APPENDIX B

# RUNWAY LENGTH ANALYSIS

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Appendix B Runway Length Analysis



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## 1.1 INTRODUCTION

Airplanes today operate in a variety of different environments and available field lengths. However, the suitability of those runway lengths is governed by the existing and forecast fleet mix, critical aircraft operational requirements, and the following variables:

- Airport elevation above mean sea level
- Mean maximum temperature
- Wind velocity
- Aircraft operating weights
- Takeoff and landing flap settings
- Effective runway gradient
- Runway surface conditions (dry, wet, contaminated, etc.)
- Operational use
- Presence of obstructions within the vicinity of the approach and departure path, and
- Locally imposed noise abatement restrictions and/or other prohibitions

The runway system at HEF is comprised of Runway 16R-34L with a length of 3,715 feet and Runway 16L-34R with a length of 6,200 feet. A runway length analysis was conducted for 16R-34L and found the existing length of 3,715 feet was adequate to accommodate critical aircraft operations operating on the runway during the planning period. According to FAA guidance, Advisory Circular 150/5325-4B, Runway Length Requirements for Airport Design, the "design objective for a primary runway is to provide a runway length for all airplanes that will regularly use it without causing operational weight restrictions".

Given FAA guidance and an initial runway length analysis, Runway, 16L-34R, was selected as the primary runway to accommodate aircraft types operating at HEF. Justification for any runway length to meet the needs of turbine aircraft would require regular use on the order of a minimum of 500 annual itinerant operations. The suitability of available runway length at HEF was previously evaluated in the FAA approved 2002 Master Plan Update. Based upon the critical aircraft at the time, Learjet 60, a runway length between 6,400 and 6,500 feet was recommended. Despite the results of the runway length analysis, the City of Manassas elected to pursue a 500-foot extension providing a length of 6,200 feet as depicted on the ALP at the time.

To evaluate the length of Runway 16L-34R, it was necessary to determine the future critical aircraft's runway length requirements in the absence of weight restrictions based on the FAA runway design criteria outlined in FAA AC 150/5325-4B – *Runway Length Requirements for Airport Design*.

## 1.2 RUNWAY LENGTH REQUIREMENTS FOR AIRPORT DESIGN

Advisory Circular 150/5325-4B provides the following five-step process to determine runway length requirements associated with the airport's existing and future critical aircraft. The five steps include:

1. Identify the list of critical design aircraft that will make regular use of the proposed runway for an established period of at least five years.
2. Identify airplanes or family of airplanes that will require the longest runway lengths at maximum certified takeoff weight (MTOW).

3. Using Table 1-1 of AC 150/5325-4B and the airplanes identified in Step #2, determine the method that will be used for establishing the recommended runway length based upon useful load and service needs of critical design aircraft or family of aircraft.

4. Select the recommended runway length from among the various runway lengths generated in Step 3 using the process identified in Chapters 2, 3 or 4 of the Advisory Circular, as applicable.

5. Apply any necessary adjustment (i.e. pavement gradient, pavement conditions, etc.). Based upon this methodology, runway length requirements for Runway 16L-34R was determined.

### 1.2.1 Step 1 - Identification of Critical Design Aircraft

The AC provides the definition of critical design airplanes as the "listing of airplanes (or a single airplane) that would result in the longest recommended runway length". Therefore, to complete Step 1, the FAA approved Aviation Activity Forecast and specific aircraft operations were assessed to develop a ten-year turbojet fleet mix.

For the purpose of this analysis, the following assumptions were made based upon information obtained from users and historical data:

1. The airport will continue to be classified as a general aviation reliever airport for Washington Dulles International Airport (IAD).

2. The number of ultra high-net worth individuals is expected to grow at rates exceeding those of previous years, creating new entrants into the market that can purchase a business jet or charter a flight. The business jet market is also being driven by a growing interest in long-range travel as borders continue to open around the world, with large jets offering the opportunity to fly further.[1]

3. Larger business-jet operations at HEF will continue to grow as forecasted in the Aviation Activity Forecast and aligns with the FAA's Terminal Area Forecast as total operations at tower airports are forecasted to grow.

