**APPENDIX E**

# Aerodrome Viability Report

# AERODROME VIABILITY REPORT

**Calgary East Aviation Project**

June 24 2022

InterVISTAS

a company of Royal HaskoningDHV

## Introduction

This report presents the aerodrome viability study for Calgary East – Wheatland County and a summary of the analysis undertaken by Inter*VISTAS*. The study included an identification of any fatal flaws from a physical space perspective that would prevent the development of an aerodrome on the proposed site. This process included the following three elements:

- The critical aircraft were identified (the most demanding aircraft that determine airside geometries and size of associated safety areas) that would operate at the aerodrome.
- The orientation and the length of the proposed runway were evaluated together with the associated protected airspace
- Several runway layout alternatives were prepared for further evaluation.

## Background

The proposed aerodrome site is located within the Province of Alberta, approximately 14 kilometers west of the town of Strathmore and 20 kilometers east of the city of Calgary. The aerodrome site is bordered by the Trans-Canada Highway 1, approximately 800 meters north of the perimeter, by Range Road 264 along the eastern side, by Range Road 265 along the western side, and by Township Road 240 along the southern border. The site is mostly surrounded by agricultural lands.

The proposed site occupies approximately 1,500 acres of land and is shown in **Figure 1**. The proposed site sits at an elevation of 3,300 feet/ 1,000 meters above sea level. The nearest major airport is Calgary International Airport, approximately 30 kilometers northwest of the site, and multiple grass strip airfields are located in a 10-kilometer radius that support local agricultural flying – with minimal air traffic movements.

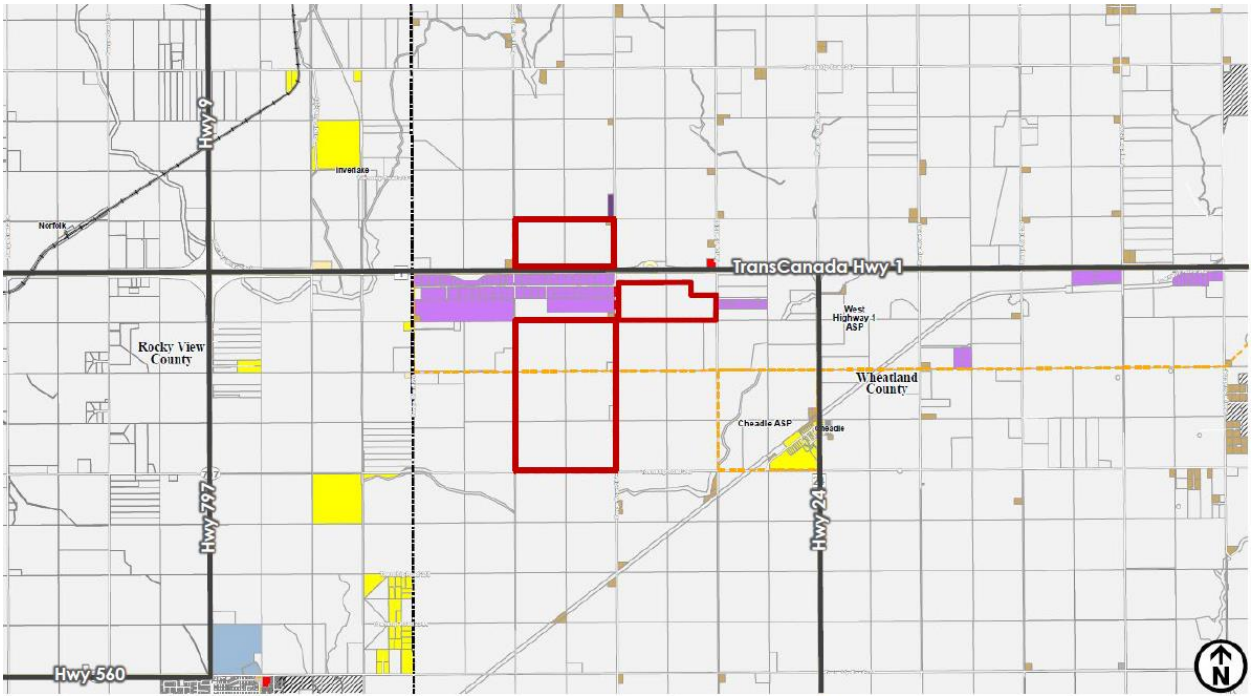


*Figure 1. Existing land use and local area context for the proposed site.*

## Critical Aircraft Determination and Runway Length

Based on conversations with De Havilland Aircraft of Canada engineers, the largest and most demanding aircraft expected to operate at the aerodrome are the Dash 8-400 and the CL 415/515. These aircraft inform the required runway length, the size of the associated safety areas, and the characteristics of the surrounding airspace. The required runway length is a function of airport elevation, the mean daily maximum temperature of the hottest month of the year and most notably the aircraft serving the airport. The critical aircraft selected here also require the longest runway length when operating at or near their respective maximum takeoff weight (MTOW).

Based on the geometric characteristics of the critical aircraft shown in **Table 1**, the Dash 8-400 is an Aircraft Group Number (AGN) IV aircraft and the CL-415 is an AGN IIIB aircraft with regard to the airfield. AGN IIIB aircraft require a minimum runway width of 30 meters and AGN IV aircraft require a minimum runway width of 45 meters. Even though the Dash 8-400 is an AGN IV aircraft, it is capable of operating from 30-meter-wide runways[1]. However, a wider 45-meter runway is recommended to provide additional safety margin for production first flights and potentially flight testing.

***Table 1. Critical aircraft characteristics***

| | Dash 8-400 | CL-415 |
|---|---|---|
| **Wingspan (m)** | 28.4 | 28.6 |
| **Outer main gear span (m)** | 9.3 | 5.3 |
| **Takeoff distance** | 8,200 ft (Flaps 5)<br>5,900 ft (Flaps 15) | 3,600 ft (Flaps 10)<br>5,400 ft (Flaps 10, utility category) |
| **Crosswind limit (knots)** | 32 | 22 (takeoff) / 24.5 (landing) |
| **AGN** | IV | IIIB |

In addition to runway width, considerations were given to the required runway length. The selected critical aircraft are likely to be heavily modified from the standard versions that will likely result in potential design weight increases (e.g., increase of 2,000 lbs. on MTOW for the Dash 8-400) and potential future developments (fuselage stretch) leading to larger aircraft and more demanding requirements for runway field length. It is understood that typical production flying would only involve crew, observers, full fuel and minimal to no payloads. However, flight tests are likely to be operated at MTOW according to De Havilland. As such, the takeoff lengths provided in **Table 1** do not account for any margin in modification and development flight testing, and therefore a longer than 8,200-foot runway would be ideal. (De Havilland engineers recommended a 10,000-foot runway to account for future designs.)

[1] EASA Comment-Response Document CRD 2017-14, Comments by Bombardier

## Wind Analysis and Runway Orientation

Aerodrome planning requires that an airport's runway(s) should be oriented such that aircraft can takeoff and land into the prevailing wind with minimal crosswind exposure. Typically, a single runway or airfield (multiple runways) should provide 95 percent wind coverage.

Inter*VISTAS* analyzed hourly wind data for a ten-year period from 2011 to 2020, obtained through Alberta Agriculture and Forestry's (AF) Alberta Climate Information Service (ACIS). Due to lack of data availability at the proposed aerodrome site, two nearby weather stations were considered: (1) the station at Calgary International Airport (data available for 2013-2020) and (2) the station east of Strathmore (data available for 2011-2020), along Tans Canada Highway 1, as shown in **Figure 2**. Another nearby station south of Keoma was also considered but it did not have the hourly wind data available for the selected timeframe.

