition, aircraft fleet mix, expected frequency of aircraft traffic, aircraft wheel loads, tire pressures and landing gear configurations, and local climatic conditions are taken into consideration. The project design team has developed project alternatives for the airfield pavement options with consideration of technical, functional, economic, and environmental issues. The alternatives discussed involved variations in the means by which potential designs may be carried out.

Rigid Portland Cement Concrete (PCC) and flexible Hot Mix Asphaltic Concrete (HMAC) pavement designs have been developed as options for the RDP, using both Public Works Canada (PWC) and Federal Aviation Administration (FAA) design methodologies. One effect to consider is that the flexible pavement structures are from 52 to 72% thicker than rigid pavements. This significant difference in thickness will have an effect on earthworks balancing and the quantity of materials that will be delivered to the airport.

As noted above, both PWC and FAA methodologies were utilized to develop the preliminary pavement sections. The TC method only uses the B777-300ER and B777-200LR as critical aircraft for the loading condition. The FAA method considers the actual departure mix and allows for different loadings in the central 'keel' area of the runway and a lighter pavement structure on the edges of the runway based on one percent (1%) of the full departure loading on the keel. Full depth keel sections are required for all taxiways, except rapid exits, which can be designed for arrival traffic only.

The rigid (concrete) and flexible (asphalt) pavement options that were evaluated using the FAA and PWC methodologies are outlined in the table below.

Table 18-6 Pavement Types Being Considered

Pavement Type	PWC (ASG-19)	FAA – 20 Year Keel	FAA – 20 Year Edge	FAA – 30 Year Keel
Rigid	430 mm PCC 200 mm CSB 470 mm Subbase	435 mm PCC 200 mm CTB 150 mm CGB 350 mm Subbase	370 mm PCC 200 mm CTB 150 mm CGB 350 mm Subbase	465 mm PCC 200 mm CTB 150 mm CGB 350 mm Subbase
Flexible	125 mm HMA 300 mm CGB 1,300 Subbase	125 mm HMA 250 mm HMA (Stab*) 250 mm CGB 1,350 mm Subbase	125 mm HMA 200 mm HMA (Stab*) 250 mm CGB 750 mm Subbase	125 mm HMA 250 mm HMA (Stab*) 250 mm CGB 1,410 mm Subbase

Notes:
PCC - Portland Cement Concrete
CTB - Cement Treated Base Course
CGB - Crushed Granular Base Course
CSB - Cement Stabilized Base Course
HMA - Hot Mix Asphalt
(Stab) - FAA requires a stabilized course under HMA*

As can be seen above, one major difference between the PWC and FAA methodologies is that FAA requires a stabilized course (asphalt or cement stabilized) below the asphalt surface for aircraft load-bearing surfaces carrying more than 45,450 kg (100,000 lbs). PWC does not require use of a stabilized layer for asphalt; however, experience has shown that a stabilized layer is recommended to limit surface distress in flexible pavements, especially when considering aircraft types such as the B777 and other wide body aircraft.

The comparison of all the costs for flexible and rigid pavement was based on the cost per square metre for the keel area of the runway or a section of the parallel taxiway. For example purposes, the FAA 20 year Keel for rigid and flexible pavement has been compared in the table below.

Table 18-7 Pavement Structure Composition (FAA – 20 Year Keel for Comparison)

Pavement Type	FAA – 20 Year Keel
Rigid	435 mm Portland Cement Concrete (PCC) 200 mm Cement Treated Base Course (CTB) 150 mm Crushed Granular Base Course (CGB) <u>350 mm Subbase</u> **1,135 mm Total Thickness**
Flexible	125 mm Hot Mix Asphaltic Concrete (HMA) 250 mm Hot Mix Asphaltic Concrete Stabilized Course (HMA) 250 mm Crushed Granular Base Course (CGB) <u>1,350 mm Subbase</u> **1,975 mm Total Thickness**

Based on the principles of using proven technology, combined with contractor familiarity and constructability, Jointed Plain Concrete Pavement (JPCP) was recommended for rigid pavement design on the RDP. The actual pavement structure(s) selected for the parallel runway and taxiways will depend on a number of factors, including a detailed life cycle cost/benefit analysis that will consider not only the initial capital cost and benefit of each pavement type, but also the long term maintenance and rehabilitation costs.