4. HEF's historic jet fleet mix for 2021 operations provided the baseline data for the types and frequency of operations (**Table 1**). Average annual turbojet operations growth of 2.9% aligns with the FAA Aerospace Forecast 2022-2042.[2]

5. The more demanding aircraft currently operating at HEF incur operational constraints. There is evidence that some aircraft carry less than desirable fuel, passengers, payload, etc. to effectively

[1] Business Airport International; *How Large Cabin Bizjets are Driving Change in Business Aviation: https://www.businessairportinternational.com/features/how-an-increasing-demand-for-larger-cabin-bizjets-is-driving-changes-in-aircraft-design.html*

[2] FAA Aerospace Forecast Fiscal Years 2022-2042: *https://www.faa.gov/sites/faa.gov/files/2022-06/FY2022_42_FAA_Aerospace_Forecast.pdf*

operate on the primary runway on higher temperature days. See **Section 1.3.2 – Operator Surveys** which substantiates these operations.

*TABLE 1*
*10-YEAR TURBOJET FLEET MIX*

| Turbojet ICAO Code | Aircraft Name | AAC-ADG | MTOW | Year | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
| **C25B** | Citation CJ3 | B-II | 13,870 | 419 | 254 | 464 | 478 | 492 | 507 | 522 | 538 | 554 | 571 | 588 | 606 | 624 |
| **E55P** | Phenom 300 | B-II | 17,968 | 208 | 141 | 400 | 412 | 424 | 437 | 450 | 464 | 478 | 492 | 507 | 522 | 538 |
| **CL60** | Challenger 601/650 | C-II | 48,200 | 421 | 306 | 360 | 371 | 382 | 394 | 406 | 418 | 431 | 444 | 457 | 471 | 485 |
| **C525** | Citation CJ1 | B-I | 10,600 | 310 | 217 | 326 | 336 | 346 | 357 | 368 | 379 | 390 | 402 | 414 | 427 | 440 |
| **C56X** | Citation Excel | B-II | 20,000 | 261 | 170 | 252 | 260 | 268 | 276 | 285 | 294 | 303 | 312 | 322 | 332 | 342 |
| **LJ60** | Learjet 60 | C-I | 22,750 | 196 | 163 | 246 | 254 | 262 | 270 | 278 | 287 | 296 | 305 | 314 | 324 | 334 |
| **CL30** | Challenger 300 | B-II | 38,850 | 239 | 186 | 242 | 250 | 258 | 266 | 274 | 282 | 291 | 300 | 309 | 318 | 328 |
| **C560** | Citation Encore | B-II | 16,830 | 240 | 124 | 232 | 239 | 246 | 254 | 262 | 270 | 278 | 287 | 296 | 305 | 314 |
| **C550** | Citation II | B-II | 14,800 | 306 | 174 | 230 | 237 | 244 | 252 | 260 | 268 | 276 | 285 | 294 | 303 | 312 |
| **H25B** | Hawker 800 | C-II | 28,000 | 261 | 151 | 220 | 227 | 234 | 241 | 248 | 256 | 264 | 272 | 280 | 289 | 298 |
| **E50P** | Phenom 100 | B-I | 10,582 | 510 | 132 | 214 | 221 | 228 | 235 | 242 | 250 | 258 | 266 | 274 | 282 | 291 |
| **BE40** | Beechjet 400 | B-I | 15,780 | 240 | 201 | 200 | 206 | 212 | 219 | 226 | 233 | 240 | 247 | 255 | 263 | 271 |
| **GLF4** | Gulfstream IV/ G450 | D-II | 73,900 | 245 | 116 | 198 | 204 | 210 | 217 | 224 | 231 | 238 | 245 | 253 | 261 | 269 |
| **FA50** | Falcon 50 | B-II | 40,780 | 130 | 101 | 178 | 184 | 190 | 196 | 202 | 208 | 215 | 222 | 229 | 236 | 243 |
| **C510** | Citation Mustang | B-I | 8,645 | 195 | 105 | 170 | 175 | 181 | 187 | 193 | 199 | 205 | 211 | 218 | 225 | 232 |
| **LJ45** | Learjet 45 | C-I | 21,500 | 127 | 49 | 152 | 157 | 162 | 167 | 172 | 177 | 183 | 189 | 195 | 201 | 207 |
| **SF50** | SF50 Vision Jet | A-I | 6,000 | 95 | 109 | 152 | 157 | 162 | 167 | 172 | 177 | 183 | 189 | 195 | 201 | 207 |
| **C68A** | Citation Latitude | B-II | 30,800 | 163 | 73 | 126 | 130 | 134 | 138 | 143 | 148 | 153 | 158 | 163 | 168 | 173 |
| **C750** | Citation X | B-II | 36,100 | 87 | 75 | 114 | 118 | 122 | 126 | 130 | 134 | 138 | 143 | 148 | 153 | 158 |
| **F900** | Falcon 900 EX | B-II | 49,000 | 149 | 47 | 108 | 112 | 116 | 120 | 124 | 128 | 132 | 136 | 140 | 145 | 150 |
| **C501** | Citation I | B-I | 11,850 | 68 | 63 | 100 | 103 | 106 | 110 | 114 | 118 | 122 | 126 | 130 | 134 | 138 |
| **PC24** | Pilatus PC-24 | A-II | 18,000 | 21 | 65 | 88 | 91 | 94 | 97 | 100 | 103 | 106 | 110 | 114 | 118 | 122 |
| **C680** | Citation Sovereign | B-II | 30,300 | 102 | 54 | 88 | 91 | 94 | 97 | 100 | 103 | 106 | 110 | 114 | 118 | 122 |
| **CL35** | Challenger 350 | C-II | 40,600 | 89 | 52 | 86 | 89 | 92 | 95 | 98 | 101 | 104 | 108 | 112 | 116 | 120 |
| **E135** | Embraer ERJ-135 | C-II | 41,888 | 77 | 84 | 84 | 87 | 90 | 93 | 96 | 99 | 102 | 105 | 109 | 113 | 117 |
| **GLF5** | Gulfstream V/G500 | C-III | 90,500 | 52 | 35 | 80 | 83 | 86 | 89 | 92 | 95 | 98 | 101 | 104 | 108 | 112 |
| **F2TH** | Falcon 2000/EX | B-II | 42,400 | 186 | 41 | 80 | 83 | 86 | 89 | 92 | 95 | 98 | 101 | 104 | 108 | 112 |