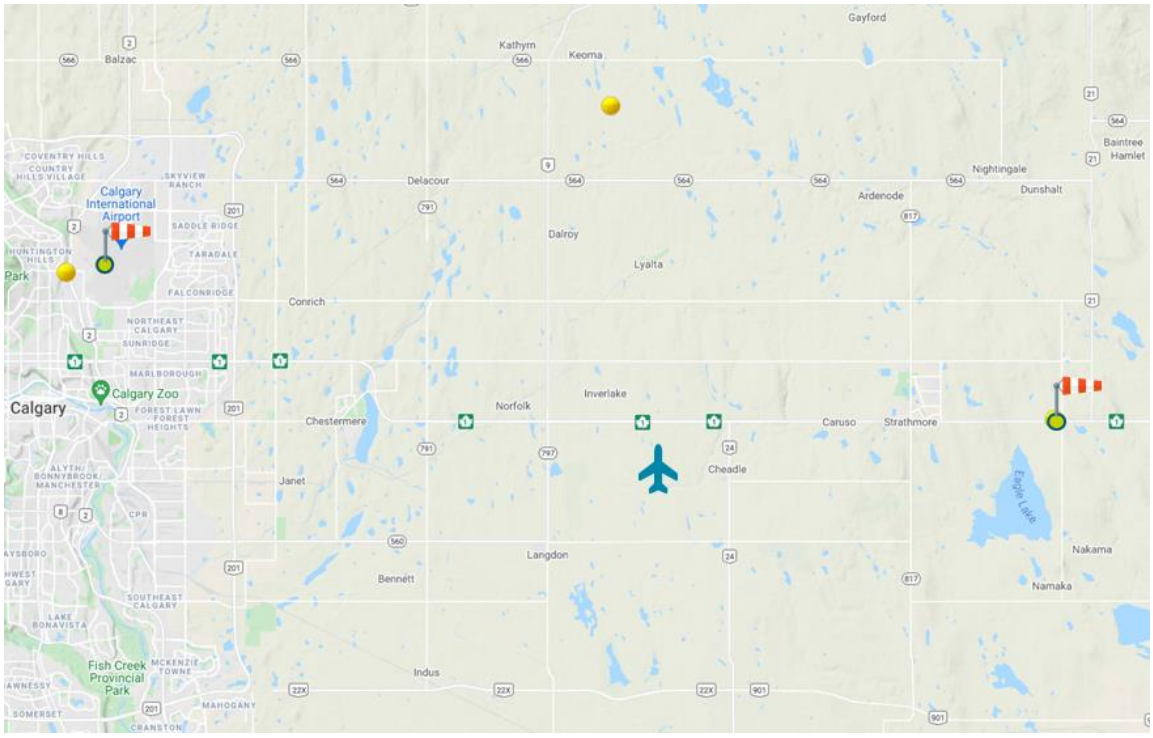


***Figure 2. Selected weather stations for wind analysis.***

Data provided by Alberta AF, Alberta Climate Information Service (ACIS). Retrieved November 2021.

The corresponding wind roses are shown in **Figure 3**. The shape and length of each arm is proportional to the frequency of events, or the number of times the wind was blowing from a specific direction and at a specific speed. As shown, the wind rose at Calgary International Airport extends the most to the north/north-northwest and to the south, meaning that winds from the north are the most common at the airport, followed by winds from the south direction. The wind rose at Strathmore indicates that winds from the southwest/south-southwest are the most common, followed by winds from the north and north-northwest.

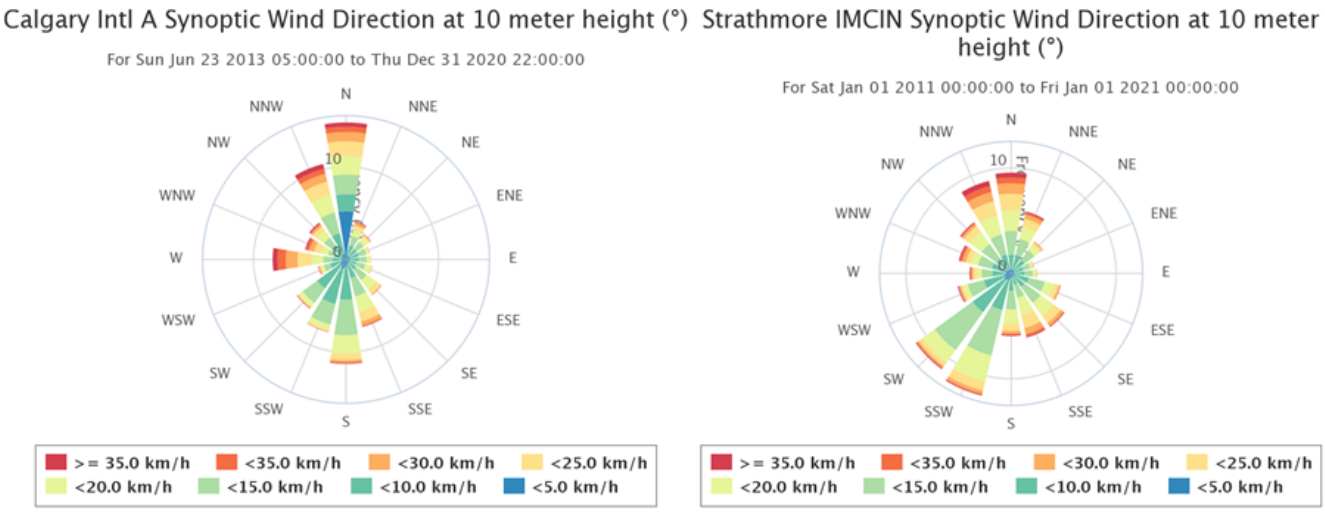


***Figure 3. Historic wind speeds and wind directions at Calgary International Airport and at Strathmore.***
Data provided by Alberta AF, Alberta Climate Information Service (ACIS). Retrieved November 2021.

Since aircraft characteristics and aircraft performance can vary, Inter*VISTAS* analyzed wind coverage data for different magnitudes of crosswind. **Table 2** and **Table 3** summarize the wind coverage of the proposed runway directions at four crosswind speeds. These speeds are the following:

- 10.5-knot crosswind component, which represents the crosswind component when pilots of small, single-engine general aviation aircraft would be unable to use the runway
- 13.0-knot crosswind component, which would limit the use of the runway for twin-engine propeller aircraft
- 16.0-knot crosswind component, which would limit the use of the runway for larger commuter aircraft for small business jets
- 20.0-knot crosswind component, which would limit the use of the runway for regional jets and small air carrier aircraft.

***Table 2. Crosswind coverage based on wind data from Calgary International Airport***

| Percentage (%) | Windspeed (knots) | | | |
|---|---|---|---|---|
| **Runway orientation** | 10.5 | 13.0 | 16.0 | 20.0 |
| **N-S** | 90.6% | 94.0% | 96.7% | 99.5% |
| **NNE-SSW** | 87.7% | 93.3% | 97.3% | 99.9% |
| **NE-SW** | 83.8% | 92.0% | 97.6% | 99.9% |
| **ENE-WSW** | 83.2% | 91.2% | 96.0% | 99.4% |
| **E-W** | 84.1% | 91.8% | 96.1% | 99.5% |
| **ESE-WNW** | 89.4% | 94.7% | 98.2% | 99.9% |
| **SE-NW** | 91.5% | 96.0% | 99.4% | 100.0% |
| **SSE-NNW** | 92.4% | 95.8% | 98.2% | 100.0% |

Based on data provided by Alberta AF, Alberta Climate Information Service (ACIS). Retrieved November 2021.

*Table 3. Crosswind coverage based on wind data from Strathmore*

| Percentage (%) | Windspeed (knots) | | | |
|---|---|---|---|---|
| Runway orientation | 10.5 | 13.0 | 16.0 | 20.0 |
| **N-S** | 94.6% | 97.4% | 99.1% | 99.9% |
| **NNE-SSW** | 90.1% | 95.4% | 98.6% | 99.9% |
| **NE-SW** | 84.5% | 92.4% | 97.3% | 99.9% |
| **ENE-WSW** | 81.7% | 90.2% | 95.5% | 99.4% |
| **E-W** | 82.1% | 90.6% | 95.7% | 99.4% |
| **ESE-WNW** | 84.3% | 92.7% | 97.4% | 99.8% |
| **SE-NW** | 90.5% | 95.9% | 98.9% | 99.9% |
| **SSE-NNW** | 94.6% | 97.6% | 99.2% | 99.9% |

Based on data provided by Alberta AF, Alberta Climate Information Service (ACIS). Retrieved November 2021.

