

CHAPTER 6

IDENTIFICATION AND EVALUATION OF ALTERNATIVES

This chapter identifies and evaluates development alternatives for the Duluth International Airport to satisfy the Airport Facility Requirements described in the previous chapter, and to achieve the Airport's strategic goals for future facility improvements. The preferred airfield, terminal area and landside alternatives analyzed in this chapter form the 20-year Master Plan Improvement Program.

Overall, the alternatives analysis process closely follows the guidance provided by FAA Advisory Circular 150-5070-6B *Airport Master Plans*, is developed in accordance with FAA and Mn/DOT airport safety standards, and seeks consistency with Airport ordinances and local regulations. As the formulation of a design recommendation rather than the presentation of a development policy, the alternatives analyses provides the technical basis for arriving at a single, preferred development concept to carry forward as part of the Airport's Capital Improvement Program and updated Airport Layout Plan (ALP) drawings.

6.1 SUMMARY OF ALTERNATIVES

The alternatives assessment is an iterative planning process, a strategic approach to document and illustrate the agreed-to concept of how future development will take form at the Airport. While the assessment of alternatives is based largely on physical merits, professional judgment, and shaped by stakeholder opinion, it is recognized that the most favorable development option should align with the Airport's strategic vision, and in-step with local planning and stakeholder coordination.

The following are the primary alternatives identified in this chapter:

- 6.2 Airfield Alternatives
- 6.3 Taxiway Alternatives
- 6.4 Terminal and Landside Alternatives

6.2 AIRFIELD ALTERNATIVES

The airfield alternatives section assesses the range of various runway and taxiway layouts best suited to accommodate the recommended facility requirements, along with resolving non-standard geometry and airspace issues identified in the previous chapter. The following summarizes the major airfield alternatives and layout options addressed in this chapter:

Alternatives Analysis:

- Resolve Runway 27 In-Line Taxiway 'E' and connecting Taxiways A5, E1 and E2
- Runway 3-21 and taxiway extension

Layout Options:

- Reconfigure Taxiway A, as linear parallel taxiway
- Reconfigure Taxiway C, as linear parallel taxiway
- Extend Taxiway B system
- Reconfigure Taxiway F

6.2.1 Runway 27 (In-Line Taxiway 'E') Alternative

The 1,000 foot in-line Taxiway 'E' is no longer an acceptable FAA geometry, and must be mitigated as part of the master plan recommendations. The options and ability to resolve the in-line taxiway have become more feasible with the closure of the access drive once extending beyond the Runway 27 end. The Runway 27 threshold/end was previously relocated 1,000 feet to satisfy Runway Safety Area (RSA) standards. The former Air National Guard access road (Haines Road/Phantom Drive) located beyond about 250 feet beyond the Runway 27 pavement has since been closed and converted to a secured access for navigational aids. The road and terrain were the RSA factors in the relocation of the Runway 27 end.

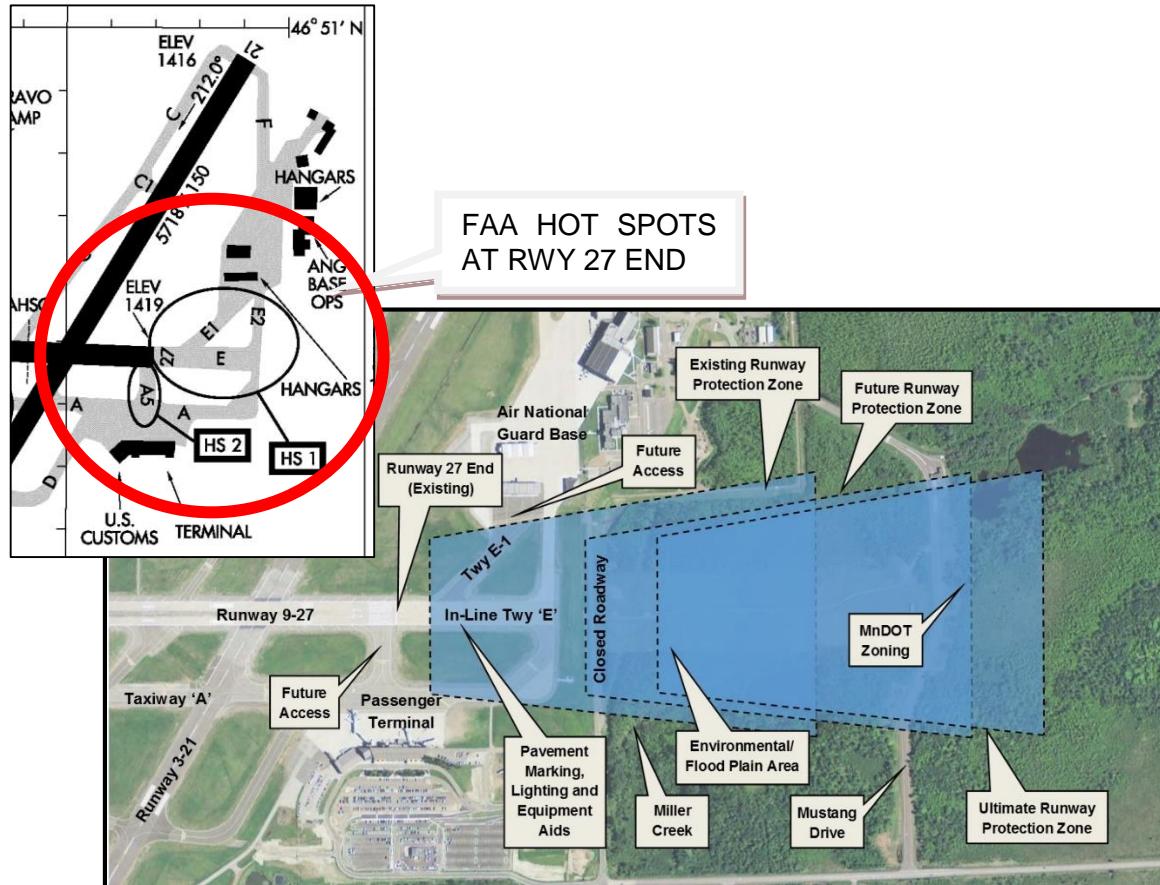
Runway 27 (In-Line Taxiway 'E') Factors:

Exhibit 6-1 illustrates the major factors involved as part of this alternative, as listed below:

- Declare the in-line Taxiway E as future 'usable' or 'unusable' runway for takeoff and/or landing - Alternatives are premised on FAA design and airspace standards. Runway 9-27 and associated taxiways are designed to accommodate Group V civilian aircraft, as represented by the Boeing 747F. The application of military design standards may increase the impacts associated with the alternatives
- Proximity to passenger terminal area and MnANG.
- Connections with existing and future taxiways, shoulders and blast pads
- Taxiway geometry - The Runway 27 end contains multiple FAA hotspots, including Taxiways 'E', 'E1', 'E2', and 'A5'. Taxiway 'E1' may require reconfiguration and/or lowering in the event the Runway 27 end is extended in order to conform with Part 77 primary surface grade requirements
- Application of FAA safety areas and separation standards
- Earthwork and grading - The terrain beyond the Runway 27 end slopes downward about 30' to 40' within the first 1,000 feet; from approximately 1,420' to approximately 1,380'. The terrain is a RSA factor in the location of the Runway 27 end
- Environmental impacts - Miller Creek represents protected headwaters of a trout stream. Minnesota environmental standards do not allow construction within 250 feet of Miller Creek due to its environmental classification as protected headwaters
- Airspace clearances - The conversion of the in-line Taxiway E to usable runway could affect the location of airspace surfaces for approach and departure purposes
- Land ownership
- Application of Mn/DOT safety zones - The conversion of the in-line Taxiway E to usable runway would affect the location of Mn/DOT safety zones (A, B and C)
- Reconfiguration of navigational aids, signage and marking - The Runway 9 localizer, located approximately 2,200' beyond the paved Runway 27 end is expected to be refurbished/replaced, but to remain in its current location
- Impact to precision and non-precision instrument approach procedure

- Aircraft approach and departure flight procedures
- Compatibility with FAA Air Traffic Control visibility, holdshort, and other
- Compatibility with FAA Regional Safety Action Team
- Compatibility with ground operations and vehicle movements
- Construction cost and future maintenance
- Effects on Runway 9-27 pavement reconstruction project

Exhibit 6-1
RUNWAY 27 END GEOMETRY ISSUES AND FACTORS



Source: Aerial Image, June 2010.

Runway 27 (In-Line Taxiway 'E') Alternatives:

The following three alternatives evaluate the recouping of Taxiway 'E' as runway while resolving the non-standard in-line taxiway condition. The alternatives presented in this section are compatible with both FAA Advisory Circular 150/5300-13A: *Airport Design* and United Facilities Criteria 3-260-01: *Airfield and Heliport Planning and Design*.

RWY 27 OPTION A: Convert In-Line Taxiway 'E' (1,000') to Usable Takeoff Runway and Implement Declared Distances for the Runway 27 End. See Exhibit 6-2.

Factors:

- Eliminates in-line taxiway
- Increases Runway 27 takeoff distance by 1,000 feet
- Runway 27 landing threshold remains at same location
- Provides 1,000 foot paved overrun for military operations
- No relocation of ILS navigational aids / no alteration to instrument procedures
- Results in eastward shift in the runway visibility zone (RVZ)
- Apply 600 foot RSA and ROFA length prior to threshold standard
- No change to the holdshort and/or critical hold positions
- No modifications required of the parallel Taxiway 'A' system
- Potentially improves noise footprint within terminal area
- Fill/grading required for paved blast pad
- Change in air traffic control line-of-sight
- Potential environmental considerations associated with wetlands impacts and Miller Creek.
- Limited construction costs
- Limited implementation timeframe

Declared Distances:

| RWY 27 OPTION A - DECLARED DISTANCES | | | | | |
|--------------------------------------|--------|--------|--------|--------|--------------------|
| Runway End | TORA | TODA | ASDA | LDA | Stopway / Clearway |
| Runway 9 | 10,162 | 10,162 | 10,162 | 10,162 | 0' / 0' |
| Runway 27 | 11,162 | 11,162 | 11,162 | 10,162 | 0' / 0' |

TORA - TAKEOFF RUN AVAILABLE | TODA - TAKEOFF DISTANCE AVAILABLE

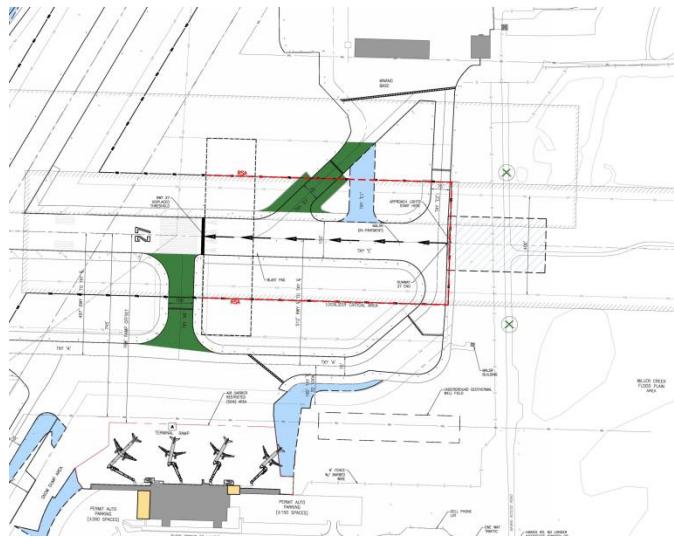
ASDA - ACCELERATE STOP DISTANCE AVAILABLE | LDA - LANDING DISTANCE AVAILABLE

Project Improvements:

- Deactivate Taxiway 'A5' (FAA Hot Spot)
- Deactivate or reconfigure-lower Taxiway 'E1' (FAA Hot Spot)
- Construct paved blast pad (400' beyond x 220' wide)
- Rehabilitate Runway 27 end pavement (1,000' x ±150')
- Modify portion of Runway 27 MALSR approach light units through paved blast pad
- Relocate Runway 27 PAPI-4L
- Reconfigure runway high intensity edge/threshold lights (FAA AC 150/5340, Figure 9)
- Reconfigure runway signage and distance-to-go markers
- Remark Runway 27 end (runway and shoulders)
- Realign portion of NAVAID access route
- Realign fencing
- Shift of Part 77 imaginary surfaces
- Possible shift/extension of Mn/DOT Land Use Safety Zones (A, B and C)
- Possible relocation of the military BAK arresting system

- Possible tree/vegetation clearing beyond Runway 27 end

Exhibit 6-2
RUNWAY 27 – OPTION A



RWY 27 OPTION B: Convert In-Line Taxiway 'E' (1,000') to Unrestricted Runway Length. See Exhibit 6-3.

Factors:

- Repositions Runway 27 end
- Eliminates in-line taxiway
- Does not invoke declared distances, improves pilot awareness
- Does not provide 1,000' foot paved overrun for military operations
- Increases Runway 27 takeoff and landing distance by 1,000 feet
- Runway Safety Area (RSA) earthwork
- Relocation of ILS navigational aid equipment
- Alters Runway 27 and 9 instrument approach procedures
- Results in eastward shift in the runway visibility zone (RVZ)
- Change to the holdshort and/or critical hold positions
- Change in air traffic control line-of-sight
- No modifications required of the parallel Taxiway 'A' system
- Potentially improves noise footprint within terminal area
- Substantial environmental considerations (Miller Creek)
- Substantial construction costs
- Substantial implementation timeframe

Declared Distances:

RWY 27 OPTION B - DECLARED DISTANCES

| Runway End | TORA | TODA | ASDA | LDA | Stopway / Clearway |
|------------------|--------|--------|--------|--------|--------------------|
| Runway 9 | 11,162 | 11,162 | 11,162 | 11,162 | 0' / 0' |
| Runway 27 | 11,162 | 11,162 | 11,162 | 11,162 | 0' / 0' |

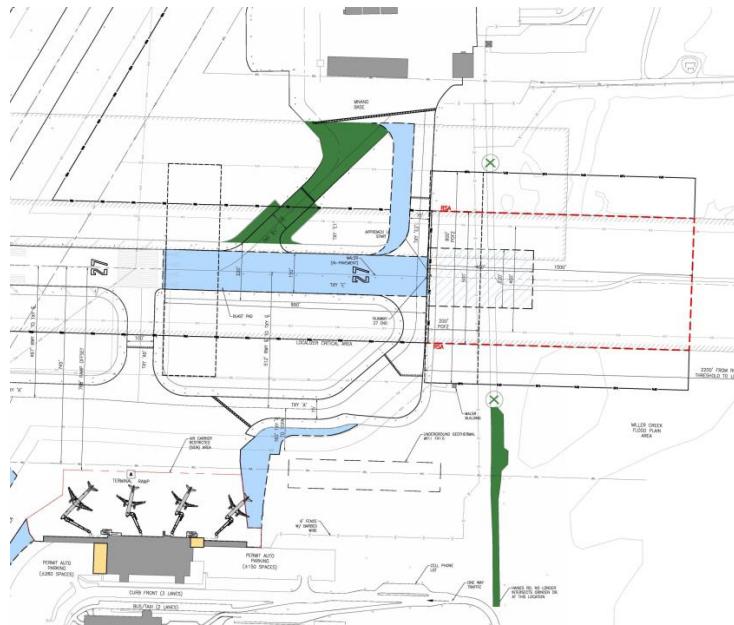
TORA - TAKEOFF RUN AVAILABLE | TODA - TAKEOFF DISTANCE AVAILABLE

ASDA - ACCELERATE STOP DISTANCE AVAILABLE | LDA - LANDING DISTANCE AVAILABLE

Project Improvements:

- Fill/grade for Runway Safety Area (RSA) dimension of 1,000' (beyond) x 500' (wide)
- Deactivate/remove Taxiway 'A5' (FAA Hot Spot)
- Deactivate/remove Taxiway 'E1' (FAA Hot Spot)
- Widen Taxiway 'E2' (FAA Hot Spot)
- Construct paved blast pad (400' beyond x 220' wide)
- Rehabilitate Runway 27 end pavements (1,000' x ±150')
- Relocate Runway 27 ILS glideslope equipment
- Relocate Runway 27 MALSR approach lighting equipment
- Relocate Runway 27 PAPI-4L
- Reconfigure runway high intensity edge/threshold lights (FAA AC 150/5340, Figure 7)
- Reconfigure runway signage and distance-to-go markers
- Remark Runway 27 end (runway and shoulders)
- Realign portion of NAVAID access route
- Realign/install new airfield fencing
- Shift of Part 77 imaginary surfaces, TERPS surfaces, RPZ, POFZ, Departure Surface
- Aeronautical study for change to instrument and possible air traffic procedures
- Shift/extension of Mn/DOT Land Use Safety Zones (A, B and C)
- Possible relocation of the military BAK arresting system
- Potential land/aviation easement acquisition beyond Runway 27 end
- Tree/vegetation clearing beyond Runway 27 end

Exhibit 6-3
RUNWAY 27 – OPTION B



RWY 27 OPTION C: Remove In-Line Taxiway 'E' and Adjoining Taxiways. See Exhibit 6-4.