| **C25A** | Citation CJ2 | B-II | 12,300 | 104 | 49 | 78 | 81 | 84 | 87 | 90 | 93 | 96 | 99 | 102 | 105 | 109 |
| **EA50** | Eclipse 500 | A-I | 5,950 | 105 | 43 | 72 | 75 | 78 | 81 | 84 | 87 | 90 | 93 | 96 | 99 | 102 |
| **HDJT** | Honda Jet | B-I | 9,038 | 73 | 50 | 66 | 68 | 70 | 73 | 76 | 79 | 82 | 85 | 88 | 91 | 94 |
| **C25C** | Citation CJ4 | B-II | 17,110 | 51 | 42 | 66 | 68 | 70 | 73 | 76 | 79 | 82 | 85 | 88 | 91 | 94 |
| **PRM1** | Beech 390 Premier I | B-I | 12,500 | 38 | 15 | 62 | 64 | 66 | 68 | 70 | 73 | 76 | 79 | 82 | 85 | 88 |
| **E545** | Embraer Legacy 450 | B-II | 35,759 | 18 | 14 | 62 | 64 | 66 | 68 | 70 | 73 | 76 | 79 | 82 | 85 | 88 |
| **G150** | Gulfstream G150 | C-II | 26,100 | 29 | 6 | 54 | 56 | 58 | 60 | 62 | 64 | 66 | 68 | 70 | 73 | 76 |
| **LJ75** | Learjet 75 | C-II | 21,500 | 52 | 16 | 34 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 49 | 51 | 53 |
| **GLF3** | Gulfstream III | C-II | 69,700 | 48 | 47 | 34 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 49 | 51 | 53 |
| **LJ35** | Learjet 35 | D-I | 18,000 | 25 | 21 | 32 | 33 | 34 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 49 |
| **C650** | Citation III | C-II | 22,000 | 64 | 13 | 32 | 33 | 34 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 49 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **G280** | Gulfstream G280 | C-II | 39,600 | 18 | 17 | 32 | 33 | 34 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 49 |
| **GLEX** | Global 6000/Express | B-III | 99,500 | 8 | 8 | 30 | 31 | 32 | 33 | 34 | 35 | 37 | 39 | 41 | 43 | 45 |
| **ASTR** | Astra 1125 | C-II | 35,650 | 49 | 24 | 30 | 31 | 32 | 33 | 34 | 35 | 37 | 39 | 41 | 43 | 45 |
| **C25M** | Citation M2 | B-I | 10,700 | 74 | 76 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 37 | 39 | 41 |
| **C55B** | Citation Bravo | B-II | 14,800 | 7 | 10 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| **LJ40** | Learjet 40 | C-I | 21,000 | 10 | 4 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| **FA20** | Falcon 2000/EX | B-II | 28,660 | 21 | 4 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| **GLF6** | Gulfstream G650 | D-III | 99,600 | 3 | 0 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| **LJ31** | Learjet 31 | C-I | 15,500 | 47 | 13 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| **GALX** | Galaxy 1126 | D-II | 35,650 | 42 | 14 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| **LJ55** | Learjet 55 | C-I | 19,500 | 9 | 16 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| **C700** | Citation Longitude | B-II | 39,500 | 0 | 4 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| **GA6C** | G600 | D-III | 91,600 | 0 | 2 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| **FA10** | Falcon 10 | B-I | 18,740 | 33 | 8 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| **E550** | Embraer Legacy 500 | C-II | 38,360 | 7 | 7 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| **CRJ2** | CRJ-200 | C-II | 53,000 | 12 | 5 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| **FA7X** | Falcon 7X | B-III | 70,000 | 17 | 9 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| **LJ70** | Learjet 70 | C-II | 21,750 | 4 | 4 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| **H25C** | Hawker 1000 | B-I | 31,100 | 8 | 11 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| **GL5T** | Global 5000 | B-III | 92,500 | 12 | 8 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| **SBR1** | Z-143 | B-I | 20,000 | 51 | 18 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| **E145** | Embraer ERJ-145 | C-II | 48,480 | 0 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| **E190** | Embraer 190 | C-III | 105,359 | 3 | 1 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| **H25A** | Bae HS 125 | C-I | 20,503 | 0 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| **WW24** | 1124 Westwind I | C-I | 23,500 | 11 | 14 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| **GL7T** | Global 7500 | B-III | 106,250 | 0 | 0 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| **LJ25** | Learjet 25 | C-I | 15,000 | 0 | 0 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| **LJ24** | Learjet 24 | C-I | 13,000 | 0 | 0 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| **Total** | | | | **6,450** | **3,886** | **6,146** | **6,359** | **6,575** | **6,802** | **7,034** | **7,273** | **7,519** | **7,773** | **8,034** | **8,304** | **8,578** |