Both the Calgary and Strathmore wind directions suggest that a future runway at the selected aerodrome site should be oriented in the south-southeast/north-northwest direction to provide the best possible crosswind coverage. However, the two selected critical aircraft have a crosswind limit larger than 20 knots, which allows for some flexibility with the preferred runway orientation. For example, orienting the runway in the north-south direction would have minimal impact on these aircraft but it may constrain operations for other, smaller aircraft types on more days than a SSE-NNW runway orientation would.

The preferred runway orientation (SSE-NNW) and the resulting air traffic is not expected to conflict with other adjacent airports. As mentioned earlier, Calgary International Airport is the closest major airport, and it operates in a north or south flow configuration most of the time. Flights departing from Calgary may overfly the proposed aerodrome at high altitude and are not expected to conflict with local air traffic. The nearby agricultural airfields and grass strips have a minimal number of air traffic movements and are unlikely to cause any airspace conflicts. As design is undertaken in the future, Inter*VISTAS* recommends coordinating with air traffic control responsible for Calgary International Airport.

## Runway Alternatives

Several aerodrome development alternatives were identified and evaluated with respect to runway length and runway orientation to meet the requirements identified earlier. The alternatives evaluation considered the recommended runway orientation, property line boundaries, major highways and roadways in close vicinity of the site, usable adjacent land, as well as the following runway safety areas and airspace surfaces (defined by *Fifth Edition of Aerodrome Standards and Recommended Practices (TP 312)*):

- **Runway Strip** – is an area including the runway and stopways if provided, intended to reduce the risk of damage to aircraft running off a runway. The runway strip should be located on airport property.
- **Runway End Safety Area (RESA)** – symmetrical area about the extended runway centerline intended to reduce the severity of damage to an aircraft in case of a runway undershoot, overshoot, or excursion. The RESA should be located on airport property.
- **Obstacle Limitation Surfaces (OLS)** – obstacle limitation surfaces establish the limit to which objects may project into the airspace associated with an aerodrome so that aircraft operations may be conducted safely. The OLS consists of the takeoff and approach surfaces, a transitional surface, and an outer surface. Much of the area under the OLS is typically located beyond the aerodrome property line.

The location of the runway is influenced by these safety and object free areas of the runway and future taxiway system, as well as the OLS associated with an instrument or non-instrument runway system capable of accommodating AGN IV aircraft. These surfaces extend both horizontally and vertically around the aerodrome, and they define the airspace that needs to be maintained free of obstacles. The dimensions of these safety areas and OLS are based on the latest guidance set in the *Fifth Edition of Aerodrome Standards and Recommended Practices (TP 312)*.

Buildings (hangars, offices, shops, radio towers, etc.) should not conflict with the recommended airport design standard defined for the runway and the protected airspace associated with the runway (height limitation imposed by the OLS). Aircraft parking areas, fueling facilities, etc. can be located near the runway, outside of the safety area, as long as the OLS transitional surface height requirements are met. The outer edge of the transitional surface extends to a heigh of 45 meters from the runway strip.

Transport Canada recommends that planning and coordination of the siting of obstacles is conducted at the earliest possible opportunity. The terrain surrounding the proposed aerodrome site appears to be relatively flat and poses little risk of obstruction of airspace. However, proximity of other obstacles, for example, wind turbines, radio towers, smokestacks, etc., may potentially have an impact on the usability of the aerodrome and would require a more detailed site survey.

Runway alternative 1A, as shown in **Figure 4**, depicts a 45-meter-wide runway in the preferred SSE-NNW orientation with a full length of 10,000 feet (3,048 meters. Each end of the runway has a 150-meter-long runway end safety area (required for runway lengths of 1,200 meters or greater, per *TP 312*) and an instrument approach associated with it (same dimensions for precision and non-precision runways), which defines the shape and size of the approach and transitional surfaces based on AGN IV aircraft (the critical aircraft). The runway strip is 122 meters wide on each side of the runway and the extended centerline. The runway is placed such that it maximizes the area occupied within the existing property line, and it leaves space for taxiway and apron development to the northeast. Trans-Canada Highway 1, a major transportation corridor, is located under the approach surface on the north side. The runway's approach surface is located such that it leaves at least 5.2 meters of height allowance above the crown of the highway, as required by *TP 312*. As a result, the runway is shifted further south, and it extends beyond the existing property line. In addition, the RESA on the south end crosses Township Road 240.

Approach lights and other runway instrumentation are not depicted on the runway alternative drawings presented here, but their land area requirements should be considered once the runway instrumentation capabilities have been determined.

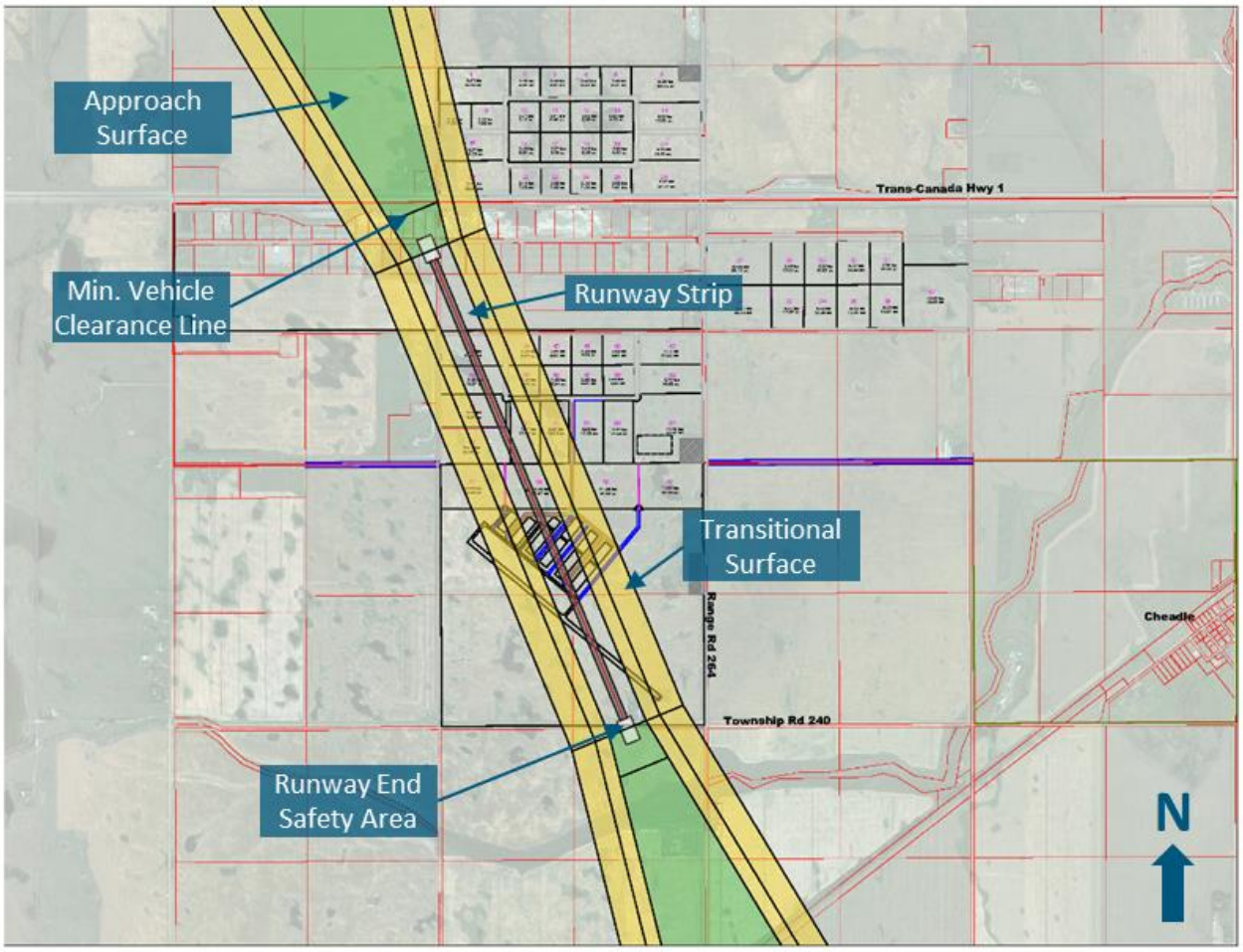


*Figure 4. Runway alternative 1A*

Alternative 1B, as shown in **Figure 5**, is a shortened version of Alternative 1A. The runway is shortened to 8,858 feet (2,700 meters) and as a result it provides sufficient clearance for vehicles on Trans-Canada Highway 1 underlying the north side approach surface and sufficient clearance for vehicles on Township Road 240 underlying the south side approach surface. *TP 312* requires that vehicles on roads are provided at least 4.7 meters of clearance measure from the crown of the roadway. This alternative maximizes existing property use and does not require any relocation or rerouting of existing roadways outside property boundary. The 8,858-foot-long runway provides 658 feet of additional runway length beyond the minimum needed for the Dash 8-400 with 5-degree flaps setting.