Factors:

- Eliminates in-line taxiway
 - Inefficient taxiway configuration for Air National Guard access
 - Runway 27 end remains at same location - no change in Runway 27 takeoff or landing distance
 - Provides paved overrun for military operations
 - No relocation of ILS navigational aids / no alteration to instrument procedures
 - No change in the runway visibility zone (RVZ)
 - Alters parallel Taxiway 'A' entrance system
 - No fill/grading required beyond runway end
 - No change in air traffic control line-of-sight
 - Limited environmental considerations / moderate construction costs

Declared Distances:

RWY 27 OPTION C - DECLARED DISTANCES

| Runway End | TORA | TODA | ASDA | LDA | Stopway / Clearway |
|-------------------|-------------|-------------|-------------|------------|---------------------------|
| Runway 9 | 10,162 | 10,162 | 10,162 | 10,162 | 0' / 0' |
| Runway 27 | 10,162 | 10,162 | 10,162 | 10,162 | 0' / 0' |

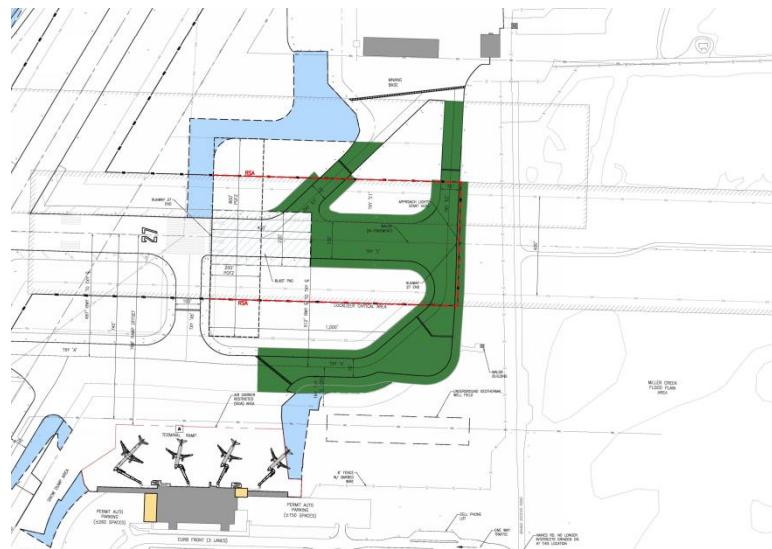
TOA - TAKEOFF RUN AVAILABLE | TODA - TAKEOFF DISTANCE AVAILABLE
ASDA - ACCELERATE STOP DISTANCE AVAILABLE | LDA - LANDING DISTANCE AVAILABLE

Project Improvements:

- Remove portion of Taxiway 'E'; Remove Taxiway 'E1' and 'E2' (FAA Hot Spot)
 - Rehabilitate paved blast pad (400' beyond x 220' wide)

- Remove existing Taxiway 'A' entrance system
 - Construct new northside taxiway entrance system

Exhibit 6-4
RUNWAY 27 – OPTION C



Mn/DOT Zoning Considerations:

The 1988 Duluth International Zoning Ordinance prescribes the Mn/DOT Safety Zones (A, B and C) for the Runway 27 end based on a precision instrument approach to the existing 1,000-foot in-line taxiway configuration. It should be noted that the 1988 Safety Zone 'A' boundary for the Runway 9 and 27 ends have been modified from Mn/DOT standards to coincide with property ownership boundaries, roadway and political boundaries.

Exhibit 6-5 depict the standard Mn/DOT Zone A and B dimensions and boundaries associated with the conversion of the inline Taxiway 'E' as usable pavement, and the identification of residences and businesses within the Zone A, as compared with the 1988 Zoning Ordinance.

Runway 27 (In-Line Taxiway 'E') Alternative Recommendation:

Following a consideration of factors involved, Option A was selected by the Airport as the preferred development concept. In addition, the alternatives were vetted with the Air National Guard, in which Alternative A was viewed as the preferred option. The following factors were a consideration in the desire to proceed with Option A:

- Resolves the FAA runway and connecting taxiway geometry issues, although invoking declared distances for a displaced (landing) Runway 27 threshold.
 - Improves aircraft circulation and pilot awareness for the Runway 27 end. Permits more effective air traffic control utilization, including intersection takeoffs and landing hold short operations. Provides a safer and more efficient entry and exit points between the runway and terminal locations.

- Provides a means to improve airspace clearances at the Runway 27 approach end, and lateral airspace clearance for the passenger terminal area and Air National Guard complex.
- By virtue of the conversion of Taxiway 'E' to usable runway length, the Runway 9-27 length is increased to 11,162 feet, which nearly achieves the future Runway 9-27 recommended runway length of 11,600 feet. This preserves runway length for Airport opportunities, including FBO fuel Techstops, the MRO tenant, and future Air National Guard missions. It should be noted that any consideration for extension of the Runway 9 end as a means to restore or recoup Runway 27 in-line Taxiway 'A' length was not considered as part of this alternatives analysis.
- Allows greater flexibility and segmentation of pavement surfaces use during periods of runway maintenance, snow removal, heavy flight training, and military operations.
- Minimizes costs and environmental implications associated with navigational and equipment relocation, and grading beyond the Runway 27 end. The high level environmental evaluation indicated that Alternative A would have less environmental impact compared with Alternative B. It should be noted that the alternatives analysis focused on the physical aspects of the options, and did not include a full analysis of all environmental, economic and costs aspects.

Runway 27 (In-Line Taxiway 'E') Alternative Evaluation:

The Runway 27 (In-line Taxiway E) alternatives were further evaluated per FAA AC 150/5070-6B, Paragraph 904 *Evaluation of Alternatives*. The AC outlines four general categories to evaluate the preferred alternative: Operational Performance, best planning tenets and other factors, environmental factors, and fiscal factors. The alternative was evaluated for each of the general categories

- Operational Performance – This category evaluates the criteria from several perspectives including capacity, capability, and efficiency.
Option A was determined to have the highest capability to meet the goals of the project and the highest efficiency for the taxiway system.
- Best Planning Tenets and Other Factors – This Category evaluates the alternatives strengths and weaknesses such as safety and security, growth beyond the planning horizon, conforms to the airport sponsor's strategic vision, flexible to change, satisfies user needs, etc.
Option A was determined to meet the best planning tenets for the airport providing a balance of capacity and flexibility to meet demand beyond the planning period.
- Environmental Factors – This category evaluates the alternative for potential environmental effects. The three alternatives were evaluated on a high level basis for each of the environmental factors that were determined to be in the airport environment. The alternatives evaluation is shown in Table 6-1.

Table 6-1
Runway 27 (In-Line Taxiway 'E') Environmental Evaluation

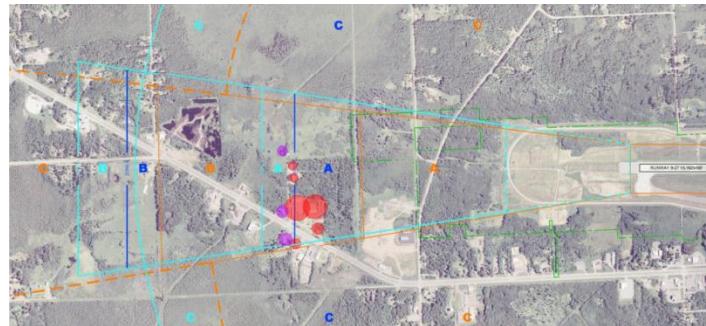
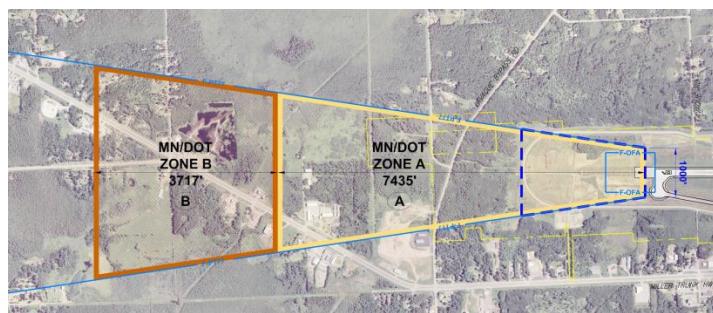
| Category | Evaluation |
|--|---|
| Compatible Land use | Alternative is within the airfield system |
| Construction Impacts | Minimal impacts due to the project being completely on airport property |
| Fish, Wildlife, and Plants | Possible tree/vegetation clearing beyond Runway 27 end |
| Floodplains | Alternative is within the airfield system |
| Hazardous Materials, Pollution Prevention, and Solid Waste | Alternative is not adding capacity or changing operations |
| Light Emissions and Visual Impacts | Alternative is not adding capacity or changing operations |
| Natural Resources and Energy Supply | Alternative is not adding capacity or changing operations |
| Noise | Alternative is not adding capacity or changing operations |
| Secondary (Induced) | Alternative is not adding capacity or changing operations |
| Socioeconomic, Environmental Justice, and Children's Environmental Health and Safety Risks | Alternative is entirely on airport property |
| Wetlands | Alternative is within the airfield system |

- Fiscal Factors – This category evaluates the alternative based on rough cost estimates.

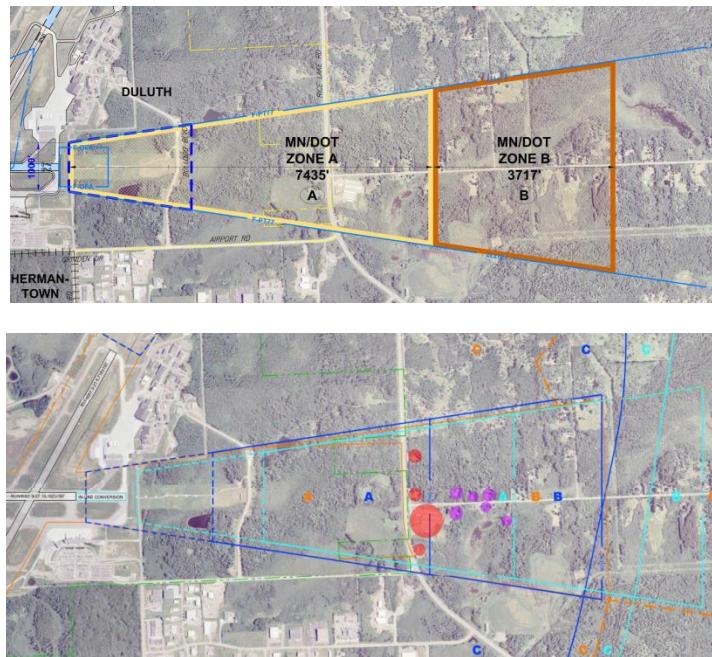
It was determined that Option A had limited construction costs when compared with the other developed alternatives.

Exhibit 6-5
RUNWAY 9 & 27 – Mn/DOT Zoning

RUNWAY 9 END



RUNWAY 27 END



6.2.2 Runway 3-21 Length Alternatives

The facility requirements section identifies the extension of Runway 3-21 to a future interim length of 7,000 feet, and an ultimate strategic length of 8,000 feet to accommodate transports associated with commercial passenger service, large cargo transport aircraft affiliated with FBO Techstop traffic, and by the Minnesota Air National Guard (MNANG) for serving the mission based in Duluth.

Runway 3-21 Planning Considerations:

The following outlines the major considerations involved as part of extending Runway 3-21:

- Runway 3-21 is a commercial service runway intended to accommodate FAA ARC C-III aircraft as represented by the CRJ-900, Embraer 170/190, Boeing 737 and MD-80. For planning and design purposes, the Runway 3-21 FAA design standards and Mn/DOT non-utility role remain the same for existing and future conditions.
- Runway 3-21 is to continue serving as a secondary commercial service runway, and as an alternate landing and departing runway during periods when the primary Runway 9-27 is non-operational. As calculated from recorded weather data observations, Runway 3-21 is required to serve all aircraft during periods existing on approximately 126 days per year (35 percent of the time) due to the combination of wind, visibility/ceiling conditions, and otherwise during periods of the day when the primary Runway 9-27 experiences snow, slush and ice contamination and routine closure due to maintenance and repair.
- Runway 3-21 is recommended as a future precision instrument runway using satellite GPS technology, with a precision instrument procedure with positive vertical guidance planned to the Runway 21 end and an approach lighting system contemplated. Currently, Runway 3-21 is a non-precision instrument approach with vertical path guidance (LPV approach), with visibility

minimums as low as 1½ miles on the Runway 3 end and 1-mile on the Runway 21 end. As a future precision runway, the Part 77 imaginary airspace approach surface and clearances become more stringent. Also, by Mn/DOT standards, any runway of 5,000 feet or more should be planned to precision capabilities, which influences the Mn/DOT Clear Zone and Mn/DOT Safety Zone A and B dimension.

- As a planned future precision instrument runway serving commercial ARC C-III aircraft, a full length parallel taxiway system is required by FAA design standards. It is recommended Taxiway 'C' be shifted/relocated/extended to a future 400' runway-to-taxiway centerline separation.
- The Runway 3-21 alternatives only considered options along the existing runway alignment, and did not contemplate relocation or realignment of the runway for several important reasons. One the wind data indicates that the current alignment of the runway is optimum for reducing crosswind to aircraft operations. Secondly, any consideration of a runway alignment other than existing Runway 3-21 would require the relocation of substantial airfield development. As identified on the Airport Diagram, Exhibit 3-2, the intersection of Runway 9-27 and Runway 3-21 divides the airport into quadrants. Any shift in the alignment of Runway 3-21 to the east would intuitively induce considerable expense in either impacting the terminal area and taxiway system on the Runway 3 end or Taxiway 'C' and the taxiway connections to the MNANG on the Runway 21 end. Any shift in the alignment of Runway 3-21 to the west would severely impact the air cargo area on the Runway 3 end and the MNANG apron and taxiway connections on the Runway 21 end.
- Due to infrastructure, airport property ownership, and the existing land uses to the south of Runway 3-21, the future runway extensions were only considered along the north Runway 21 end.
- Consideration of potential Airport developments planned in the northwest quadrant (north of Taxiway 'B').
- Existing military use as a taxiway and limited touch and go runway, and potential military use as a usable runway for landing and takeoffs.