Source: FAA Offload Data ; RS&H Analysis

### 1.2.2 Step 2 – Aircraft Requiring the Longest Runway Length at MTOW

Step 2 of FAA AC 150/5325-4B states: "identify the airplanes that will require the longest runway length at maximum certificated takeoff weight (MTOW). The methodology found in this step is based on the MTOW of the aircraft types operating on a regular basis (minimum of 500 annual operations). **Table 1** provides the fleet mix operations forecast and MTOW. The Advisory Circular groups aircraft into three weight categories"

- Small aircraft – MTOW 12,500 pounds or less. Aircraft in this category can range from ultralight to small turboprop aircraft. Aircraft within the small aircraft category were not evaluated as the runway lengths at HEF allow these aircraft to takeoff at MTOW without weight restrictions.

- Large aircraft – MTOW over 12,500 pounds but less than 60,000 pounds. This group is further categorized by "75 percent of fleet" and "100 percent of fleet". The Challenger 300, Citation Excel, and Citation I are small and mid-size business jets within the "75 percent of fleet" category which operate at HEF. Aircraft in the "100 percent of fleet" category operating at HEF include the Citation X, Learjet 60 and Falcon 900.

- Individual large Airplanes – MTOW over 60,000 pounds. When MTOW of the operating aircraft is over 60,000 pounds, the recommended runway length is determined by referencing performance charts in each airplane manufacturer's Airport Planning Manual (APM).

The fleet mix depicted in **Table 1** confirms the majority of jet aircraft operating at HEF fall within large aircraft category with a MTOW over 12,5000 pounds but less than 60,000 pounds.

### 1.2.3 Step 3 – Airplane Weight Categorization for Runway Length Requirements

Step 3 of FAA AC 150/5325-4B directs airport sponsors to use Table 2 and the airplanes identified in Step 2 to determine the method that will be used for establishing the recommended runway length. The required runway length will be determined by a family grouping of large airplanes as determined by charts within the guidance.