Table 18-8 Pavement Type Alternatives

Option/Methods	Advantages	Disadvantages
Rigid Pavements	• Concrete is strong, durable material. • Concrete can accommodate unlimited tire pressures without rutting. • Normally have fewer layers. • Can have better load distribution. • Concrete can have a longer service life and may require less maintenance in subsequent years. • Concrete costs are not subject to fluctuations in the price of oil. • For FAA 20 year Keel, the total thickness is 1,135 mm, 840 mm less than flexible pavement structure. • Concrete has higher friction readings. • Possible to recycle and reuse concrete.	• Concrete does not remould, and may crack under repetitive heavy loading over time and at joints without suitable load transfer. • Concrete products require curing time. • Concrete products are more labour intensive for construction with careful grade control and mix designs. • Cracks can be more difficult to repair. • Concrete pavement can require a higher initial cost. • High initial CO2 emissions during cement manufacture.
Flexible Pavements	• PWC does not require use of a stabilized layer; however, experience has shown that a stabilized layer is recommended to limit surface distress in flexible pavements, especially when considering aircraft types such as the B777 and other wide body aircraft. • Has evolved to incorporate additional layers to improve surface performance and load distribution characteristics while retaining its flexibility to accommodate settlement. • Asphalt pavements can be placed much more quickly than other products. Early use is possible, and the flexible material can be laid overnight with the runway open to traffic during the day. • Resurfacing not only returns it to its original smoothness, but it also adds structural value to withstand increased weights and traffic volumes. • When specified and constructed correctly, asphalt can be resistant to ruts, while maintaining load distribution. • Flexibility can accommodate settlement. • 100% of asphalt runway can be picked up, remixed with fresh material, and reused. • Recycling asphalt pavement is more cost effective than using only new materials. • Asphalt retains heat better than concrete, so ice forms more slowly and melts more quickly than on concrete.	• FAA requires a stabilized course (asphalt or cement stabilized) below the asphalt surface for aircraft load-bearing surfaces carrying more than 45,450 kg (100,000 lbs). • Pavement structure is 1,975 mm thick, which is 840 mm thicker than the rigid pavement is for a FAA 20 year Keel. • Pavement requires more careful earthworks control and consistency since it cannot bridge over soft spots. • Asphalt generally requires more layers. • Asphalt does not accommodate unlimited tire pressures and can become soft in hot weather conditions and results in rutting or settlement. Asphalt ages and oxidizes, resulting in loss of flexibility, thermal cracking, and more frequent maintenance as it ages. • Excessive settlement can result in poor surface drainage, loss of runway profile, and hydroplaning hazards to aircraft. • Since asphalt flexibility increases with temperature, it is more susceptible to rutting at high pavement temperatures. • Dealing with settlement may change the profile of the runway and may significantly affect runway ride performance. • Thermal expansion/contraction of asphalt pavement over time will lead to cracking and need for sealing as the asphalt ages. • Asphalt surfaces can polish over time and grooving (if applied) can deteriorate, thus

Option/Methods	Advantages	Disadvantages
	• Asphalt pavements can be designed so that rainwater drains through the surface layer, reducing tire spray, plus reducing hydroplaning. • Elimination of joints, which can be important to reduce the potential ground penetration from potential spills. • An asphalt overlay can be placed over concrete as a top layer replacement. • Greater design capacity in regards to surface water discharge management.	reducing friction characteristics and reducing braking capacity of the surface.

18.3.3.1 Rigid Pavements

The performance criterion for this alternative is assessed as follows:

- Cost effectiveness is **preferred** because, despite marginally higher initial construction costs, the overall 40 year life cycle is less due to lower maintenance, as well as causing less disruption to airfield operations.
- Practicality is **preferred** because it requires 50% less maintenance over the 40 year life cycle and accommodates unlimited tire pressures and provides better surface friction characteristics.
- The effects on the natural environment are **acceptable;** despite the initial high CO_2 emissions during concrete manufacture, it is possible to recycle and reuse concrete.
- Optimizing socio-economic benefits is **acceptable** due to increased operating efficiency and minimal overheads.

18.3.3.2 Flexible Pavements

The performance criterion for this alternative is assessed as follows:

- Cost effectiveness is **acceptable** because, despite greater associated material cost risks by virtue of importing a higher quantity of materials onto the site, it is only 10% more expensive over a 40 year life cycle.
- Practicality is **acceptable** because asphalt may be laid more quickly and permits early trafficking.
- The effects on the natural environment are **acceptable** since asphalt permits greater design capability in regards to surface water discharge management.
- Optimizing socio-economic benefits is **acceptable** since there is risk of disruption to operations in terms of rehabilitating the pavement due to its physical characteristics (e.g., polishing, rutting).

Table 18-9 Pavement Type Alternatives - Conclusions

Option	Cost Effectiveness	Practicality	Natural Environment	Socio-economic
Rigid Pavements	Preferred	Preferred	Acceptable	Acceptable
Flexible Pavements	Acceptable	Acceptable	Acceptable	Acceptable

A decision on whether to implement rigid or flexible pavements has not yet been reached. An evaluation will consider which has a higher initial cost, which has a longer lifespan, and which is most economic in regards to total reconstruction or major rehabilitation that is presently underway. A variety of rigid and flexible pavement types are possible, and a final selection of the preferred type should only be done as final design is imminent, given the high variability of commodity prices and only when a revised air traffic movement forecast is available. A decision regarding pavement structure type (rigid or flexible) will be made after completion of a life cycle cost/benefit analysis by the RDP design team.

18.3.4 Issues Raised by Stakeholders

Issue: Changing the location of the proposed runway within airport lands

Response: The 2004 Master Plan for YYC includes the future needs of a parallel runway to accommodate the forecasted increase in demand, and the land around YYC has been acquired to this end. Infrastructure and land use classifications have been developed with consideration to the presence of the PRP in the proposed location in the future. Land use classifications for commercial, retail, and light industrial purposes have been in place since 1979 and are consistent with the presence of the PRP in the proposed location.