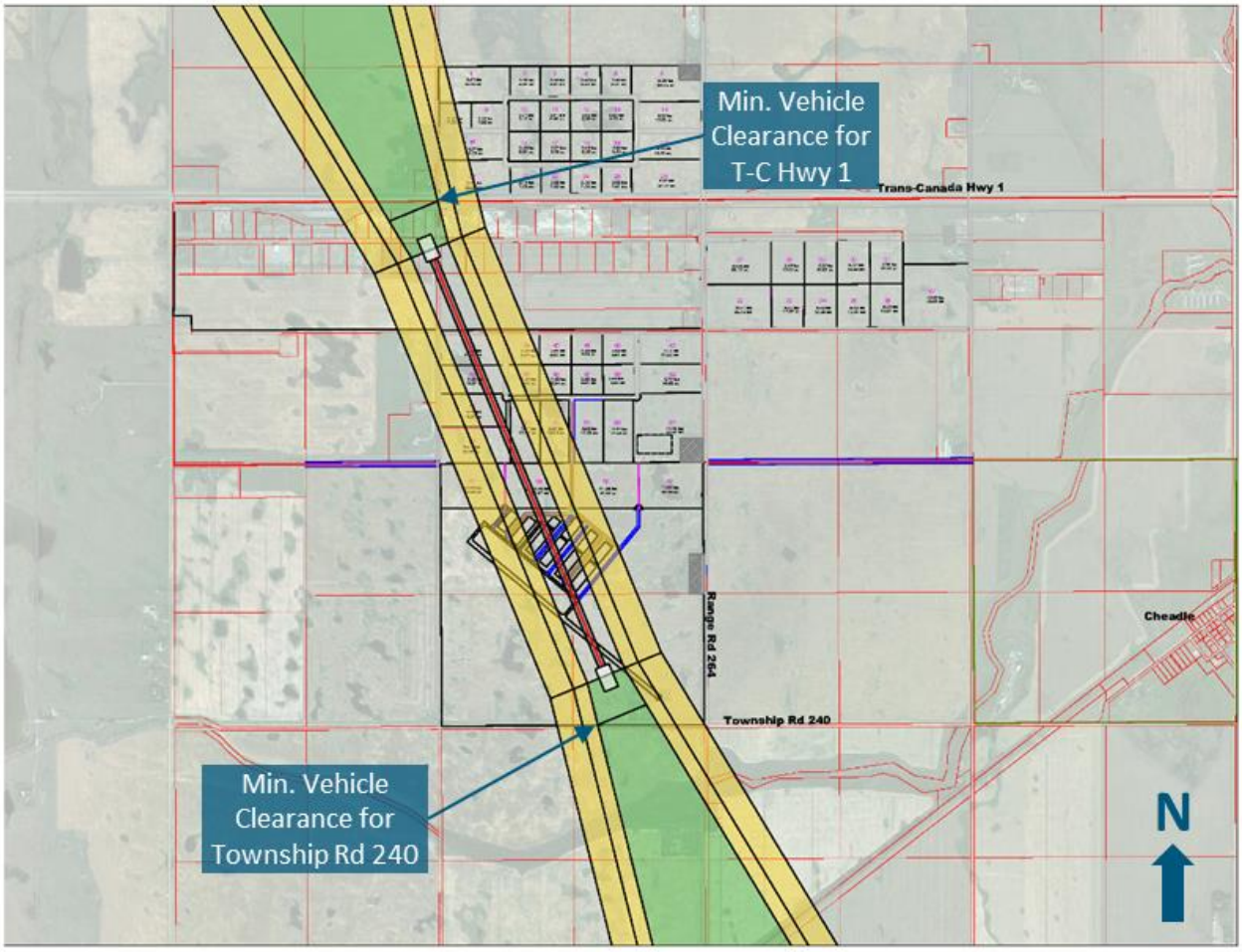


***Figure 5. Runway alternative 1B***

Alternative 2, shown in **Figure 6**, depicts a similar 10,000-foot (3,048-meter) runway with instrument approaches on both ends, as in Alternative 1A, but the runway is re-oriented in a more northwest-southeast direction. This orientation provides the necessary road clearance over Township Road 240 on the south side (south side stays within property boundary) and leaves more clearance on the north side. However, the northwest side does extend beyond property line and would require the acquisition of the parcel currently occupying that area. Notably, air traffic movements by the critical aircraft would be largely unaffected by the revised orientation; however, smaller aircraft air traffic movements, which are more sensitive to crosswind, could be impacted from time to time.