Runway 3-21 Extension Factors:

The following outlines the major physical site and land use factors associated with the planned Runway 3-21 extension to the northeast:

- Airport zoning is currently reflected by the 1988 Duluth Airport Zoning Ordinance document. This ordinance provides Runway 3-21 with Mn/DOT Safety Zone standards based on a precision instrument approach, as the result of the runway being longer than 5,000 feet.

The Mn/DOT Safety Zone A and B dimension coincides with the FAA Part 77 inner approach surface, while the inner portion of the Safety Zone A dimension corresponds with the Mn/DOT Clear Zone boundary, which also coincides with the FAA Runway Protection Zone (RPZ) dimension. Mn/DOT policy requires the Airport fee ownership of Clear Zones, similarly in which the FAA design standards recommend airport ownership of the entire Runway Protection Zones (RPZ). Use restrictions for Mn/DOT Zone A extend two-thirds of the existing or planned runway length, as generally regulated by type of development. Use restrictions for Mn/DOT Zone B extend one-third of the existing or planned runway length, as generally regulated based on building densities. The following lists the Mn/DOT Safety Zone lengths:

1988 Duluth Zoning Ordinance:

- Runway 03: Zone A Length = ±3,100' / Zone B Length = ±1,785'
- Runway 21: Zone A Length = ±4,500' / Zone B Length = ±1,990'

Mn/DOT Standards at Existing 5,718' Length:

- Runway 03: Zone A Length = 3,812' / Zone B Length = 1,906'
- Runway 21: Zone A Length = 3,812' / Zone B Length = 1,906'

Mn/DOT Standards for 7,000' Interim Planned Length:

- Runway 03: Zone A Length = 4,667' / Zone B Length = 2,333'
- Runway 21: Zone A Length = 4,667' / Zone B Length = 2,333'

Mn/DOT Standards for 8,000' Ultimate Planned Length:

- Runway 03: Zone A Length = 5,333' / Zone B Length = 2,667'
- Runway 21: Zone A Length = 5,333' / Zone B Length = 2,667'

Note: Zone A is the primary emphasis of the Runway 3-21 extension analysis. Zone B was not fully assessed due to unknown site and building density conditions.

Note: The 1988 Ordinance called for the relocation of the Runway 3 threshold 750 feet northeast to remove existing development from the area impacted by the Zone A restrictions, however, this runway relocation did not occur.

- Taxiway access to the Runway 21 end along Taxiway 'C' is occasionally restricted to only Category A and B aircraft due to the non-standard runway-to-taxiway centerline separation. Taxiway access to the Runway 3 end along Taxiway 'C' is constrained by the air cargo ramp.
- Runway Visibility Zone (RVZ) line-of-sight standards between Runway 3-21 and Runway 9-27.
- Northeast of Runway 3-21 is a deactivated Western Lake Superior Sanitary District landfill with a top elevation of about 1,475 feet; about 60 feet above the Runway 21 end elevation. There are no known airspace obstruction impacts associated with the Runway 3-21 options, aside from the typical grading and tree clearing requirements.
- Paved airfield perimeter road beyond the Runway 3 and 21 ends.
- Environmental considerations beyond the Runway 3 and 21 ends.

Summary of Runway 3-21 Extension Options:

The Runway 3-21 extension options (A, B, C, D and E) each reflect an ultimate 8,000 foot length, and have been developed in response to accommodating the Mn/DOT Safety Zones with minimal impact. The options assess various combinations of displaced thresholds and relocated runway ends using standard and non-standard Mn/DOT zone lengths in order to achieve an optimal land use condition for the future Runway 3 and 21 ends. The following is a brief discussion and corresponding exhibit of the five Runway 3-21 options (A, B, C, D and E) under consideration:

OPTION A: Relocate Runway 3 end 3,600'; 5,900' Runway 21 extension

OPTION B: Displace Runway 3 end 750'; 2,282' Runway 21 extension

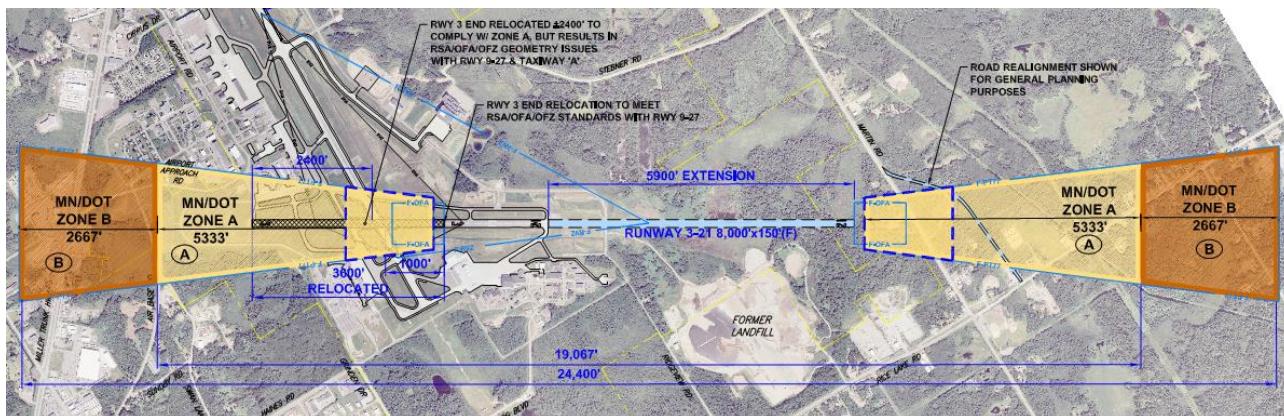
OPTION C: Relocate Runway 3 end 750'; 3,032' Runway 21 extension

- OPTION D:** Displace and Relocate Runway 3 end a total of 1,400'; 3,032' Runway 21 extension
OPTION E: Maintain Runway 3 end; 2,282' Runway 21 extension

Exhibit Depiction: Runway Extension (blue hatch)
Mn/DOT Zone A (yellow hatch)
Mn/DOT Zone B (orange hatch)
Mn/DOT Clear Zone (blue dashed)

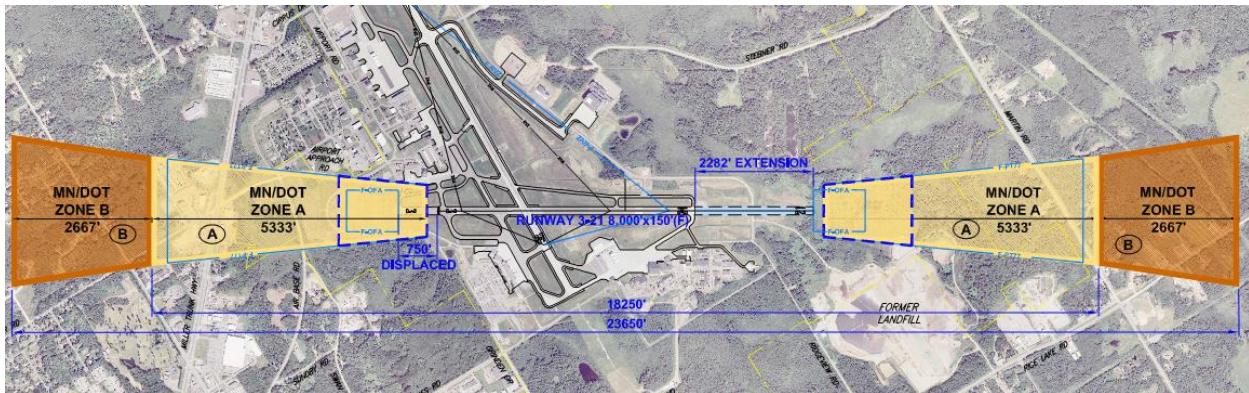
Runway 3-21 OPTION A: Involves the relocation of the Runway 3 end 3,600 feet to the northeast in an attempt to provide for full Mn/DOT Zone A conformance, which also includes locating the Runway 3 end 1,000 feet beyond the Runway 9-27 centerline to meet FAA Runway Safety Area (RSA), Object Free Area (OFA), and Object Free Zone (OFZ) standards. This requires a Runway 21 extension of 5,900 feet to obtain a future 8,000-foot length. This option results in extensive on and off-Airport infrastructure and roadway improvements, substantial property acquisition, and penetrations to the future Runway Visibility Zone (RVZ) between the Runway 21 end and Runway 9-27. This option would still likely require a variation to the Mn/DOT Safety Zone standards. See Exhibit 6-6.

Exhibit 6-6
RUNWAY 3-21 8,000' LENGTH – OPTION A



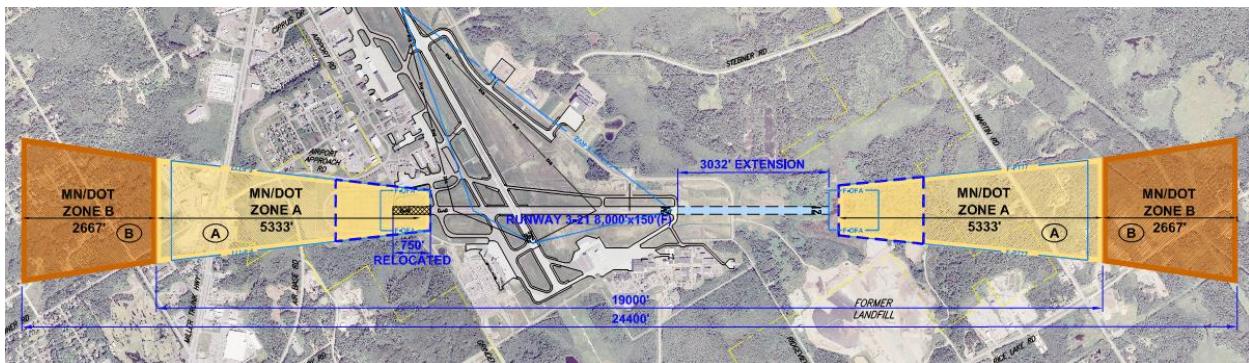
Runway 3-21 OPTION B: Involves the displacement of the Runway 3 end by 750 feet and extension of the Runway 21 end by 2,282 feet to achieve a future 8,000-foot length. The displaced threshold would shorten the Runway 3 landing distance available (LDA). The 750-foot distance coincides with prior zoning considerations to remedy land developments beyond the Runway 3 end. Geometrically, the proposed Runway 3 end displacement coincides with Taxiway 'D' as a future entry taxiway. This option would require a variation to the Mn/DOT Safety Zone standards. See Exhibit 6-7.

Exhibit 6-7
RUNWAY 3-21 8,000' LENGTH – OPTION B



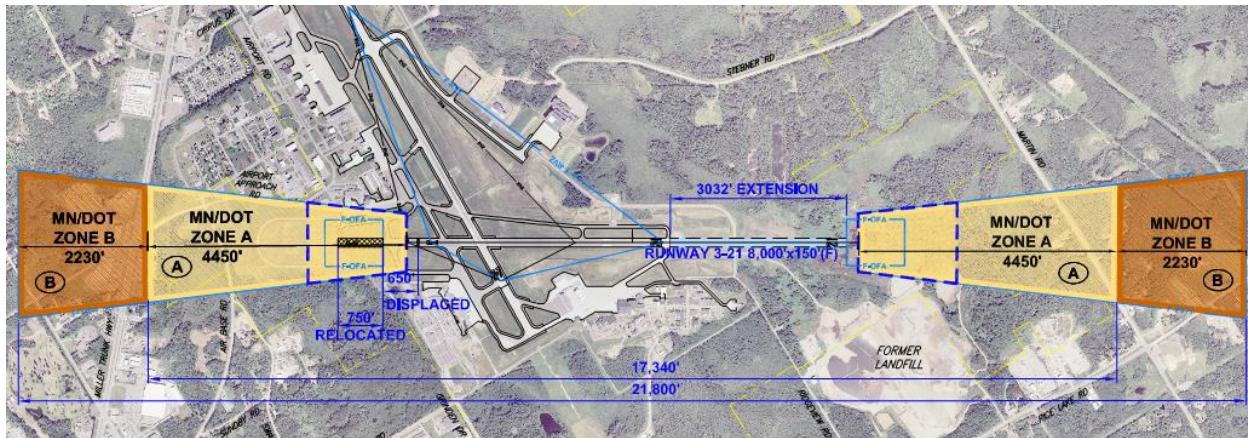
Runway 3-21 OPTION C: Involves the relocation of the Runway 3 end by 750 feet and extension of the Runway 21 end by 3,032 feet to achieve a future 8,000-foot length, including recouping the relocated 750 foot Runway 3 end. The 750 feet beyond the Runway 3 end could not be used for landing or takeoff, but could be converted into a paved blast pad. The 750-foot distance coincides with prior zoning considerations to remedy land developments beyond the Runway 3 end. Geometrically, the Runway 3 end coincides with Taxiway 'D' as a future entry taxiway. See Exhibit 6-8.

Exhibit 6-8
RUNWAY 3-21 8,000' LENGTH – OPTION C



Runway 3-21 OPTION D: Involves a combination of displaced thresholds and relocated runway end criteria to the Runway 3 end to obtain a future 8,000' runway length. This entails relocating the Runway 3 end 750 feet in addition to displacing the Runway 3 end another 650 feet (1,400 feet from the existing Runway 3 end) and extending the Runway 21 end 3,032 feet. The displaced threshold would shorten the Runway 3 landing distance available (LDA). The 1,400 foot location was identified in the previous Master Plan as an acceptable Zone A and B distance, in which a safety zone variance could reasonably be sought from Mn/DOT. In this option, the Zone A and B lengths are non-standard for the ultimate 8,000 foot Runway 3-21 length. See Exhibit 6-9.

Exhibit 6-9
RUNWAY 3-21 8,000' LENGTH – OPTION D



Runway 3-21 OPTION E: Involves an extension without displaced threshold and/or relocated Runway 3 end criteria to obtain a future 8,000' runway length. The existing Runway 3 end would remain at the present location, with a 2,282 foot extension to the Runway 21 end. This option does not require a change to the Runway 3 end (lighting, signage, marking, instrument procedures), or recouping runway length as part of the Runway 21 extension. See Exhibit 6-10.