***TABLE 2***
***AIRPLANE WEIGHT CATEGORIZATION FOR RUNWAY LENGTH REQUIREMENTS***

| Airplane Weight Category Maximum Certificated Takeoff Weight (MTOW) | | | Design Approach | Location of Design Guidelines |
|---|---|---|---|---|
| 12,500 pounds (5,670 kg) or less | Approach Speeds less than 30 knots | | Family grouping of small airplanes | Chapter 2; Paragraph 203 |
| | Approach Speeds of at least 30 knots but less than 50 knots | | Family grouping of small airplanes | Chapter 2; Paragraph 204 |
| | Approach Speeds of 50 knots or more | With Less than 10 Passengers | Family grouping of small airplanes | Chapter 2; Paragraph 205 Figure 2-1 |
| | | With 10 or more Passengers | Family grouping of small airplanes | Chapter 2; Paragraph 205 Figure 2-2 |
| Over 12,500 pounds (5,670 kg) but less than 60,000 pounds (27,200 kg) | | | Family grouping of large airplanes | Chapter 3; Figures 3-1 or 3-2 [1] and Tables 3-1 or 3-2 |
| 60,000 pounds (27,200 kg) or more or Regional Jets [2] | | | Individual large airplane | Chapter 4; Airplane Manufacturer Websites (Appendix 1) |

**Note [1]:** When the design airplane's APM shows a longer runway length than what is shown in figure 3-2, use the airplane manufacturer's APM. However, users of an APM are to adhere to the design guidelines found in Chapter 4.

**Note [2]:** All regional jets regardless of their MTOW are assigned to the 60,000 pounds (27,200 kg) or more weight category.

Source: FAA AC 150/5325-4B, Runway Length Requirements for Airport Design

To determine the proper runway length for aircraft that have a greater MTOW than 12,500 pounds but less than 60,000 pounds, and are not regional jets, airport sponsors group similar aircraft together based on performance characteristics and operating weights. This grouping of aircraft is referred to as a family. The runway length recommended for this type of aircraft is then determined based on this family grouping. For this size of aircraft, FAA guidance groups them into the "75 percent fleet" and "100 percent fleet" mix. The breakdown of these aircraft operating at HEF over the next five years is divided into each of these groups in Table 3 and Table 4.

*TABLE 3*
*75 PERCENT OF FLEET MIX*

| Aircraft Name | AAC-ADG | MTOW | Year 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|---|---|---|---|---|---|---|---|
| **Beechjet 400** | B-I | 15,780 | 200 | 206 | 212 | 219 | 226 | 233 |
| **Citation I** | B-I | 11,850 | 100 | 103 | 106 | 110 | 114 | 118 |
| **Beech 390 Premier I** | B-I | 12,500 | 62 | 64 | 66 | 68 | 70 | 73 |
| **Citation M2** | B-I | 10,700 | 28 | 29 | 30 | 31 | 32 | 33 |
| **Falcon 10** | B-I | 18,740 | 12 | 13 | 14 | 15 | 16 | 17 |
| **Citation Excel** | B-II | 20,000 | 252 | 260 | 268 | 276 | 285 | 294 |
| **Challenger 300** | B-II | 38,850 | 242 | 250 | 258 | 266 | 274 | 282 |
| **Citation Encore** | B-II | 16,830 | 232 | 239 | 246 | 254 | 262 | 270 |
| **Falcon 50** | B-II | 40,780 | 178 | 184 | 190 | 196 | 202 | 208 |
| **Citation Sovereign** | B-II | 30,300 | 88 | 91 | 94 | 97 | 100 | 103 |
| **Falcon 2000/EX** | B-II | 28,660 | 20 | 21 | 22 | 23 | 24 | 25 |
| **Citation Latitude** | B-II | 30,800 | 126 | 130 | 134 | 138 | 143 | 148 |
| **Citation Bravo** | B-II | 14,800 | 22 | 23 | 24 | 25 | 26 | 27 |
| **Learjet 45** | C-I | 21,500 | 152 | 157 | 162 | 167 | 172 | 177 |
| **Learjet 40** | C-I | 21,000 | 20 | 21 | 22 | 23 | 24 | 25 |
| **Learjet 31** | C-I | 15,500 | 18 | 19 | 20 | 21 | 22 | 23 |
| **Challenger 350** | C-II | 40,600 | 86 | 89 | 92 | 95 | 98 | 101 |
| **Citation III** | C-II | 22,000 | 32 | 33 | 34 | 35 | 37 | 39 |
| **Learjet 35** | D-I | 18,000 | 32 | 33 | 34 | 35 | 37 | 39 |
| **75% Fleet Mix Total** | | | **1,902** | **1,965** | **2,028** | **2,094** | **2,164** | **2,235** |