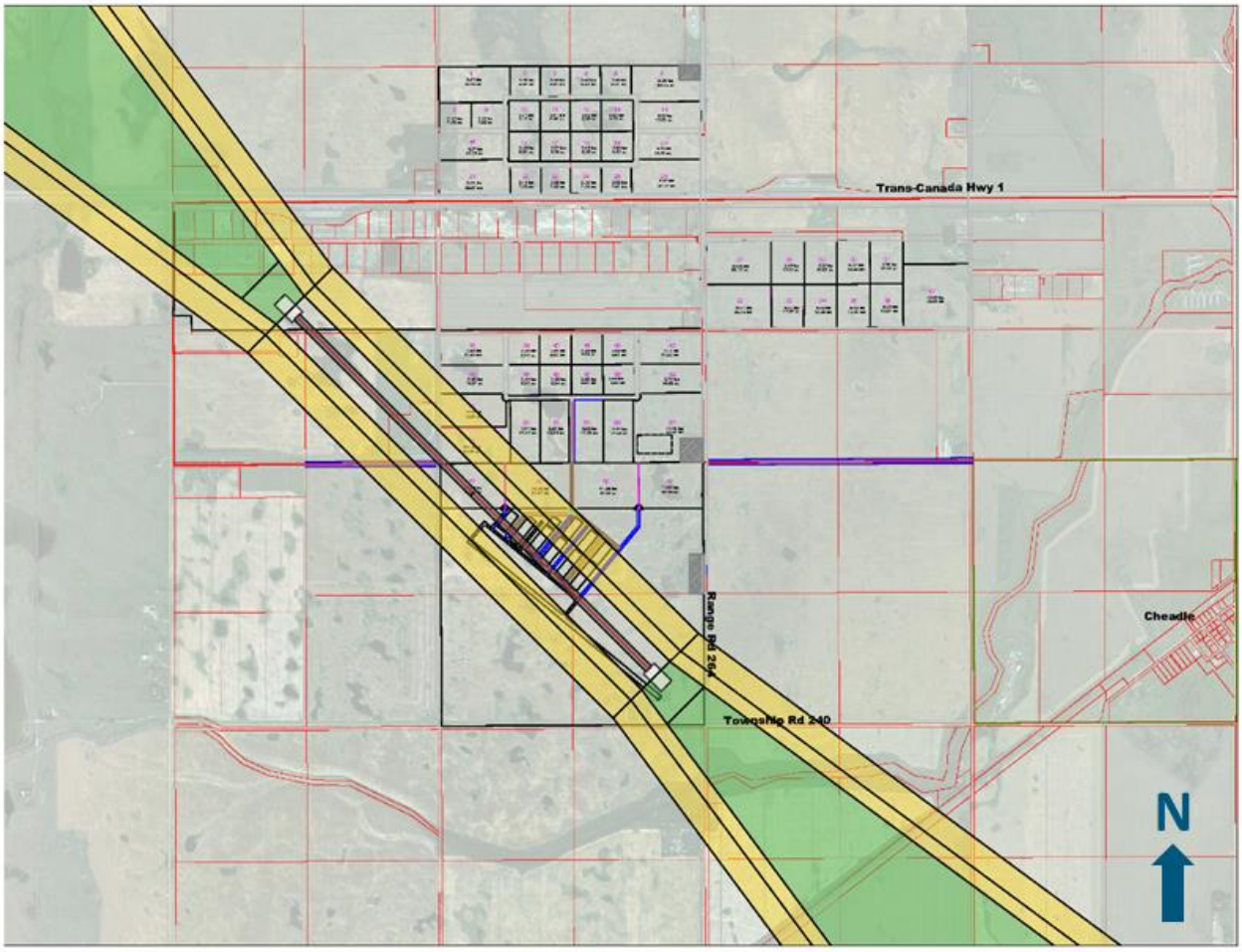


*Figure 6. Runway alternative 2*

Alternative 3, shown in **Figure 7**, is also a 10,000-foot (3,048-meter) runway in the preferred NNW-SSE orientation but the north end of the runway is assumed to have a non-instrument approach. This change makes the associated approach surface and transitional surfaces less restrictive on the north side but still meets the minimum clearance requirements above Trans-Canada Highway 1. The south side of the runway shifts a little further north, but the RESA still overlaps Township Road 240, and the approach surface does not provide enough clearance for vehicles to pass underneath. As such, this alternative would require Township Road 240 to be re-aligned.

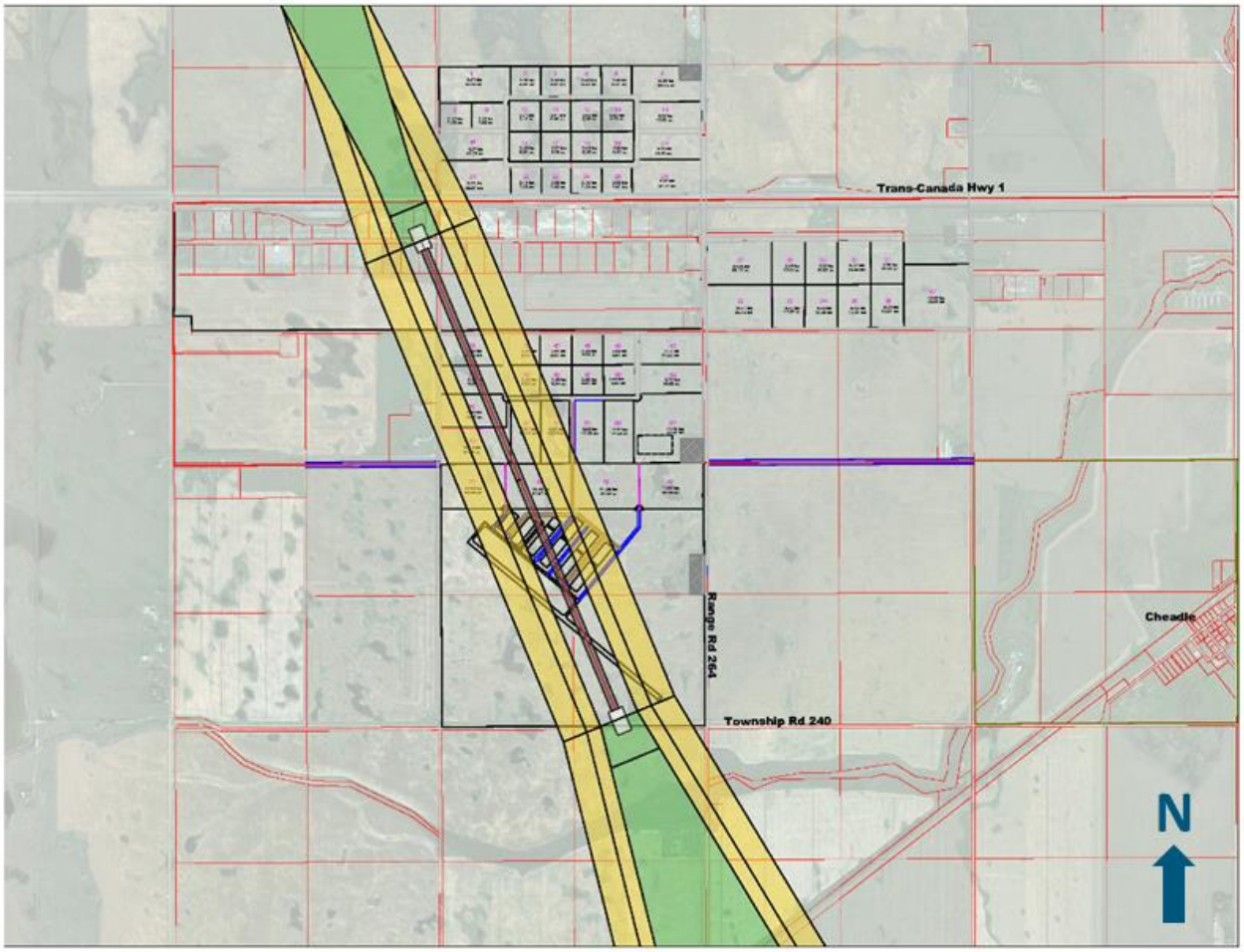


*Figure 7. Runway alternative 3*

**Figure 8** shows Alternative 4, a 10,000-foot-long (3,048 meters) runway with non-instrument approaches at both ends. This alternative is the least airspace restrictive option among the 10,000-foot alternatives. The runway is oriented in the preferred NNW-SSE direction and the north side is aligned to provide sufficient vehicle clearance over Trans-Canada Highway 1. The south side, however, still extends beyond existing property line and conflicts with Township Road 240, which would need to be re-aligned to accommodate this runway alternative.