Exhibit 6-10
RUNWAY 3-21 8,000' LENGTH - OPTION E (PREFERRED)



Preferred Runway 3-21 Alternative Recommendation:

The Runway 3-21 extension Option E is the preferred expansion concept, as per the following assessments and development factors:

- + Does not involve displaced or relocated thresholds, which eliminates change to the Runway 3 end for lighting, marking, signage or instrument procedures, and therefore, does not require recouping usable runway length as part of the Runway 21 extension. This also aids with the future pavement improvements and extension constructability to Runway 3-21.
- + Requires the least runway extension of all options, which minimizes environmental and cost impacts. It should be noted the planned extension would require more formal environmental study prior to construction, including possible noise analysis.
- + The ultimate Runway 3 Mn/DOT Clear Zone remains on existing Airport property. The ultimate Runway 21 Mn/DOT Clear Zone extends beyond existing Airport property, for an approximate 0.5 acre area.
- + The Runway Visibility Zone (RVZ) northwest of the runway intersection between Runway 21 and Runway 9 involves potential tree (wooded area) encroachments, but no structures.
- + The existing and planned Runway 21 threshold elevation is 1,415.9'. At this elevation, the Part 77 imaginary airspace surfaces (approach and transitional) do not encroach the former landfill northeast of Runway 3-21. The landfill highest top elevation is estimated at 1,475.0 feet mean sea level, a point approximately 4,350 feet from the existing Runway 21 end and 1,350 feet from the ultimate Runway 21 end.
- The Runway 3-21 extension would likely require an update of the 1988 Duluth Airport Zoning Ordinance to bring the existing Runway 3 and future Runway 21 land use safety zones in accordance with recommended Mn/DOT standards. It should be noted that the updated ordinance may require a continuation of exemptions, waivers and/or variances to address non-standard compliance items. Mn/DOT coordination (2014) has indicated that land use conditions within existing Zones A and B should not be allowed to worsen with the runway extension. Zone A requirements would be subject to the first 1,000-feet of Zone A length.
- The departure surface extending over Taxiway 'C' could present issues with the location of hold short positions east and west of Runway 3-21.
- Taxiway access to the future Runway 21 end from the east presents taxiway geometry issues with Minnesota Air National Guard taxiway facilities. Taxiway 'F' provides the Minnesota Air National Guard Ramp access to the Runway 21 end. The Minnesota Air National Guard's Installation Development Plan recommends realignment of Taxiway 'F' as a future partial parallel taxiway to Runway 21 with a taxiway-to-runway separation of 400 feet, and an additional exit Taxiway to Runway 3-21. The Guard's Development Plan also recommends extending Taxiway 'F' commensurate to any Runway 21 extension.
- The perimeter airfield access road north of Runway 21 would require relocation.
- The alternative is consistent with the FAA Advisory Circular 150/5300-13A, Change 1 and Unified Facility Criteria 3-260-01.

Preferred Runway 3-21 Alternative Evaluation:

The Runway 3-21 alternatives were further evaluated per FAA AC 150/5070-6B, Paragraph 904 *Evaluation of Alternatives*. The AC outlines four general categories to evaluate the preferred alternative: Operational Performance, best planning tenets and other factors, environmental factors, and fiscal factors. The alternative was evaluated for each of the general categories

- Operational Performance – This category evaluates the criteria from several perspectives including capacity, capability, and efficiency.
The Option E alternative for the extension of Runway 3-21 was determined to have the highest capability to meet the goals of the project and provides the highest efficiency for the runway system.
- Best Planning Tenets and Other Factors – This Category evaluates the alternatives strengths and weaknesses such as safety and security, growth beyond the planning horizon, conforms to the airport sponsor's strategic vision, flexible to change, satisfies user needs, etc.
The Option E alternative was determined to meet the best planning tenets for the airport providing a balance of capacity and flexibility to meet demand beyond the planning period.
- Environmental Factors – This category evaluates the alternative for potential environmental effects. The five alternatives were evaluated on a high level basis for each of the environmental factors that were determined to be in the airport environment. The evaluation is shown in Table 6-2.

Table 6-2
Preferred Runway 3-21 Alternative Environmental Evaluation

| Category | Evaluation |
|--|---|
| Compatible Land use | The alternative is compatible with land use guidelines |
| Construction Impacts | Construction may impact nearby communities |
| Fish, Wildlife, and Plants | Clearing on vegetation and grading will be required off the Runway 21 end |
| Floodplains | Further evaluation will be needed |
| Hazardous Materials, Pollution Prevention, and Solid Waste | |
| Light Emissions and Visual Impacts | |
| Natural Resources and Energy Supply | |
| Noise | Noise impacts to the community may be impacted due to increased capacity |
| Secondary (Induced) | Future evaluation will be needed |
| Socioeconomic, Environmental Justice, and Children's Environmental Health and Safety Risks | Alternative is within airport property |
| Wetlands | Further evaluation will be needed |

- Fiscal Factors – This category evaluates the five options based on rough cost estimates.
It was determined that Option E had the least construction cost when compared with the other developed alternatives.

6.2.3 Options for Temporary Runway During Center Portion of Runway 9/27 Reconstruction

Chapter 5 – Facility Requirements established that the key needs for DLH in the future have to do with runway and taxiway reconstruction and rehabilitation. Much of the envisaged airport development program consists of these types of projects.

This section describes phasing alternatives associated with the center portion of Runway 9/27 reconstruction. As described above, the runway is anticipated to be reconstructed in three phases; Phase I, the east end (approximately 2,800 feet); Phase II, the west end (approximately 2,000 feet); and Phase III, reconstruction of the center portion of the runway of about 6,200 feet. When Phase III is construction, it will be necessary to find an acceptable alternative to keep the airport open. It has not been determined at this time whether the center portion of the runway's reconstruction will require one or two construction seasons to perform due to the unknown nature of the weather conditions for the construction seasons at the time of construction.

The Master Plan considers “keeping the airport open” meaning the provision of 7,000 feet of runway which is a minimum runway length for accommodating commercial and military operations, as determined through detailed interviews with both the airlines the Minnesota Air National Guard. Although 7,000 feet will ensure the airport can remain operational, the reduced runway length may limit some large transport techstop and military aircraft operations as discussed in Chapter 5 – Facility Requirements.

It is anticipated that some portion of Category C aircraft (5% which may be conservative) and Category D aircraft would require some payload reduction to operate on 7,000-feet. In terms of operational levels over the period of 2010-2030, depending upon the point at which this project could occur, approximately 750-1,000 Category C and Category D aircraft operations would be impacted or more, not counting impacts to military air traffic. No estimate is made regarding the potential for impacting military fighter jet or transport aircraft. The fast approaching military aircraft use Runway 9-27 exclusively for arrivals which is the impetus for the ultimate extension of Runway 3-21 to 8,000 feet. It would be assumed that military fighter jet and transport aircraft requiring more than 7,000-feet would not operate at DLH during the period of reconstruction of the center portion of Runway 9-27 even with the extension of Runway 3-21 to 7,000-feet.

There are four options that available to DLH to “keep the airport open”. These are:

- Nighttime Closure and Individual Panel Replacement of the Center Portion of Runway 9/27. This option would keep Runway 9/27 operational;
- Extension of Taxiway ‘A’ for Use as a Temporary Runway in Lieu of Runway 9/27;
- Extension of Taxiway ‘B’ for Use as a Temporary Runway in Lieu of Runway 9/27; and,
- Extension of Runway 3/21.

Background

Runway 9/27 was constructed in the late 1940's. The pavement structure consists of 10" of Portland Cement Concrete (PCC) on 7" of aggregate base, on a 4" filter course aggregate, on select subgrade fill.

The Pavement Condition Index (PCI) of Runway 9/27 in 2010 ranged from fair to poor on the west end to very good to excellent on the east end of the runway. This represents some of the lowest rated pavement on the runway. Since PCI is a surface rating based on a visual inspection of the

runway, additional testing was done to better determine the condition of the in-place pavement structure.

Pavement cores were taken at various locations on Runway 9/27. American Engineering and Testing conducted an engineering analysis to determine the pavement condition of Runway 9/27. The study included a field investigation of pavement condition and falling weight deflectometer testing of the runway. The results of the investigation are summarized in the "Report of Pavement Testing and Engineering Analysis" dated June 24, 2009.

The findings of the report indicated that the runway concrete panels are on the low side of adequacy in structural strength and load transfer. Large voids exist under the concrete panels in corners where subgrade support needs improvement. It is anticipated that the concrete panels will perform adequately for a limited time period, but structural improvements should be planned in the near future. It is anticipated that the pavement will be beyond its useable life in 5 to 10 years and will require reconstruction.

When Runway 9/27 is reconstructed, phasing needs to be developed to minimize construction impacts to the airport, especially to air carrier operations. Similar to phasing developed during the Runway 9/27 shoulder project, the east and west ends of the runway can be reconstructed while maintaining an 8,000 foot runway. When the center section is reconstructed, runway 9/27 will need to be closed to aircraft traffic.

Runway 9/27 Night Closure Panel Replacement

Without an adequate alternate runway that could be used during reconstruction of Runway 9/27, the only alternative would be night closure and nighttime construction on Runway 9/27. To be able to reopen the runway each morning, panels would need to be replaced with high early strength concrete. No changes in longitudinal or transverse grades would be able to be accommodated by this construction method.

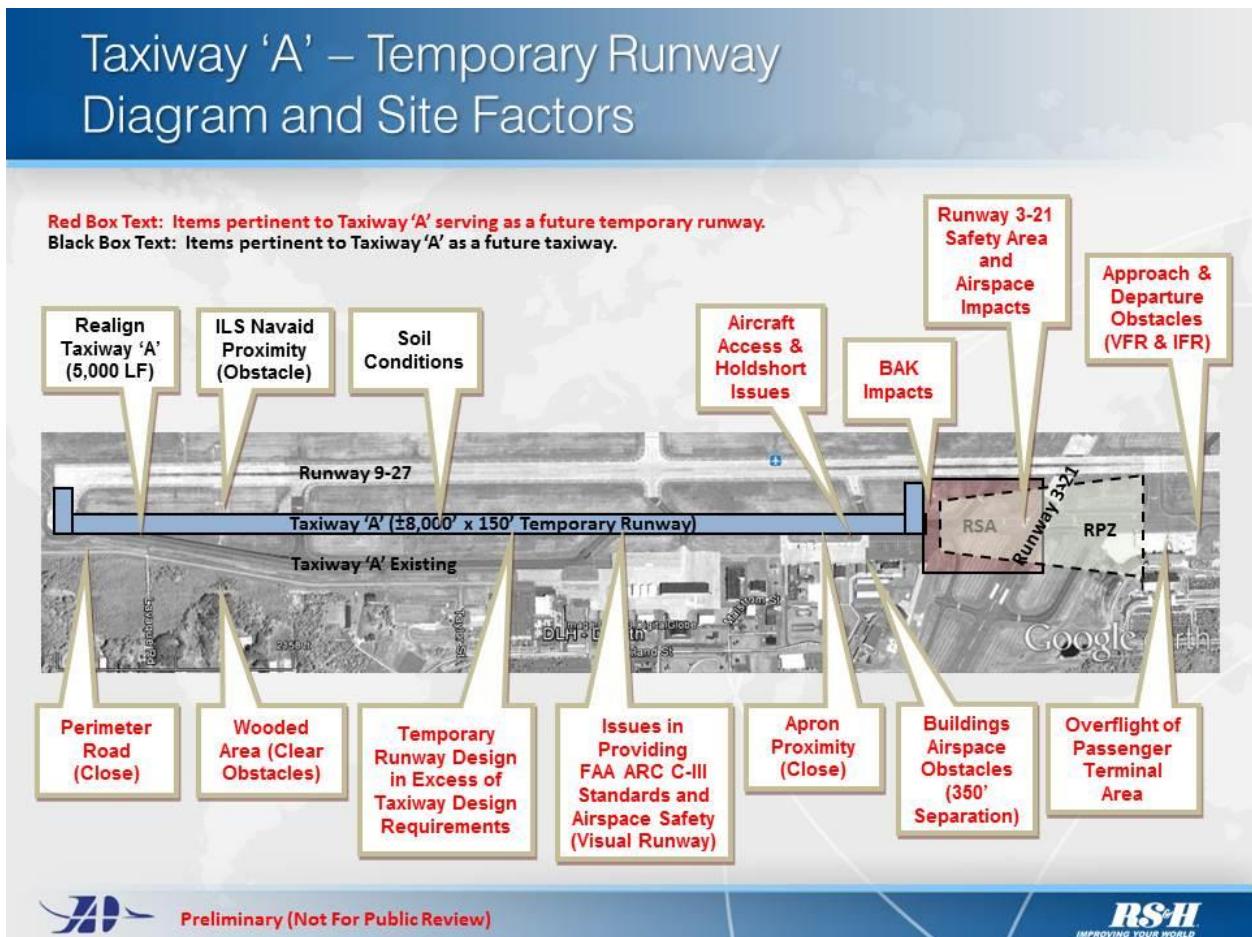
The panel replacement rehabilitation method would not allow for any substantial change in the pavement structure. Running the FAA pavement design software using a thicker concrete panel (14") on the existing base and subgrade material results in less than six months expected pavement life. Additional pavement base corrections would not be possible in the limited overnight construction timeframe. Panel replacement using high early strength concrete would be substantially more expensive and greatly increase the construction time necessary to complete the project. Also, there have been durability issues with high early strength concrete, especially if not constructed properly, which resulted in early failures of the pavement.

A 14 ½" unbounded overlay of the runway would provide the pavement life necessary per FAARFIELD. This would require closure of the runway until the project is completed.

Taxiway 'A' Re-Alignment/Temporary Runway

Taxiway 'A' is currently 75' wide and has an S-curve in the approximate middle of the taxiway. The PCI rating of Taxiway 'A' ranges from Fair to Poor. To meet the requirements of a temporary runway, Taxiway 'A' would need to be strengthened, widened and straightened. Construction of Taxiway 'A' to be used as a temporary runway would require construction of the taxiway in excess of what would be required by taxiway standards. There are many issues associated with this option as shown on the exhibit below.

Exhibit 6-11
USE OF TAXIWAY 'A' AS A TEMPORARY RUNWAY



Taxiway 'B' Extension/Temporary Runway

Taxiway 'B' is currently 75' wide with paved shoulders. The PCI rating of the taxiway is very good. To meet the requirements of a temporary runway, Taxiway 'B' would need to be extended to the west. Extension of Taxiway 'B' is shown as future development on the ALP. But building Taxiway 'B' to be able to be used as a temporary runway would require construction of additional taxiway length than what is currently planned and construction of the taxiway in excess of what would be required by taxiway standards. There are many issues associated with this option as shown on the exhibit below.

Exhibit 6-12
USE OF TAXIWAY 'B' AS A TEMPORARY RUNWAY

Taxiway 'B' – Extension / Temporary Runway Diagram and Site Factors



Extension of Runway 3/21

To meet the 7,000 foot requirement, Runway 3/21 would need to be extended by 1,300 feet. Runway 3/21 is currently 150' wide and the extension would be built to match. To accommodate this, the perimeter road and fence, would also need to be relocated.

Cost Comparison

The costs of the various project alternatives are summarized in the Table 6-3.

Table 6-3
 Cost Comparisons of Temporary Runway Options for Center Reconstruction of Runway 9/27

| Project | Estimated Cost |
|--|----------------|
| Runway 3/21 extension | |
| Runway Extension | \$7,065,000 |
| Taxiway C Extension | \$5,485,000 |
| Total | \$12,550,000 |
| Taxiway A Conversion to Temp R/W | \$49,560,000 |
| Taxiway B Conversion to Temp R/W | \$49,133,000 |
| Runway 9/27 Panel Replacement Night Work | \$39,427,000 |
| Runway 9/27 Rehab Center Section | \$22,800,000 |

Conclusions

The cost estimates show the most economical project alternative for the Runway 9/27 reconstruction project is the extension of Runway 3/21 followed by a rehabilitation of the center section of Runway 9/27. This alternative also provides the best engineered solution for Runway 9/27, providing a full pavement section to meet the 20 year pavement design life requirement. Also, due to the durability issues, design life expectations, cost increase, and schedule issues, a nighttime closure/panel replacement rehabilitation project should not be considered for Runway 9/27. Reconstruction of Taxiway 'A' or Taxiway 'B' are the most expensive alternative, and still have many operational and obstruction issues associated with them.