*TABLE 4*
*100 PERCENT OF FLEET MIX*

| Aircraft Name | AAC-ADG | MTOW | Year 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|---|---|---|---|---|---|---|---|
| **Hawker 1000** | B-I | 31,100 | 6 | 7 | 8 | 9 | 10 | 11 |
| **Citation X** | B-II | 36,100 | 114 | 118 | 122 | 126 | 130 | 134 |
| **Falcon 900 EX** | B-II | 49,000 | 108 | 112 | 116 | 120 | 124 | 128 |
| **Falcon 2000/EX** | B-II | 42,400 | 80 | 83 | 86 | 89 | 92 | 95 |
| **Learjet 60** | C-I | 22,750 | 246 | 254 | 262 | 270 | 278 | 287 |
| **Learjet 55** | C-I | 19,500 | 16 | 17 | 18 | 19 | 20 | 21 |
| **Challenger 601/604/605/650** | C-II | 48,200 | 360 | 371 | 382 | 394 | 406 | 418 |
| **Hawker 800** | C-II | 28,000 | 220 | 227 | 234 | 241 | 248 | 256 |
| **Astra 1125** | C-II | 35,650 | 30 | 31 | 32 | 33 | 34 | 35 |
| **Galaxy 1126** | D-II | 35,650 | 18 | 19 | 20 | 21 | 22 | 23 |
| **100% Fleet Mix Total** | | | **1,198** | **1,239** | **1,280** | **1,322** | **1,364** | **1,408** |

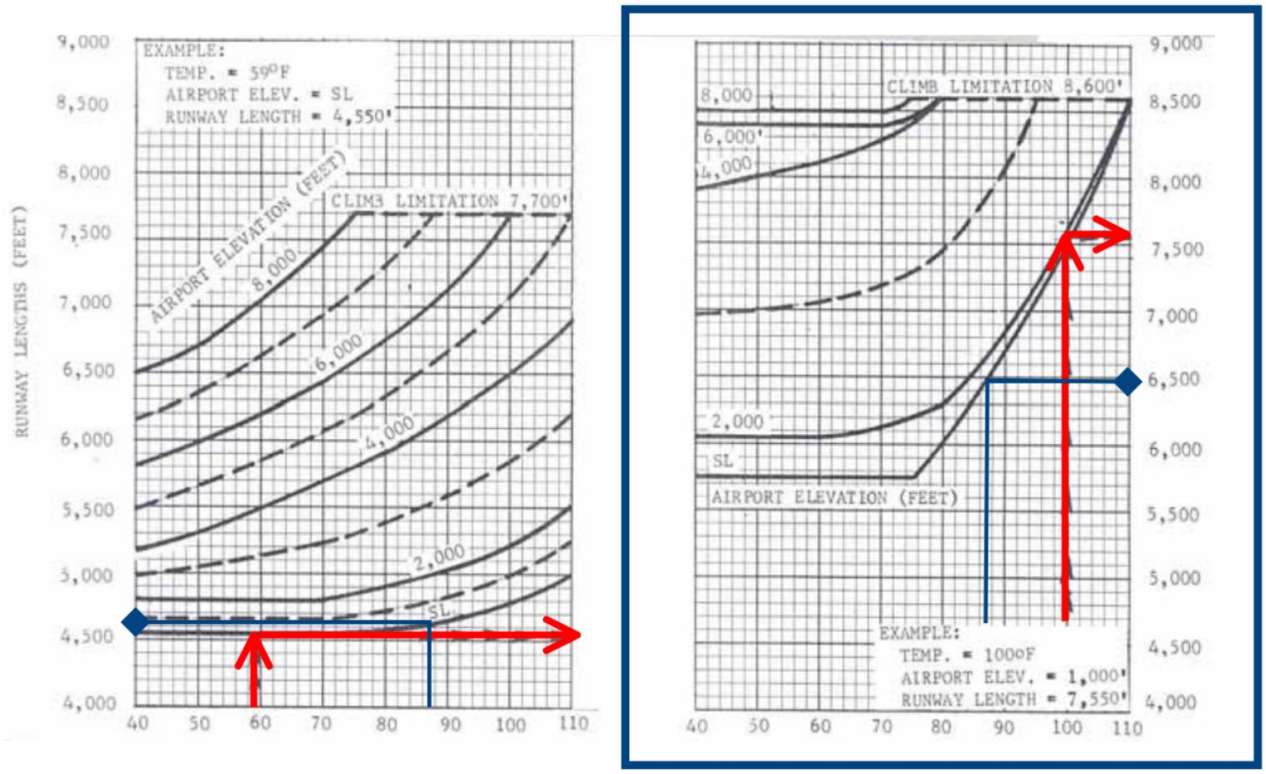
### 1.2.4 Step 4 – Select Recommended Runway Length

According to this analysis, the airport experienced 1,902 operations in the 75 percent fleet mix in 2021 with a projected 2,235 operations by 2026. The airport experienced 1,198 operations in the 100 percent fleet mix in 2021 with a projected 1,408 operations by 2026.