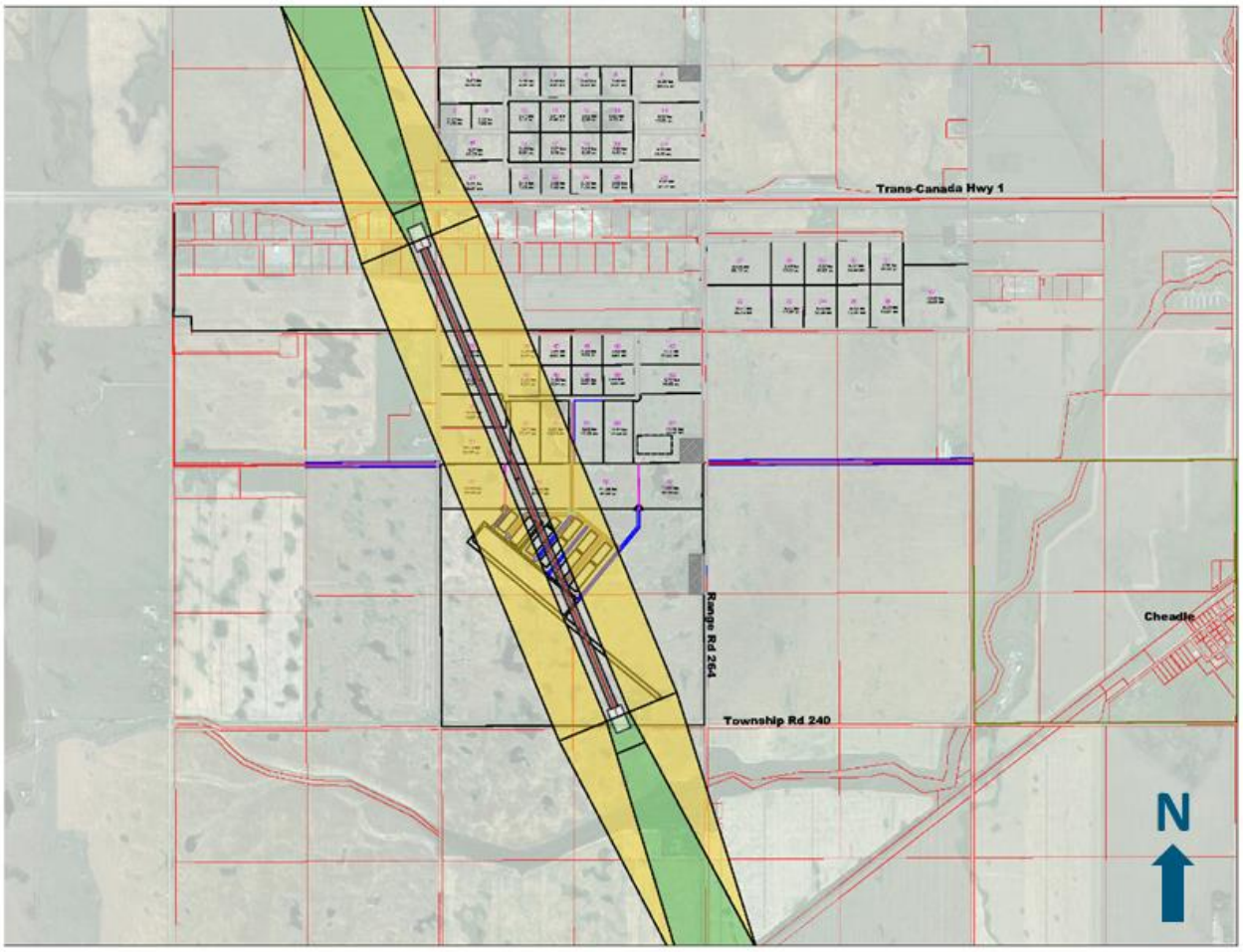


*Figure 8. Runway alternative 4*

**Figure 9** illustrates Alternative 5, an 8,530-foot-long runway (2,600 meters) in the preferred NNW-SSE orientation. The runway length is based on land availability between Trans-Canada Highway 1 on the north side and Township Road 240 on the south side. There are instrument approaches available to both runway ends, and the associated approach surfaces provides sufficient clearance for vehicles on the roadways. The runway length exceeds the needs of the Dash 8-400 with flaps set to five degrees (8,200 feet); however provides less than the ideal length of 10,000 feet recommended by De Havilland engineers.

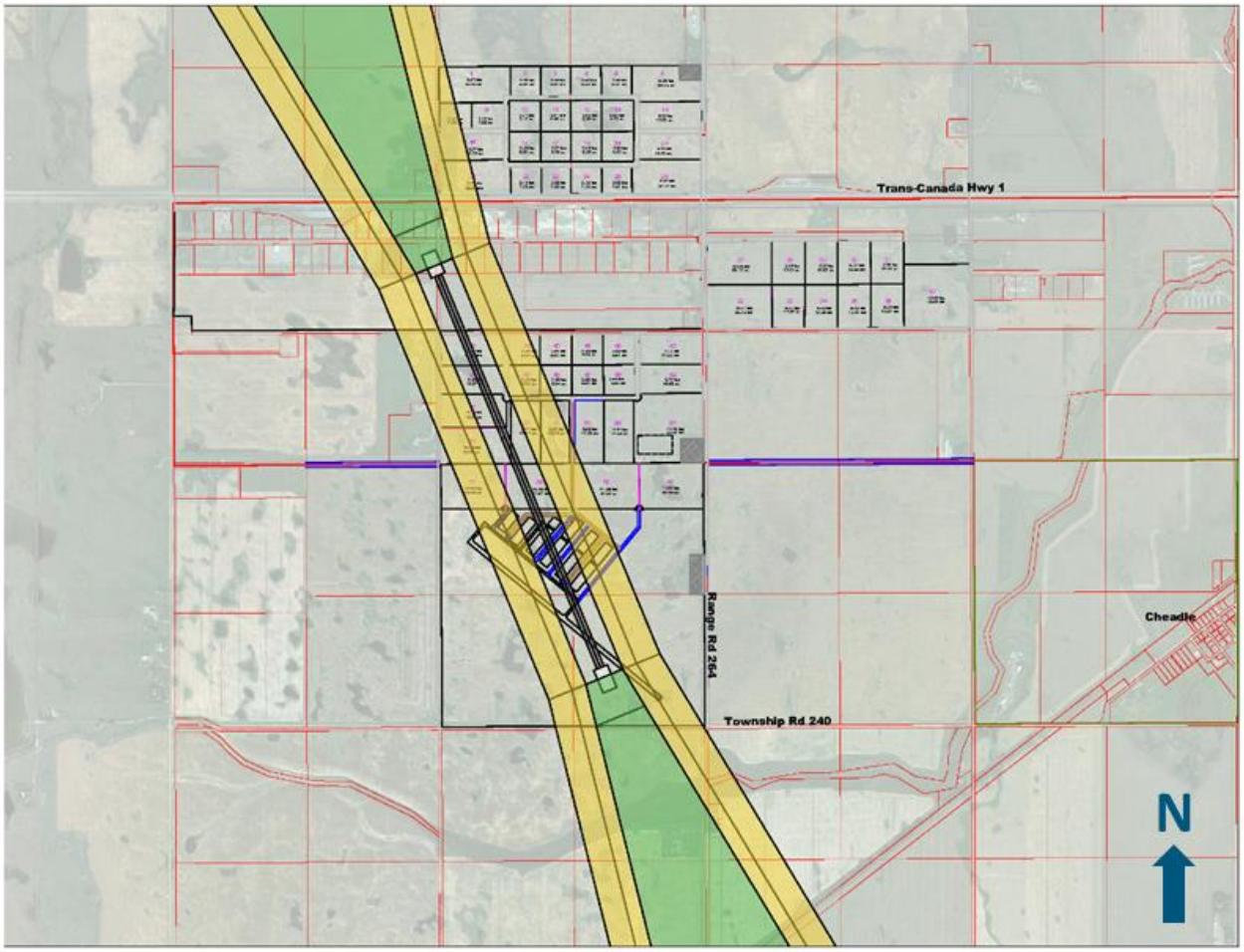


*Figure 9. Runway alternative 5*

Alternative 6, shown in **Figure 10**, depicts the shortest runway among the alternatives. This 6,070-foot runway (1,850 meters) is based on existing property lines, keeping the runway, the RESAs, and the runway strip within the boundary. It also provides the necessary vehicle clearances for Range Road 265 on the northwest side and Township Road 240 on the south side, assuming instrument approaches at both runway ends. The approach surface on the north side provides much higher clearance over Trans-Canada Highway 1 than the minimum required. The runway length is sufficient for the Dash 8-400 with flaps set to 15 degrees (5,900 feet) but it is likely to be constraining for test flights.