Preferred Temporary Runway during Runway 9/27 Construction Alternative Evaluation:

Runway 3/21 extension is the preferred alternative for the Runway 9/27 reconstruction project and was further evaluated per FAA AC 150/5070-6B, Paragraph 904 *Evaluation of Alternatives*. The AC outlines four general categories to evaluate the preferred alternative: Operational Performance, best planning tenets and other factors, environmental factors, and fiscal factors. The alternative was evaluated for each of the general categories

- Operational Performance – This category evaluates the criteria from several perspectives including capacity, capability, and efficiency.
 The Runway 3/21 extension alternative was determined to have the highest capability to meet the goals of the project and provides the highest efficiency for the runway system as well as the best engineered solution for Runway 9/27.
- Best Planning Tenets and Other Factors – This Category evaluates the alternatives strengths and weaknesses such as safety and security, growth beyond the planning horizon, conforms to the airport sponsor's strategic vision, flexible to change, satisfies user needs, etc.
 This alternative was determined to meet the best planning tenets for the airport providing a balance of capacity and flexibility to meet demand beyond the planning period. It provides useful extension of Runway 3/21 and provides a full pavement section for the 20 year pavement design life requirement. In addition, as compared to the Extension of Taxiway 'A' or Taxiway 'B', the alternative does not have a multitude of potential impacts to airport operation, such as affecting approach and departures, overflight of the Terminal (Taxiway 'A') or Air National Guard (Taxiway 'B'), or having

- significant impacts to existing airport infrastructure (See Exhibits 6-11 and 6-12). Whereas the least short-term impacts is the Runway 9-27 night closure panel replacement, that project has no life cycle value.
- Environmental Factors – This category evaluates the alternative for potential environmental effects. The alternative was evaluated for each of the environmental factors that were determined to be in the airport environment.
 - o There are few potential impacts associated with the Runway 9-27 night closure panel replacement. The potential impacts impacts for the Runway 3/21 Extension Alternative are presented in Section 6.2.2 and primarily relate to potential wetlands impacts on the Runway 21 end. However, the extensions and use of Taxiway 'A' or Taxiway 'B' as a temporary runway also have environmental implications. There are poor soil conditions and wooded areas that would be impacted by Taxiway 'A' and there are drainage issues, wooded areas, land acquisition and residential relocation associated with Taxiway 'B'. On balance, the potential environmental operational risk and natural environmental consequences for the two taxiway alternatives appear equivalent to or greater than the potential for environmental consequences associated with Runway 3-21 extension. This would need to be determined in an environmental assessment.
 - Fiscal Factors – This category evaluates the alternative based on rough cost estimates.

The extension of Runway 3/21 was shown to be the most cost effective method to allow full reconstruction of Runway 9/27. This will also eliminate night closures and allow for the best engineered solution for the runway.

6.3 TAXIWAYS

As identified in the facility requirements chapter, the following taxiways have certain operational constraints or contain non-standard geometry which requires planning resolution:

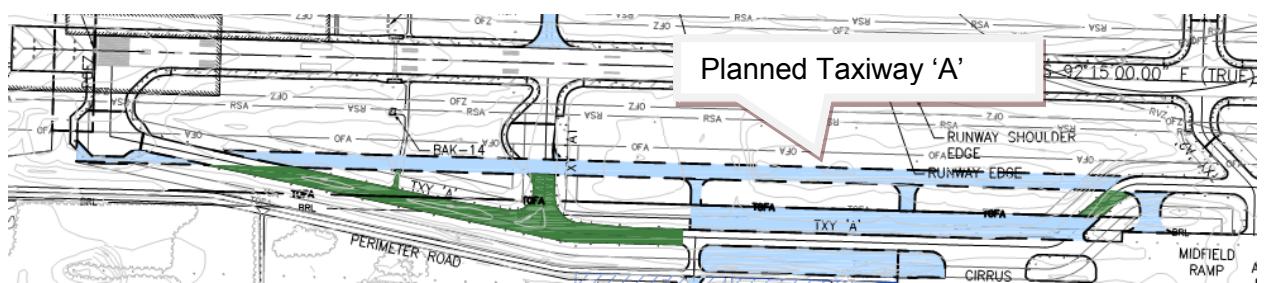
- Taxiway 'A' segment between Taxiway 'A2' and the Runway 9 end
- Taxiway 'B' limited access from Runway 3-21 and the Runway 9 end
- Taxiway 'C' taxiway-to-runway separation standards
- Taxiway 'E' in-line taxiway beyond the Runway 27 end; Taxiways E1, E2 and A5
- Taxiway 'F' access to Minnesota Air National Guard Ramp (military project)

It should be noted that these taxiway facility improvements are not necessarily alternatives per se, but more layout concepts, due to the limited planning resolution needed to meet FAA design standards.

6.3.1 Taxiway 'A'

Taxiway 'A' between Taxiway 'A2' and the Runway 9 end has a runway-to-taxiway separation of nearly 850 feet, exceeding the FAA 500-foot minimum separation by nearly 450 feet. This segment of taxiway also contains an irregular 'S' curve, which contributes aircraft oversteering issues and to air traffic control tower line-of-sight visibility constraints when large aircraft are parked on the Midfield Ramp. As shown in **Exhibit 6-13**, it is recommended that Taxiway 'A' ultimately be realigned in a linear manner consistent with the eastward segment of Taxiway 'A', which has a 512.5 foot taxiway-to runway separation, sufficient separation for runways with less than one-half mile visibility. The re-alignment of Taxiway 'A' will permit further expansion of the apron/ramp areas, as demand warrants.

Exhibit 6-13
TAXIWAY 'A' – PLANNED LAYOUT CONCEPT

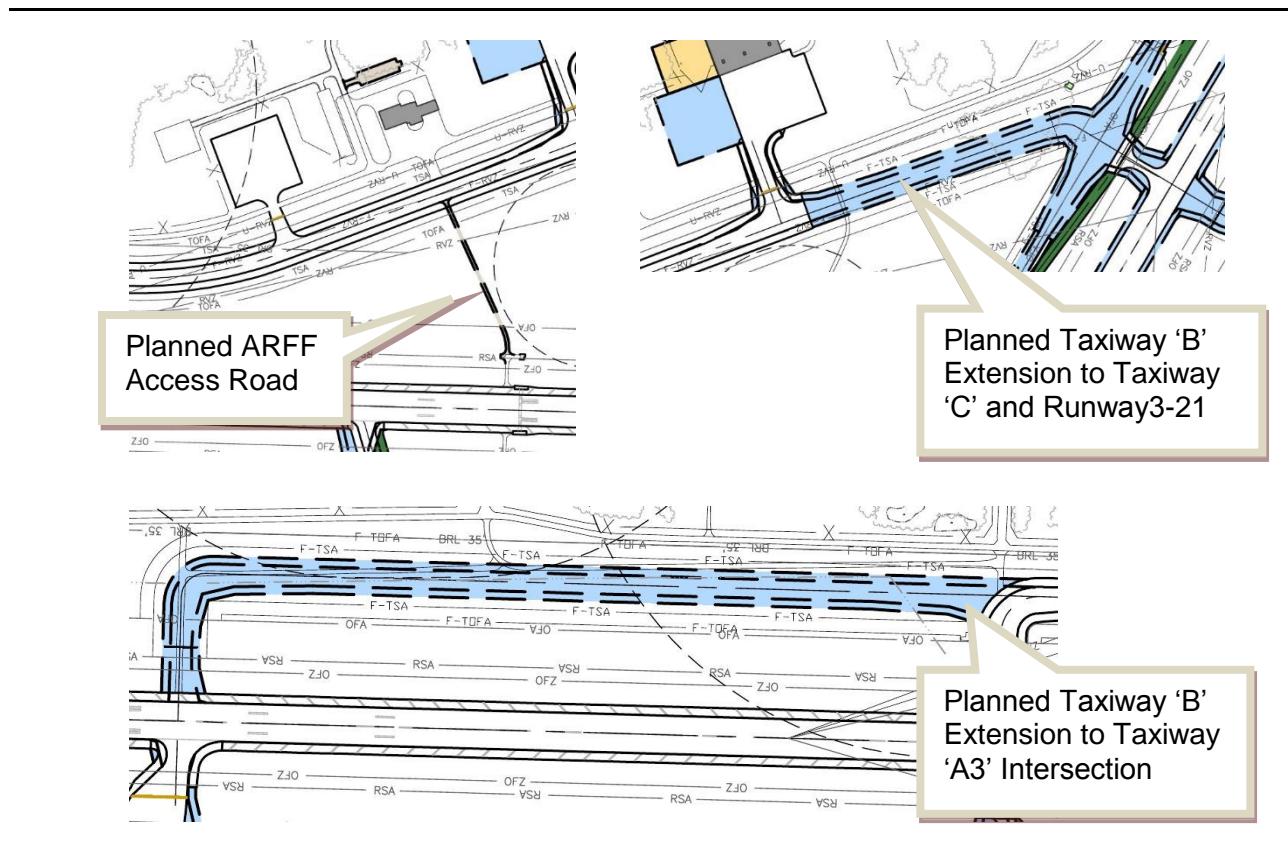


6.3.2 Taxiway 'B'

Taxiway B is the connector providing a single access point between Runway 9-27 and the North Business Development Area. The North Business Development Area is planned to accommodate various commercial and private tenants, potentially a flight school. Therefore, a mix of aircraft would be generated from these prospective tenants, resulting in potential congestion points which could require alternate taxiway access points. As shown in **Exhibit 6-14**, it is recommended Taxiway 'B' be progressively planned for the following improvements:

- New exit taxiway between Runway 9-27
- Eastward extension to Taxiway 'C' and Runway 3-21
- Westward extension for Runway 9 departures (to accommodate flight school operations)

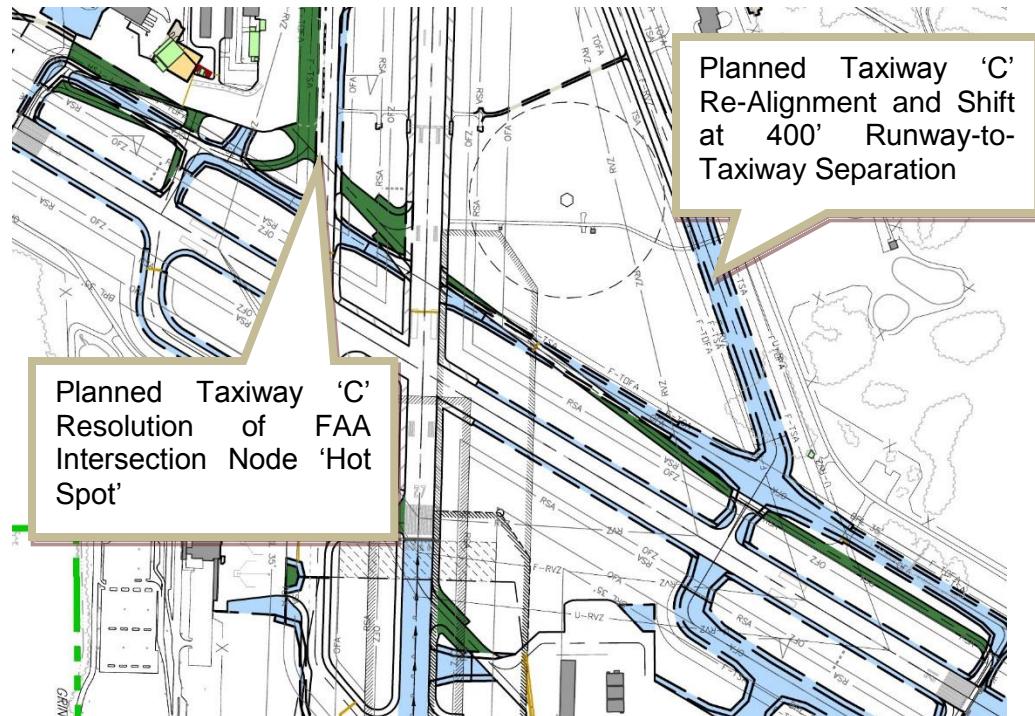
Exhibit 6-14
TAXIWAY 'B' – PLANNED LAYOUT CONCEPT



6.3.3 Taxiway 'C'

Taxiway 'C' is the full parallel taxiway serving the west side of Runway 3-21. It is a non-linear taxiway, and involves an intersection node with Taxiway 'A' resulting in a FAA Hot Spot. As shown in **Exhibit 6-15**, it is recommended Taxiway 'C' be relocated at a 400-foot taxiway-to-runway separation to meet ARC C-III standards for future precision instrument capabilities. The realignment would resolve the non-standard runway-to-taxiway separation, mitigate the FAA Hot Spot intersection node, and correct geometry issues associated with the cargo ramp area at the Runway 3 end.

Exhibit 6-15
TAXIWAY 'C' – PLANNED LAYOUT CONCEPT

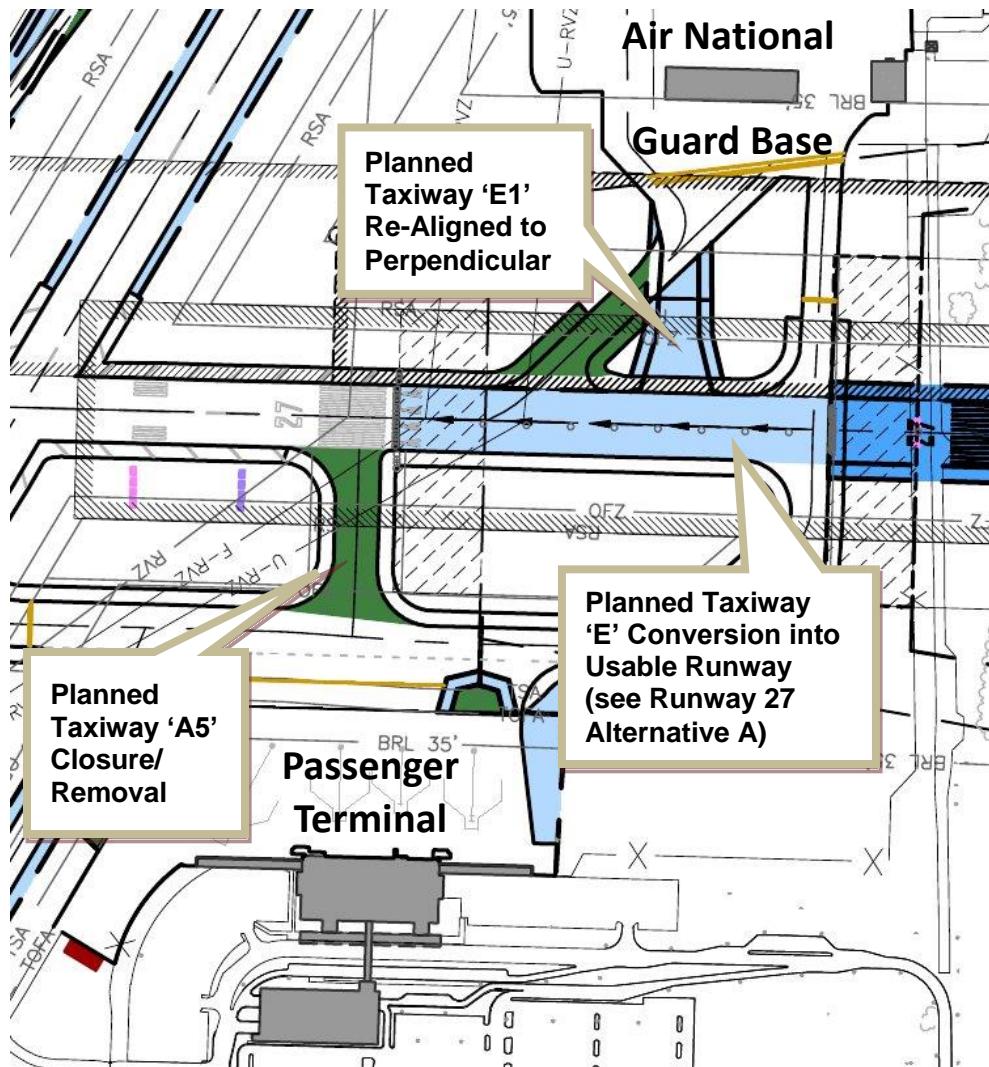


6.3.4 Taxiway 'E' Segments

Taxiway 'E' is a 1,000 foot in-line taxiway beyond the Runway 27 end, and part of a the Taxiway E1, E2 and A5 system identified as FAA Hot Spots due non-standard geometry and runway incursion risk. FAA standards no longer permit in-line taxiways. As shown in **Exhibit 6-16**, it is recommended the

Taxiway 'E', 'E1', 'E2' and 'A5' conform with the preferred Runway 27 (In-Line Taxiway) Alternative 'A' concept. This entails Taxiway 'E' being deactivated and converted into usable runway, Taxiway 'A5' being removed, and Taxiway 'E2' being re-aligned into a perpendicular.