The 75 percent fleet mix contains most of the aircraft operations in 2021 and the forecasted five years. The aircraft that require the longest runway lengths at MTOW are in the 100 percent fleet mix. Therefore, the 75 percent fleet mix and 100 percent fleet mix were analyzed to determine the required runway length. The recommended length for 75 percent and 100 percent groups of airplanes is found in Chapter 3 of FAA AC 150/5325-4B – specifically in Figure 3-1 and Figure 3-2 respectively.

The 75 percent fleet mix and 100 percent fleet mix are further divided by a 60 percent useful load and 90 percent useful load. For the aircraft to operate with a lower useful load (60 percent), either the aircraft must operate at a lighter takeoff weight, requiring less cargo and passengers, or the aircraft must fly shorter distances in order to operate with a lower useful load. Consequently, aircraft operating with a 60 percent useful load, would be restricted to a limited number of markets before having to stop for refueling at a certain point in the journey. From operator surveys conducted on-airport (results of which are shared in Section 2.3.2) and flight tracking software, there is evidence confirming the existing runway length has resulted in payload restrictions during takeoff and flying shorter distances to refuel. The business aviation market in the DC area is experiencing significant growth, accompanied by a notable increase in flights exceeding 1,000 NM out of HEF. This trend suggests that business jet operations requiring a higher useful load of 90 percent will continue to increase in the planning period. Consequently, the analysis of runway length is best suited for the 90 percent useful load curve, making it the most suitable approach. Research conducted in this Master Plan update showed that this ability is necessary to meet the needs of the aircraft using HEF over the next 20-years and will also allow for flexibility in the GA fleet to serve larger aircraft. As noted in the Inventory and Facility Requirement Chapter the mean maximum temperature at the airport is 87 degrees Fahrenheit and field elevation is 192.3 feet above mean sea level. These respective reference points in the 75 percent of fleet mix and 100 percent fleet mix tables were utilized in determining the unadjusted runway length.