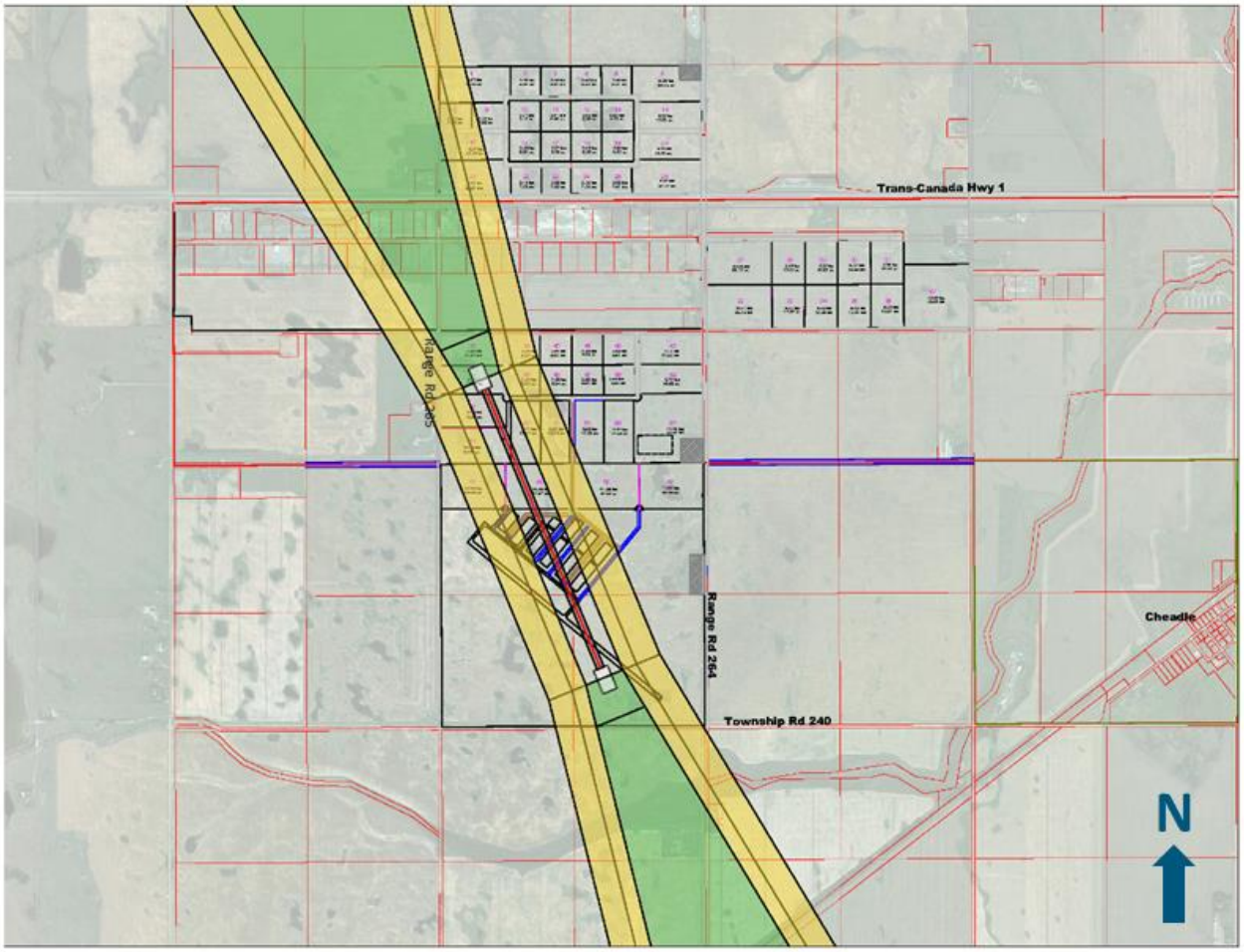


*Figure 10. Runway alternative 6*

## Alternative Refinements from Stakeholder Input

Runway alternatives were presented to key stakeholders for consideration. Upon presenting the runway alternatives, input was provided that required refinements to be made to the planning parameters initially defined for this study. The following paragraphs describe the refinements made to the planning parameters.

The first planning parameter that was refined was the amount of available land for the proposed runway. The proposed site, shown previously in **Figure 1,** consists of three parcels. One north of TransCanada Hwy 1 and two south of the highway. The acquisition of additional parcels was explored, but it was determined that the proposed runway concept and safety envelopes must remain within the current property boundaries.

Additionally, the proposed development site has existing oil wells. Each oil well has a 100-meter buffer where no development can occur. The oil wells were not to be altered or capped for siting the runway.

Finally, most of the initial runway alternatives examined having either one end or both runway ends capable of accommodating a precision approach, such as a CAT I. Upon further discussion with stakeholders, the approach capability for the north end was to be Visual while the southern end of the runway was to accommodate a non-precision approach procedure, such as an RNAV (GPS).

Runway Alternative 6 was selected to be refined as it aligned closest to the revised planning parameters. These refinements included shifting, slightly rotating, and extending the runway length to meet the revised planning parameters.

## Preferred Alternative

The preferred runway alternative selected was Refined Alternative 6. The preferred runway alternative, as shown in **Figure 11**, depicts a 45-meter-wide runway with a length of 6,698 feet. The runway's orientation is slightly rotated to the north, compared to the initial alternatives, with a wind orientation of SSE-NNW. This orientation provides ample wind coverage for the operations that are anticipated to be conducted on the runway. By rotating the runway slightly to the north, this allowed the proposed runway to be extended farther compared to the previous iteration. The runway is aligned to avoid any impacts to the existing oil wells.

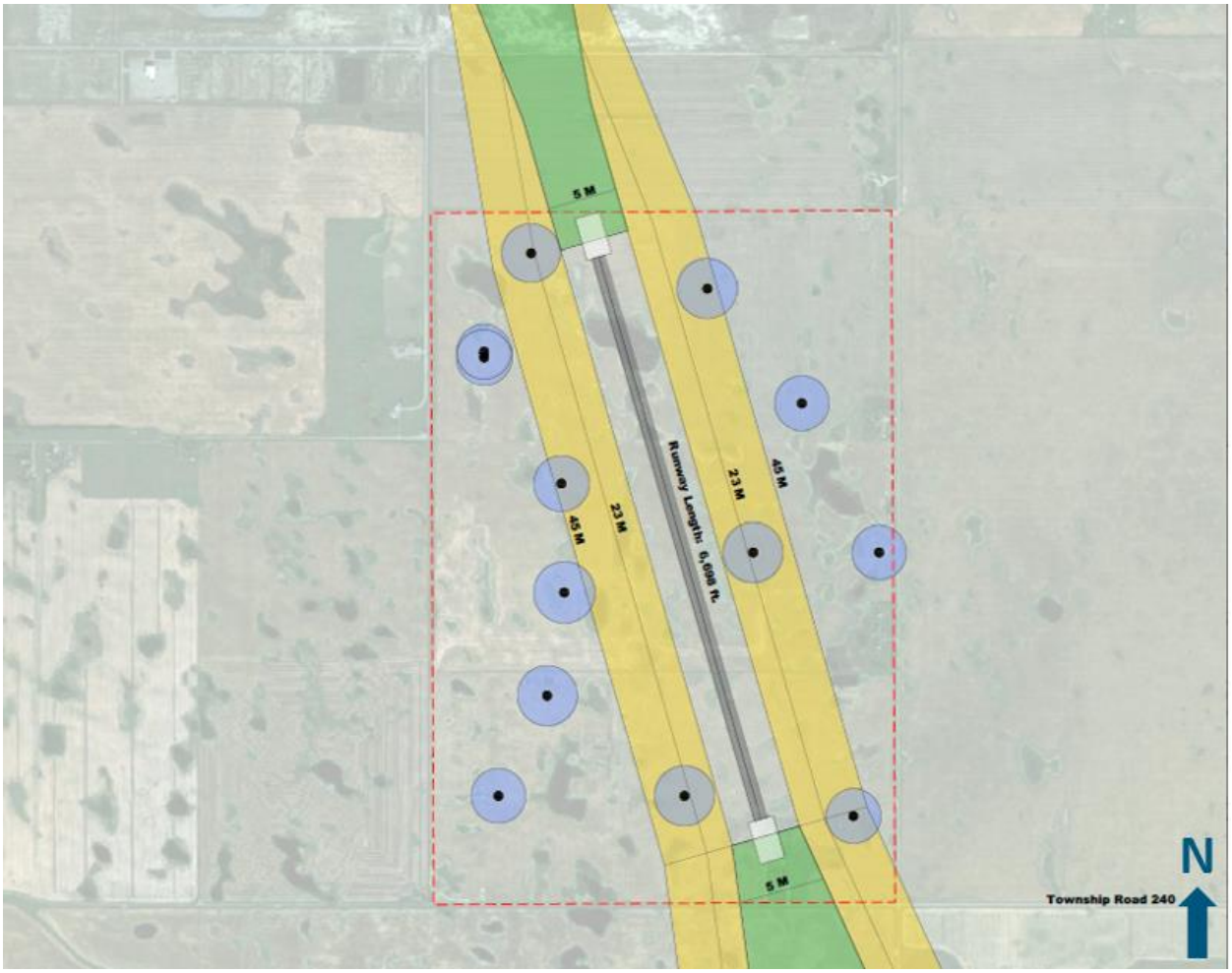


*Figure 11. Preferred runway alternative with Oil Well Locations*

Changing the approach capabilities from precision to non-precision resulted in an evaluation surface that is less restrictive. This provided an opportunity to shift the runway farther to the south, closer to Township Road 240 and provide additional runway length. From an airspace perspective the preferred concept provides the necessary vehicle clearances over Township Road 240 on the south side and TransCanada Hwy 1 on the north side. **Figure 12** depicts the airspace surfaces for the preferred runway alternative.