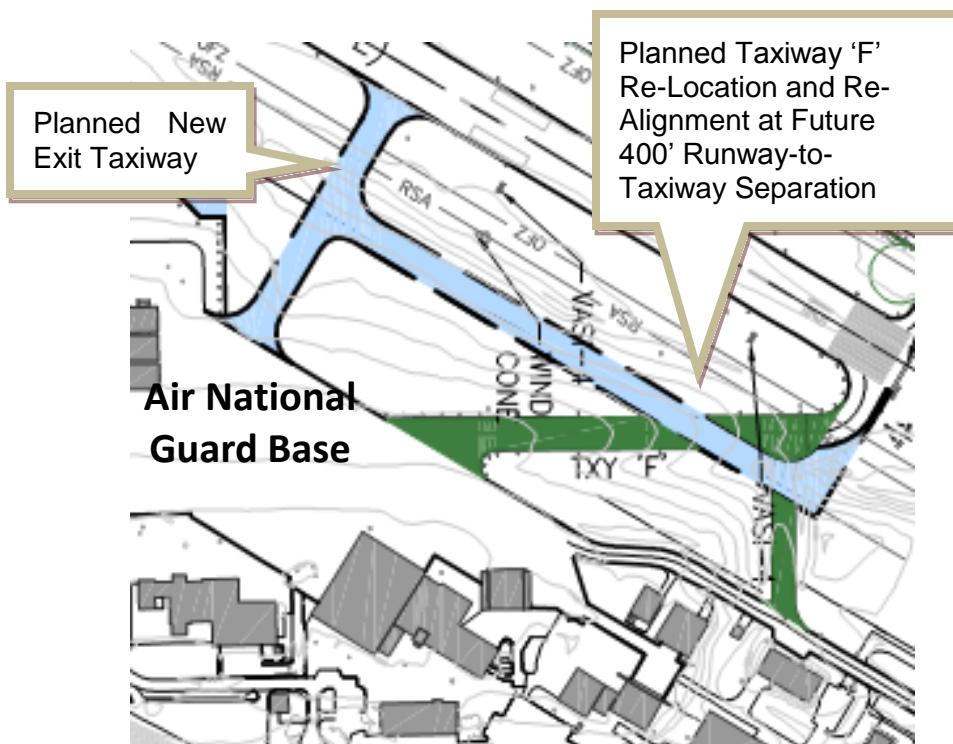
Exhibit 6-16
TAXIWAY 'E' SYSTEM – PLANNED LAYOUT CONCEPT



6.3.5 Taxiway 'F'

Taxiway 'F' is a connector taxiway between the Minnesota Air National Guard Ramp and Runway 21 end. As shown in **Exhibit 6-17**, the *Minnesota Air National Guard's Installation Development Plan* recommends realignment of Taxiway 'F' as a future partial parallel taxiway to Runway 21 with a taxiway-to-runway separation of 400 feet, and an additional exit Taxiway to Runway 3-21. The Guard's Development Plan also recommends extending Taxiway 'F' commensurate to any Runway 21 extension.

Exhibit 6-17
TAXIWAY 'F' – PLANNED LAYOUT CONCEPT



6.4 TERMINAL AND LANDSIDE ALTERNATIVES

The following are the primary terminal and landside alternatives identified in this chapter:

- Buildings and Structures to be Removed
- Air Traffic Control Tower Replacement
- Air Cargo Facilities
- Aircraft Manufacturing/Production Expansion
- Helicopter Hangar/Building Site Development
- Unmanned Aircraft Systems (UAS/UAV) Site Development
- Aircraft Hangars Options – Large and Small
- Ramp Areas

6.4.1 Buildings and Structures to be Removed

As part of the terminal options, due to condition and redevelopment opportunities, various buildings have been identified by the Airport as potential removal/relocation. **Table 6-4** lists the buildings/structures planned to be removed, replaced or relocated. See the Airport Layout Plan, Terminal Area Drawing for structures proposed to be removed during the 20-year planning period.

The Old Terminal Building (Building 616) and a large maintenance hangar (Building 622) represent some of the larger and older structures in a prime area for future redevelopment. Although portions of the Old Terminal Building are vacant, the building currently houses the FAA ATCT, the FAA Weather Observer, and private businesses which lease space from the Airport.

Table 6-4
BUILDINGS REMOVED/RELOCATED/REPLACED

| AIRPORT BUILDINGS | | | | | |
|-------------------------------|---|--------------------------|--------------------------|-------------------------|------------------------|
| AIRPORT BUILDING NUMBER | STRUCTURE | BUILDING OWNER | TENANT (LEASEHOLDER) | BUILDING DISPOSITION | ESTIMATED TIMEFRAME |
| 123 | MN/ANG DRMO Warehouse | Mn/ANG | Mn/ANG | Remove | 0 - 10 Years |
| 124 | MN/ANG Lab/Offices | Mn/ANG | Mn/ANG | Remove | 0 - 10 Years |
| 125 | MN/ANG DRMO Warehouse | Mn/ANG | Mn/ANG | Remove | 0 - 10 Years |
| 206 | Base Exchange (Commissary) | Mn/ANG | Mn/ANG | Remove | 6 - 10 Years |
| 232 | Warehouse | -- | -- | Remove | 0 - 5 Years |
| 301 | Emergency Generator / Electrical Vault | Duluth Airport Authority | -- | Remove | 0 - 5 Years |
| 304 | ANG Barracks | MN/ANG | MN/ANG | REMOVED (2012) | -- |
| 305 | Manufacturing Facility | Duluth Airport Authority | Hydro Solutions | Replace | 6 - 20 Years |
| 306 | Duluth Airport Authority SRE | Duluth Airport Authority | Duluth Airport Authority | Remove | 0 - 5 Years |
| 308 | Office Building | Duluth Airport Authority | Vacant | Remove | 0 - 10 Years |
| 311 | Federal Prison Dormitory Housing | Duluth Airport Authority | Vacant | Remove | 0 - 10 Years |
| 361 | Mn/ANG Bulk Fuel Facility (East) | Mn/ANG | Mn/ANG | REMOVED (2012) | 6 - 20 Years |
| 362 | Mn/ANG Bulk Fuel Facility (West) | Mn/ANG | Mn/ANG | REMOVED (2012) | 6 - 20 Years |
| 603 | Airport Cold Storage | Duluth Airport Authority | -- | Remove | 0 - 5 Years |
| 608 | T-Hangars (5 Units) | Duluth Airport Authority | Monaco Air (FBO) | Replace | 0 - 5 Years |
| 611 | Old SRE / FBO Storage Facility | Duluth Airport Authority | Monaco Air (FBO) | Replace | 0 - 10 Years |
| 614 | Hangar (Ranch Hangars - 7 Units) | Duluth Airport Authority | Monaco Air (FBO) | Relocated | ±20 Years |
| 615 | T-Hangars (13 Units) | Duluth Airport Authority | Monaco Air (FBO) | Relocated | ±20 Years |
| 616 | FAA ATC Tower/Offices/Classroom | Duluth Airport Authority | FAA, Various | Remove | 0 - 10 Years |
| 622 | Municipal Hangar #2 -FedEx Storage Facility | Duluth Airport Authority | Fed Ex | Replace | 0 - 5 Years |
| 705 | Box Hangar | Monaco | Monaco Air (FBO) | Replace | 0 - 10 Years |
| 709 | FAA Garage / Storage | -- | FAA | Remove | 0 - 10 Years |

Note: Reference Airport Layout Plan, Terminal Area Drawing Sheet for building/structure location.

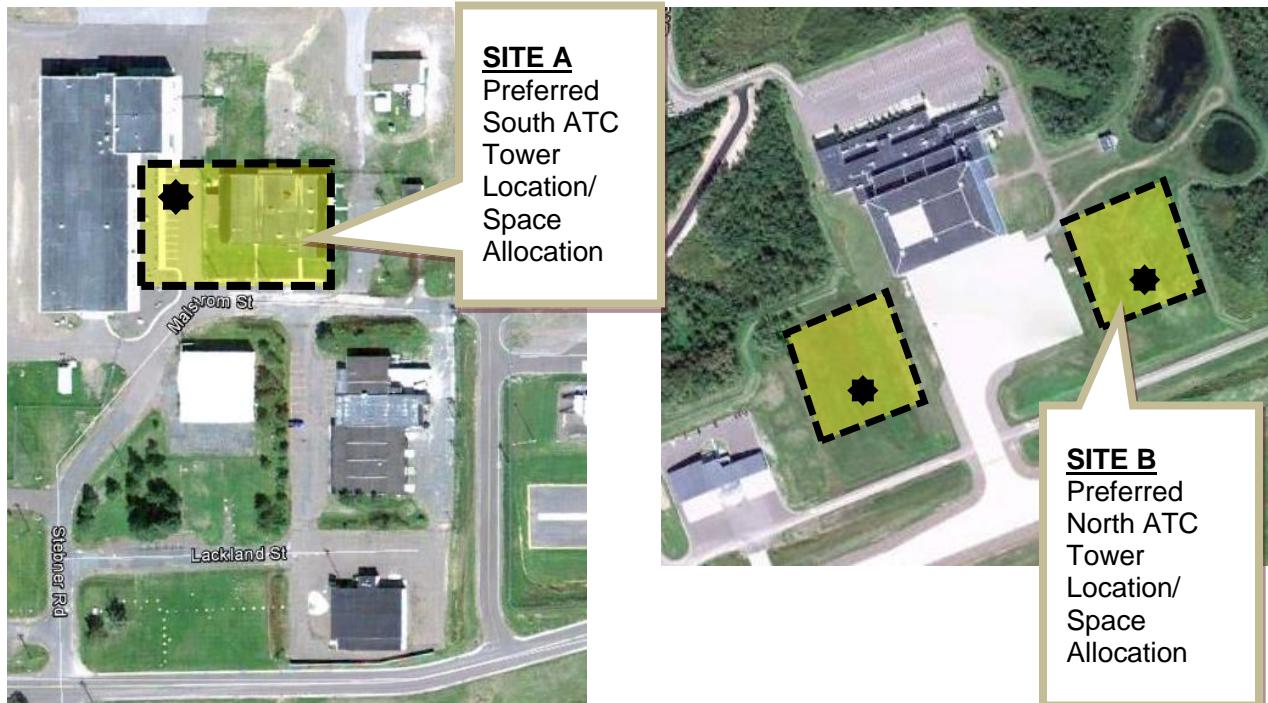
6.4.2 Air Traffic Control Tower (ATCT) Site Options

The Air Traffic Control Tower (ATCT) is being considered for replacement, as the existing building condition, location, cab height and line-of-sight visibility are deficient. FAA standards recommend a one to four acre site for accommodating a stand-alone ATCT facility. For Duluth, a one to two acre site with an approximate 40' x 40' building footprint appears to be adequate to accommodate the future Duluth ATCT/Radar service facility, including auto parking.

Exhibit 6-18 illustrates the general location of the potential north and south ATCT site vicinities, and preferred site locations. The Airport staff has identified this area as the preferred location for the replacement ATCT facility. Both vicinities are geographically central to the airfield, and have a tower location and line of sight to all runway ends within existing airport property. The Site A location is within

an area of buildings planned to be removed in the near-term (301, 305, 306, 308, 311, 608), as depicted on the ALP Drawings.

Exhibit 6-18
AIR TRAFFIC CONTROL TOWER RELOCATION – PLANNED NEW SITE



Site A: located within the terminal area north of Malstrom Street and immediately southeast of the Airport SRE building. The site is close to the terminal flightline and has favorable line-of-sight site to terminal area facilities and aircraft parking/apron ramps, and favorable orientation for sun angle direction. Utilities and roadway access is provided to the site. Utilities and roadway access is provided to the site, with close access to existing ATC communication lines. This location would likely require the removal of the electrical vault building (#301), as the Minnesota Air National Guard Barracks building (#304) has already been removed. Based on planning level calculations, it is estimated a tower (cab) height of 38' to 54' above ground level is needed to provide adequate line of sight to the Runway 3 end.

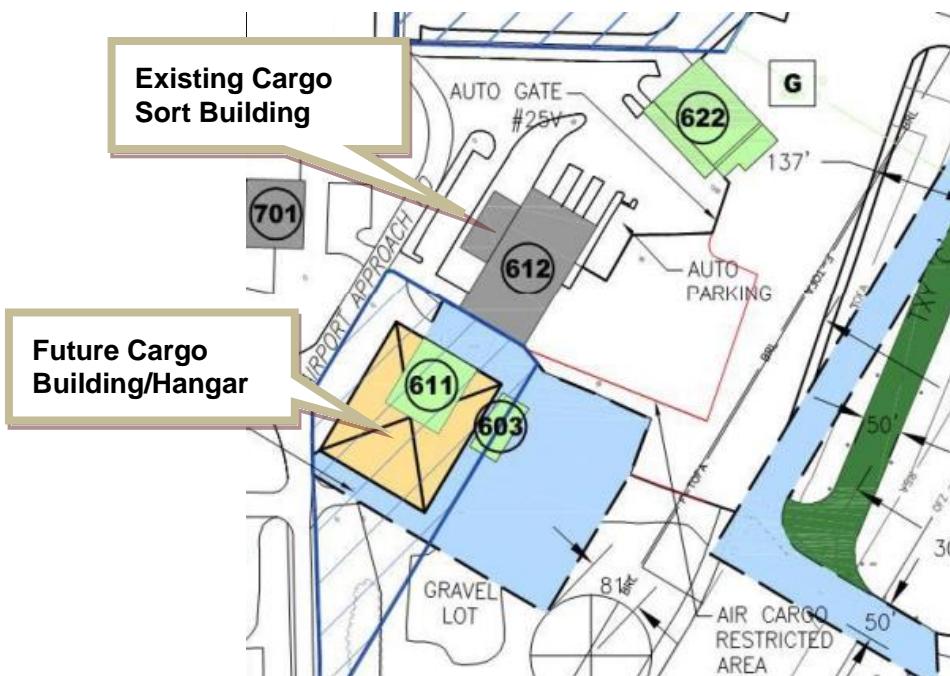
Site B: located either southeast or southwest of the aircraft maintenance hangar. This site would require improvements for auto access, parking and extension of utilities.

Both Site A and B are depicted on the Airport Layout Plan. It should be noted that these two ATCT sites have been identified for general planning purposes, to reserve sufficient space allocation and land development compatibility upon relocation of the ATCT facilities. The sites have not been comparatively ranked to arrive at a preferred option. No FAA ATCT study has been conducted to validate the options, site suitability, or configuration requirements.

6.4.3 Air Cargo Facilities

Exhibit 6-19 depicts the possible expansion of the air cargo facility west of the Runway 3 end, occupied by FedEx. The future cargo facility expansion is planned south of the existing sort build, and would require the removal of storage buildings #611 and #603. The expanded site is planned to accommodate building with auto access and/or a hangar with future ramp access.

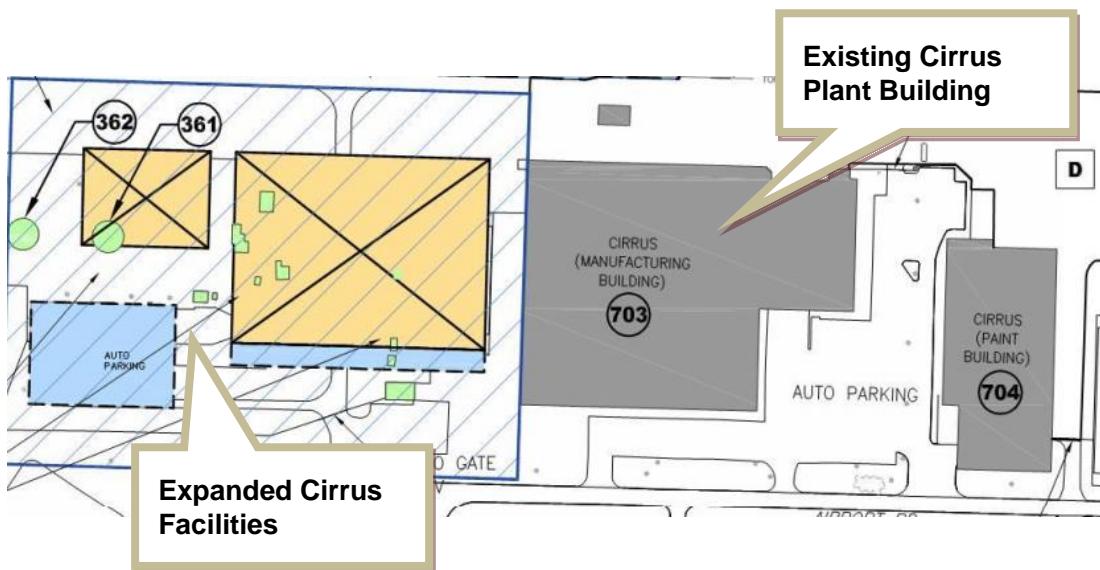
Exhibit 6-19
AIR CARGO – PLANNED SITE EXPANSION



6.4.4 Aircraft Manufacturing/Production Expansion

Exhibit 6-20 depicts the possible expansion of the Cirrus manufacturing facilities. The future expansion is planned west of the existing building, and would require the removal of military petroleum, oil and lubricant (POL) storage facilities. The expanded site is planned to accommodate a comparable hangar and multiple buildings with auto access. The site would require grading and fill in order to provide continuous ramp access to the adjacent Taxiway 'A'.

Exhibit 6-20
AIRCRAFT MANUFACTURING/PRODUCTION EXPANSION



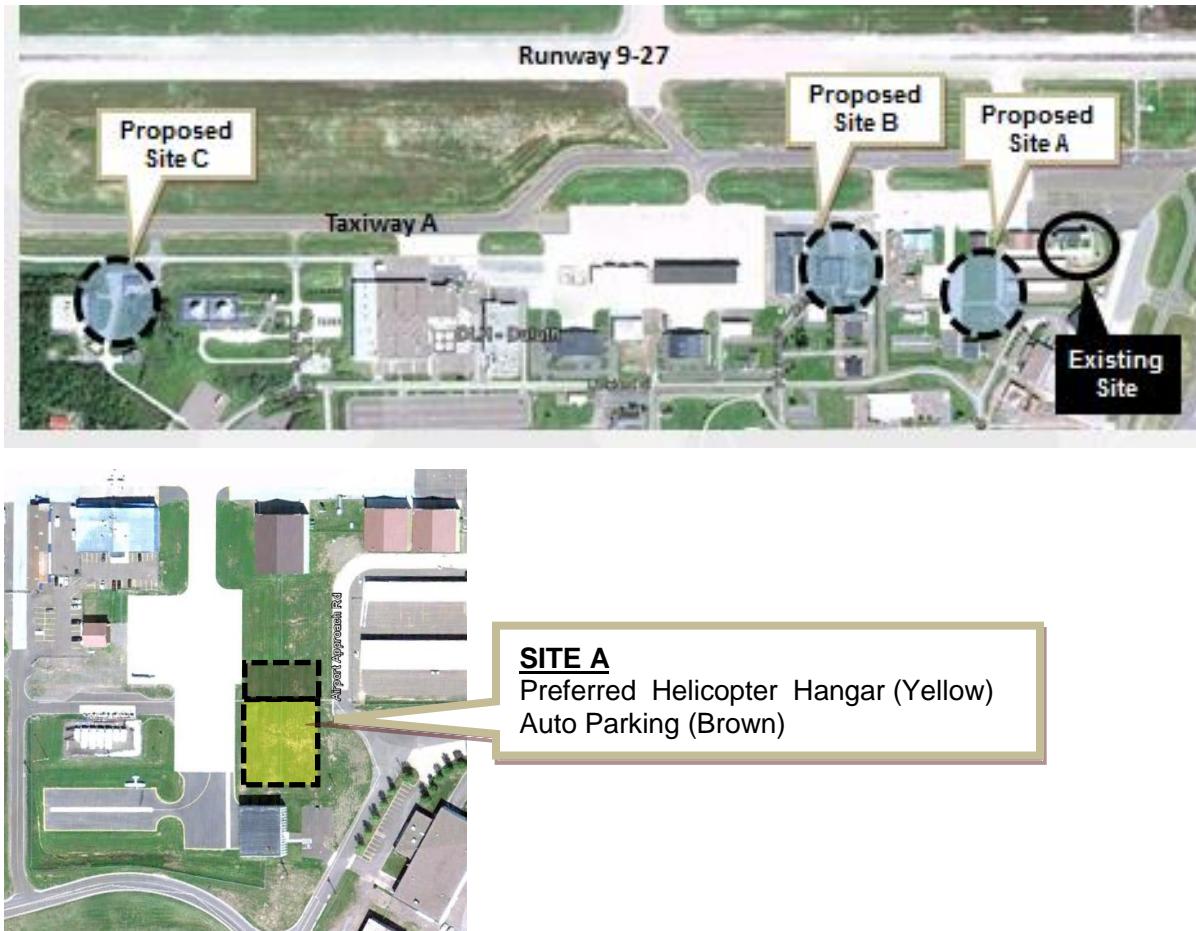
6.4.5 Helicopter Hangar/Building Site Development

The helicopter school is contemplating the relocation of its operations to another location on the airport. The operator is located in Building #616 and using hangar #614, and due to expansion of services, is planning to locate a site with the following general site characteristics:

- 0.5 to 1.5 acres space allocation
- Direct ramp or pavement access
- FAR Part 141 operator, with possible FAR Part 135 commercial operations
- 12,000 square foot hangar accommodating 4 helicopters
- Provide dedicated vehicle access, with 20 to 30 auto parking spaces

Exhibit 6-21 illustrates the general location of the potential site vicinities located within the south terminal area, along with the preferred helicopter site location. Site A is the preferred helicopter location, which is southwest of the FBO building, and is provided auto access from Airport Approach Road. This site is depicted on the ALP Drawings.

Exhibit 6-21
HELICOPTER HANGAR SITE OPTION



6.4.6 Unmanned Aircraft Systems (UAS/UAV) Site Development

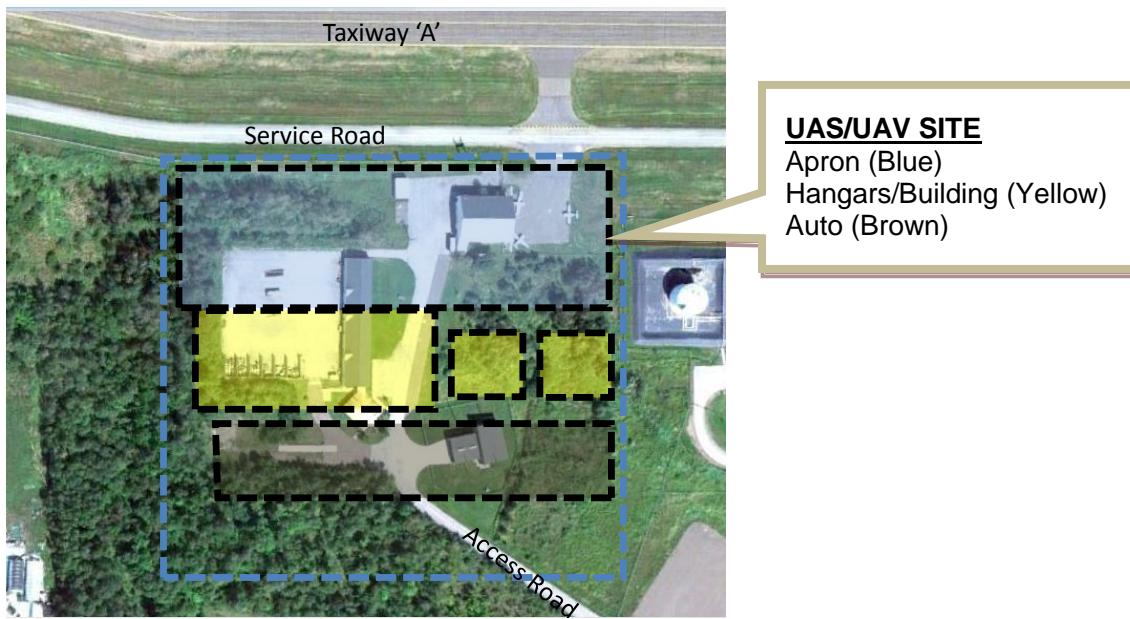
The Airport is pursuing planning for Unmanned Aircraft Systems (UAS) vehicles, initially through inclusion into the FAA UAS Test Program, then in some form of unmanned aerial vehicle operations beyond the test program. UAV aircraft are rapidly becoming a more mainstream aeronautical platform supporting various civilian and military flight applications. These aircraft, which are inherently different from manned aircraft, are flown by a pilot-in-command located remote to the vehicle, using various data links and monitoring systems. At present time, the UAV aircraft include a wide assortment of shapes and sizes, and serve very diverse purposes. They include both fixed-wing and rotorcraft, powered by piston and turbine engines, with wingspans ranging from a small radio-controlled model airplane to a Boeing 737.

The UAS Test Program is intended to facilitate integration of the UAS aircraft into the National Airspace System, as airspace is typically the most consequential impact of supporting UAS operations. UAV activity typically necessitates nearby special use airspace (restricted or warning areas) with lower-altitude transitional areas between the Airport, with airspace blocks dependent upon the type of UAS,

local airspace architecture, flight patterns, and radar coverage. Although the FAA has not instituted airport design standards for UAS aircraft, the Department of Army and Air Force have developed operational specifications used for developing unmanned vehicle facilities. As the UAS program evolves from the FAA experimental to certified phase, some aspect of UAS activity is anticipated at Duluth, particularly due to the based military influence. In terms of facility requirements, the UAV aircraft performances tend not to influence the airfield facility needs, but might eventually require some type of dedicated terminal or landside area as a domicile for aircraft parking or support buildings.

Exhibit 6-22 depicts the preferred site location and layout for the UAV developments. Although unspecified at this time, such UAS facilities could likely be accommodated within the various site development areas reserved planned for other types of aeronautical developments, as depicted on the Airport Layout Plan.

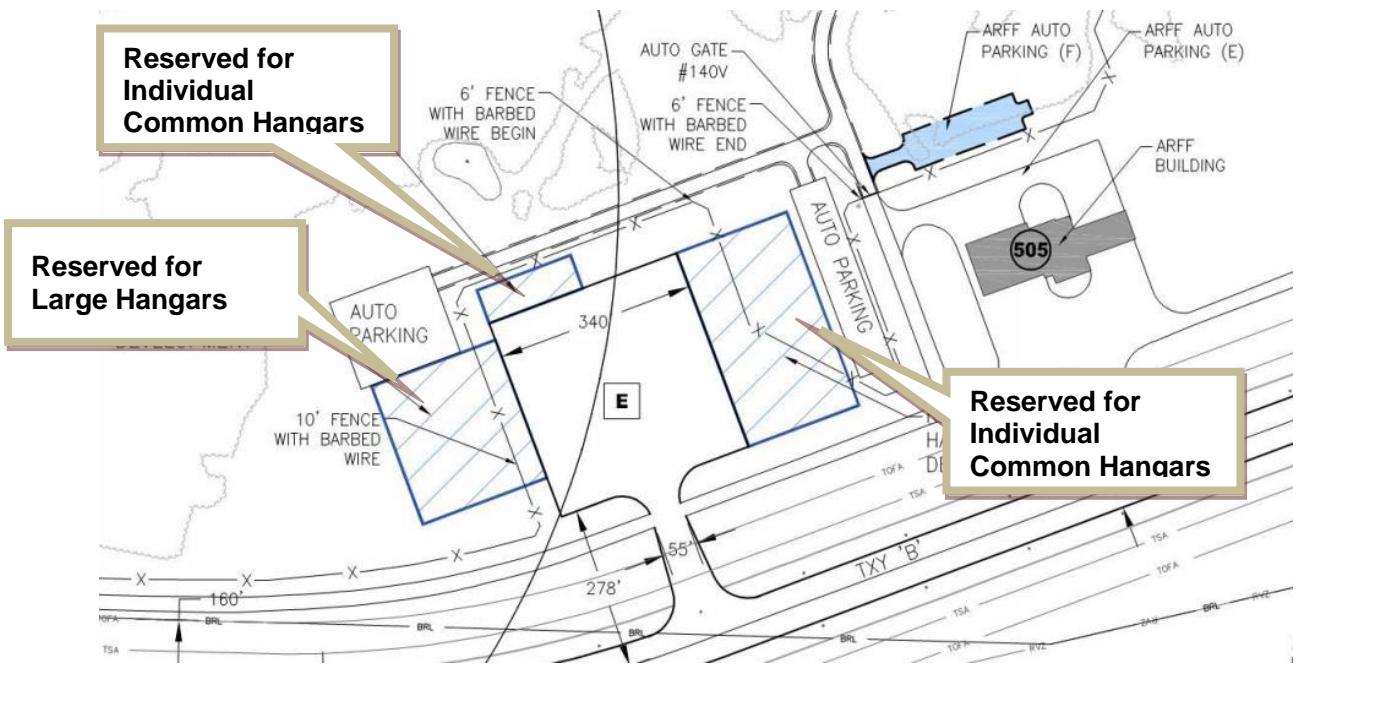
Exhibit 6-22
UAV SITE DEVELOPMENT OPTION



6.4.7 Large Aircraft Hangars Options (Northside):

Large aircraft hangars will be required to provide additional storage capacity for new large turboprop and business jet based aircraft, and as an option for existing obsolete hangar buildings. **Exhibit 6-23** depicts the option for expansion of the larger general aviation hangars, located within the northside apron along Taxiway 'B'. The site provides approximately 150,000 square feet of additional hangar space. A fuel farm is also anticipated to be located in this area. Proposed development within this area should be reviewed for effects on navigational and communication aids located within the vicinity.