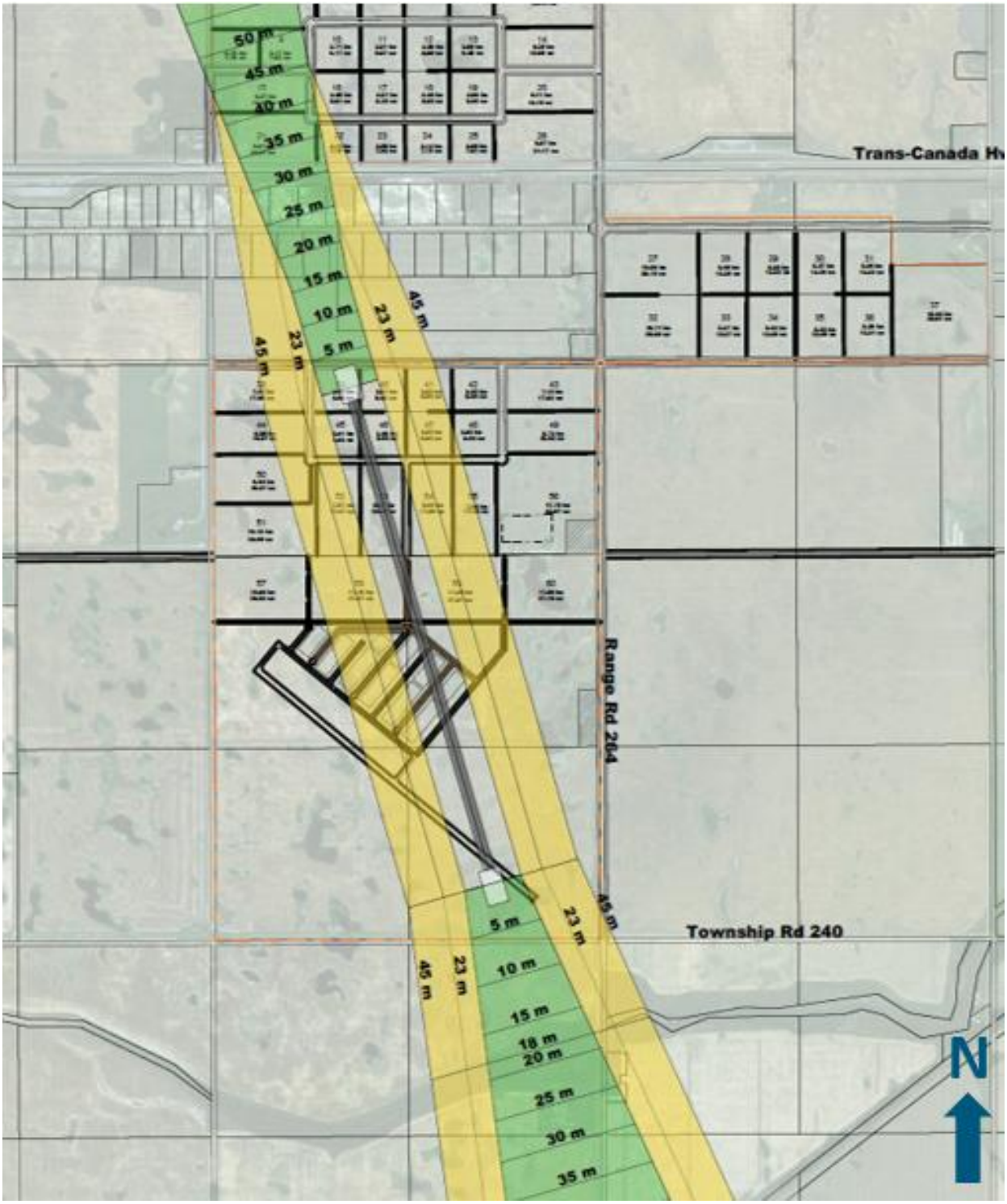


*Figure 12. Preferred runway airspace surfaces*

## Considerations for Additional Runway Length

There are two considerations if additional runway length is desired beyond the capabilities of the preferred alternative without the need of purchasing additional land or creating airspace challenges. The first consideration is to establish a clearway off one or both runway ends. A clearway is a defined rectangular area over land or water under the control of the aerodrome operator, selected as a suitable area over which an aircraft may make a portion of its initial climb to a specified height[2]. **Figure 13** shows a diagram of the declared distances with an established clearway. For the take-off distance available (TODA), the length of the take-off runway available includes the length of the runway plus the clearway. Though there is not a change in the runway length, defining a clearway could provide up to an additional 240 meters for TODA calculations which could be beneficial for users.

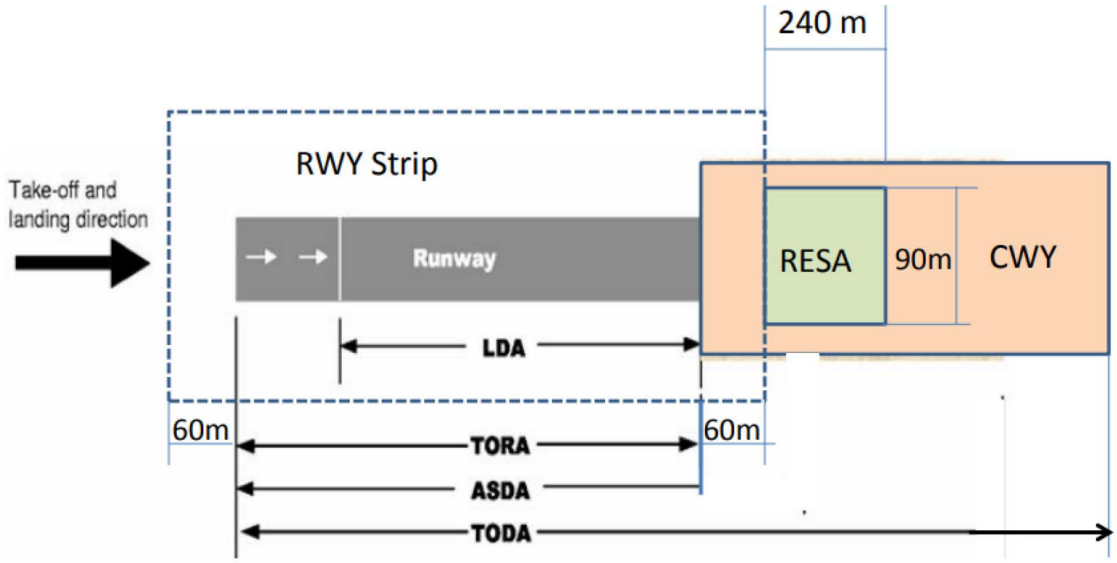


*Figure 13. Declared distances*

Another consideration to achieve additional runway length is to construct an engineered material arresting system (EMAS) on either one or both ends of the runway. By constructing an EMAS system, this would reduce the amount of RESA that needs to be protected by nearly half. This is because of the deceleration properties the system has to quickly stop aircraft that overrun the runway. Since less RESA needs to be protected, the runway could be extended in either one or both directions depending upon where the EMAS is located. At the time of this writing, Runway Safe is the sole manufacturer of EMAS. Constructing an EMAS system is costly compared to other alternative means for either achieving a longer runway or having a compliant RESA, such as acquiring land. Though constructing an EMAS could be a viable consideration for additional runway length, it also requires the aerodrome operator to justify why an EMAS is needed to the approving agency which can be time consuming.

[2] TP312 – Aerodrome Standards and Recommended Practices, 2015