Exhibit 6-23
LARGE GENERAL AVIATION HANGAR SITE DEVELOPMENT OPTION



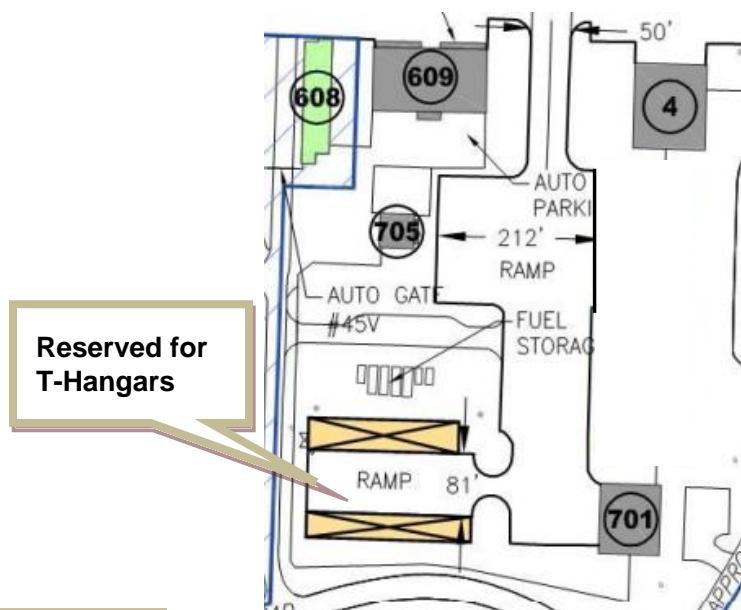
6.4.8 Small Aircraft Hangars Options (Southside):

Nearly 54,000 square feet of hangar space could be needed for small piston aircraft storage throughout the 20-year planning period. Future hangar space should include an area dedicated to small piston aircraft storage, either from new based planes or displaced through hangar replacements and relocations.

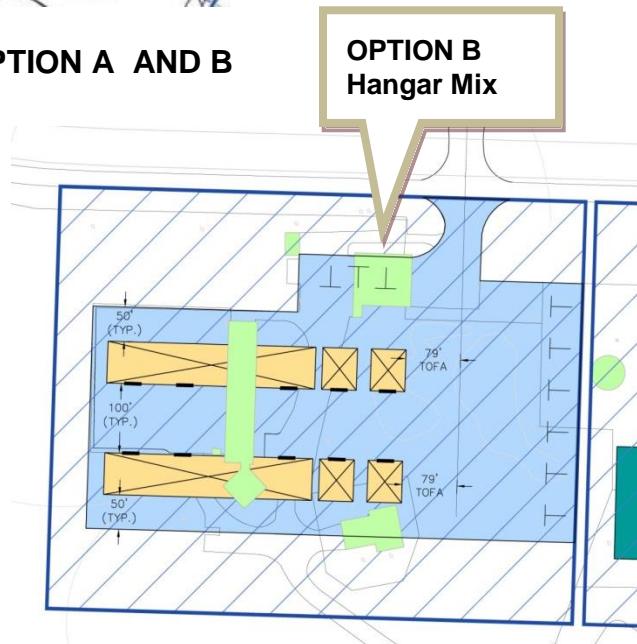
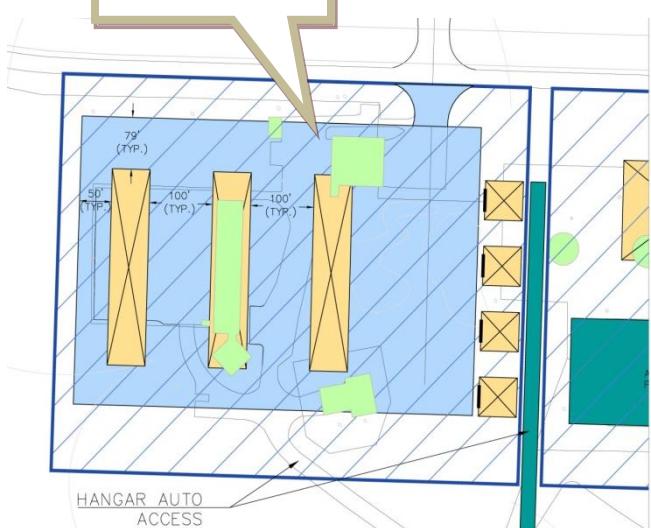
Exhibit 6-24 depicts the option for expansion of the smaller general aviation hangars, at an east site located south of the FBO and fuel storage facilities, and if not used for other development, a west site beyond the Cirrus and military POL facilities, currently leased by the MN Air National Guard. The west site provides about 60,000 square feet of development, but would initially involve the removal of buildings/structures, which is surrounded by a wooded area, drainage, and utility lines. The west site identified two possible hangar layout configurations. It should be noted that these options have been provided for general planning purposes only, to demonstrate and reserve sufficient space to accommodate typical aircraft hangar sizes and layouts.

Exhibit 6-24
SMALL GENERAL AVIATION HANGAR SITE DEVELOPMENT AREA

EAST SIDE



WEST SIDE – OPTION A AND B



Future Hangar Development:

The assessment of hangar facility needs focuses on square footage of hangar space. The master plan assumes that due to winter conditions, all based aircraft are stored in hangars. The smaller single-engine aircraft and light multi-engine aircraft are generally stored in T-hangar units while larger multi-engine aircraft, business jets, and rotorcraft are stored in common hangars. Hangars should be segregated by the type of user and aircraft size:

- Large Site: Commercial w/ Public Access (Design Group II and III) - at least one to two large site development areas should be reserved for potential large scale commercial use
- Medium Site: Corporate w/ Office (Design Group II and III)
- Small Site: Individual Box or T-Hangars (Design Group I and II)

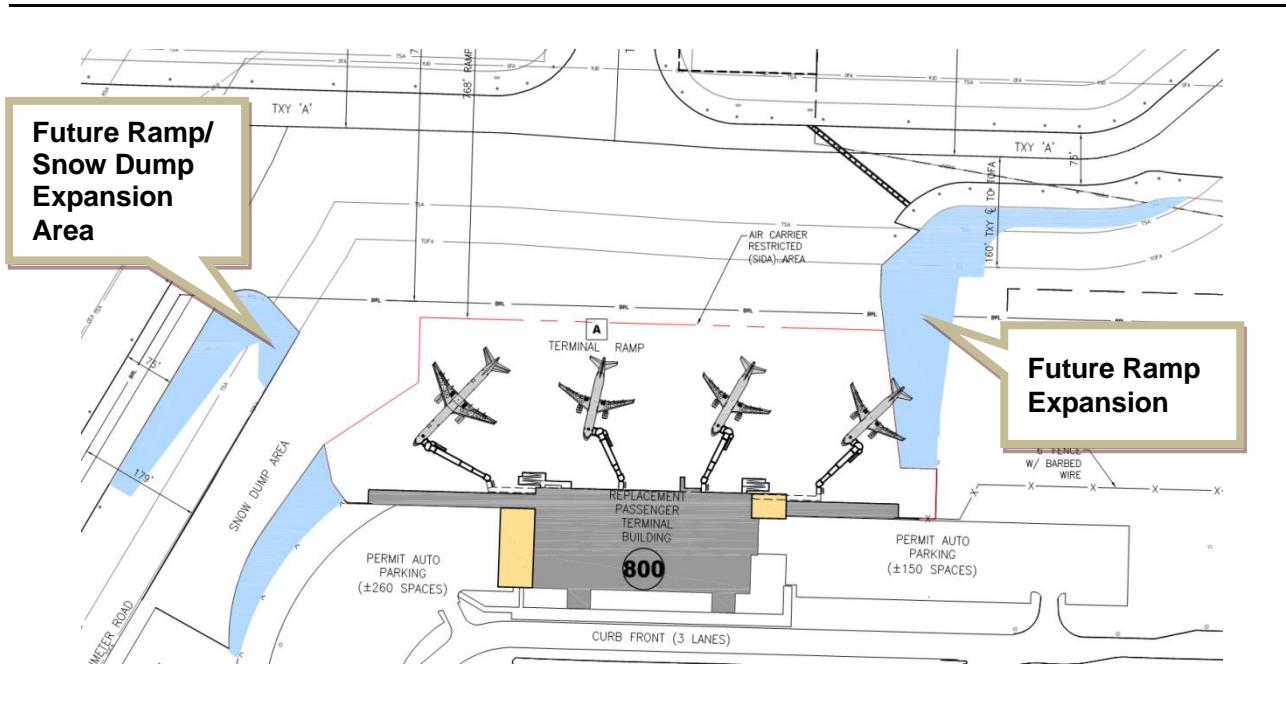
The following are general guidelines for proper hangar development:

- Hangars must be constructed beyond the runway safety areas (OFA, RSA, OFZ, RPZ), not encroach imaginary airspace surfaces, and remain beyond the taxiway/taxilane object free area (TOFA).
- Hangars should provide, at minimum, the standard taxilane object free area (TOFA) width for ramp and taxiing separation between opposing hangar doors.
- Hangars should be centralized in terms of auto access, and located along the existing flight/hangar building line(s) to minimize costs associated with paved areas, drainage, utilities and auto parking expansion.
- Hangars, to the extent possible, should be segregated based on the hangar type and function. Arrange hangars by functional size and type, by locating the larger box hangars closer to the main apron/taxiway, and the smaller hangars further back in the hangar area.
- Hangar development should allow adequate drainage with minimal slope differential (1% to 1.5%), particularly in front of hangar door.
- Constructs hangars in a linear fashion, which accommodates greater flexibility in sizing hangars, improves pilot visibility and makes the extension of utilities.
- Orient hangar doors favorable with winter snow and ice conditions.
- The hangar site development option allows for expansion beyond the projected 20-year hangar demands, including areas to accommodate larger general aviation hangars used for commercial purposes.

6.4.9 Ramp Areas – Commercial Passenger

Exhibit 6-25 depicts the option for future ramp expansion associated with the increased utilization of the new air carrier building. These ramp areas are planned to be used for aircraft maneuvering, ground vehicles, and snow dump areas.

Exhibit 6-25
COMMERCIAL RAMP EXPANSION



6.4.10 Ramp Areas – General Aviation

Exhibit 6-26 depicts the option for future ramp expansion along the midfield ramp area. The Midfield Ramp expansion connects the FBO Ramp with the Midfield Ramp, in order to provide additional maneuvering and parking. The West End Ramp could be constructed following the relocation of Taxiway 'A', which would provide additional flight line and ramp access, as development unfolds. These ramps should be constructed with a 166-foot separation with the Taxiway 'A' centerline in order to preserve safety area and wingtip clearance for large transport aircraft (Galaxy C-5A, Design Group VI).

6.5 ALTERNATIVES SUMMARY AND COORDINATION

6.5.1 Alternatives Review and Coordination

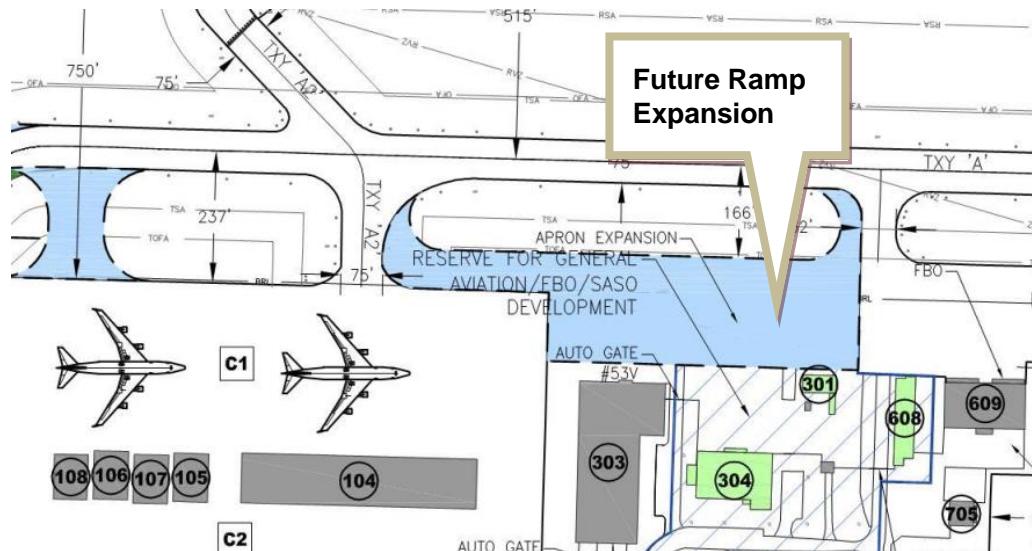
The development alternatives and site options presented in this chapter were reviewed by the Airport Staff and Airport Master Plan Advisory Committee for technical and community-related input, and made available for public display and feedback. The alternatives were also presented to the Airport Board, for

their subsequent consideration, input and approval. Input and comments was collected and documented as part of the master plan process. The information from these meetings was recorded for consideration as part of the alternatives, and for future environmental purposes. The alternatives were refined, based on feedback, with the revised documents and exhibits provided electronically on the Airport website for public viewing.

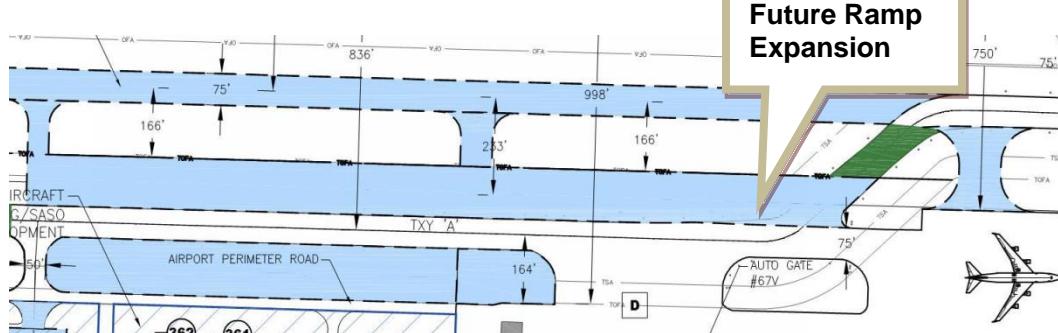
The alternatives have been developed in consideration of environmental factors documented in the Inventory Chapter, as it is anticipated that an Environmental Assessment (EA) will be required for most project implementation.

Exhibit 6-26
GENERAL AVIATION/RAMP EXPANSION

MIDFIELD RAMP



WEST END RAMP



6.5.2 Alternatives Summary

The following lists the preferred Airport alternatives:

Runway 27 (In-Line Taxiway 'E') – Option A

Runway 3-21 Extension – Option E

These preferred layouts are carried-forward as development items inserted on the updated Airport Layout Plan (ALP) drawings, and included in the 20-year Airport Master Plan development program and FAA Airport Capital Improvement Plan (ACIP), as applicable.