***FIGURE 1***
***75 PERCENT FLEET MIX AT 60 AND 90 PERCENT USEFUL LOAD***




**Mean Daily Maximum Temperature of Hottest Month of the Year in Degrees Fahrenheit**

**75 percent of feet at 60 percent useful load** **75 percent of feet at 90 percent useful load**

Source: FAA AC 150/5325-4B, Runway Length Requirements for Airport Design

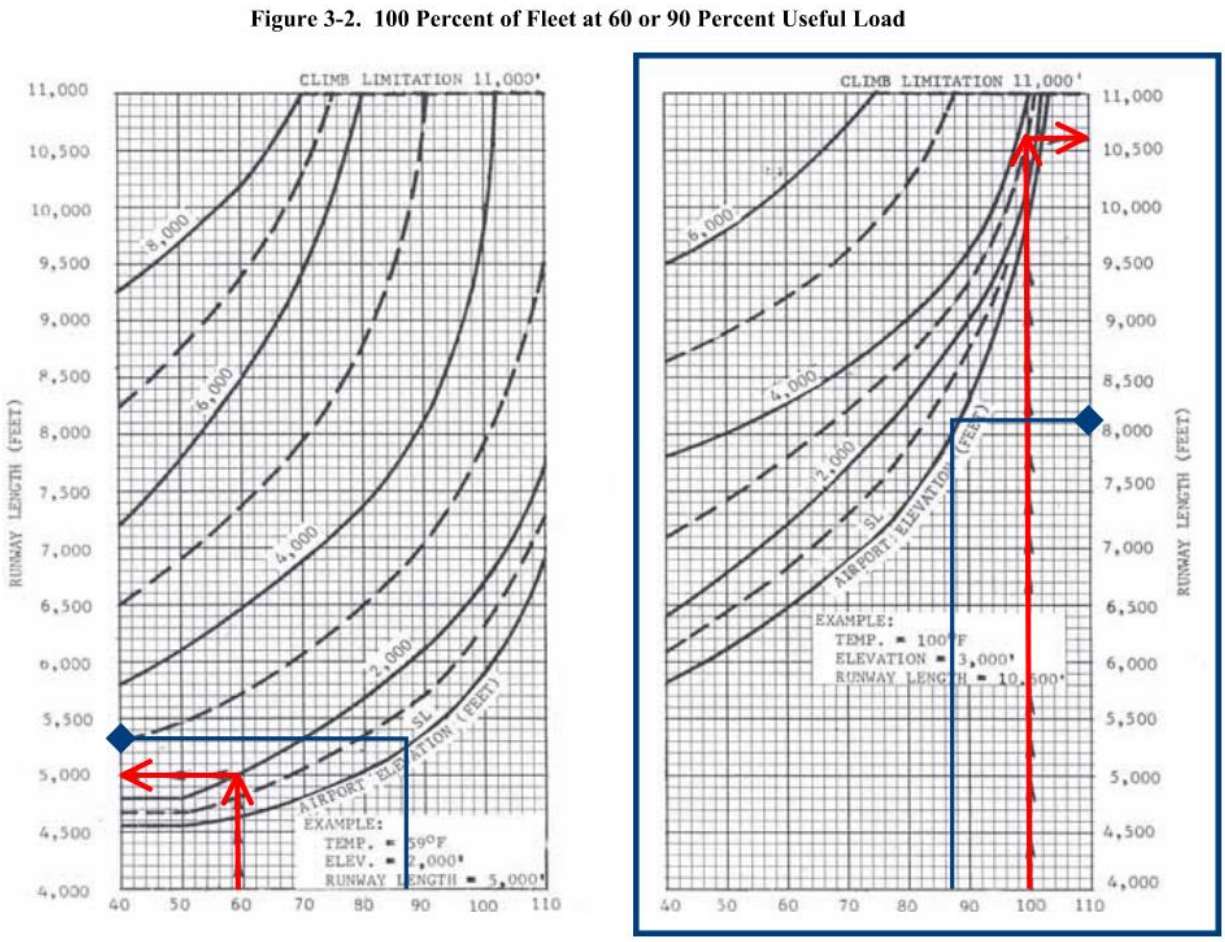
The blue line in Figure 1 represents the analysis completed as part of the master plan effort. The red line was included in the Advisory Circular for reference. Analysis of the 75 percent of fleet mix at 60 percent useful load resulted in a recommended runway length of 4,600 feet. Analysis of the 75 percent of fleet mix at 90 percent useful load resulted in a recommended runway length of 6,500 feet.

***TABLE 5***
***75 PERCENT FLEET MIX UNADJUSTED RUNWAY LENGTH***

| Accommodated Fleet | 60% Useful Load | 90% Useful Load |
|---|---|---|
| 75% (Figure 3-1) | 4,600' | **6,500'** |

Source: FAA AC 150/5325-4B, Runway Length Requirements for Airport Design

*FIGURE 2*
*100 PERCENT OF THE FLEET AT 60 AND 90 PERCENT USEFUL LOAD*




Source: FAA AC 150/5325-4B, Runway Length Requirements for Airport Design

The blue line in Figure 2 represents the analysis completed as part of the master plan effort. The red line was included in the Advisory Circular for reference. Analysis of the 100 percent of fleet mix at 60 percent useful load resulted in a recommended runway length of 5,300 feet. Analysis of the 100 percent of fleet mix at 90 percent useful load resulted in a recommended runway length of 8,100 feet.

*TABLE 6*
*100 PERCENT FLEET MIX UNADJUSTED RUNWAY LENGTH*

| Accommodated Fleet | 60% Useful Load | 90% Useful Load |
|---|---|---|
| 100% (Figure 3-2) | 5,300′ | **8,100′** |

Source: FAA AC 150/5325-4B, Runway Length Requirements for Airport Design

### 1.2.5 Step 5 – Apply Necessary Adjustments

The final step to determine the required runway length is to apply any necessary adjustments to the runway lengths in Step 4. For the purposes of takeoff length, one adjustment must be applied to the unadjusted runway length. The runway gradient must be factored into the required runway length. To calculate the runway grade adjustment, both runway end elevations must be known. The runway lengths obtained from Step 4 are increased at a rate of 10 feet for each foot of elevation difference between the high and low points of the runway centerline. Based on the high and low points on Runway 16L-34R, the unadjusted lengths were increased by 150 feet.

***TABLE 7***
***UNADJUSTED RUNWAY LENGTH***

| Large Airplanes between 12,500 lbs and 60,000 lbs | Unadjusted Runway Length | Gradient Adjustment | Wet Conditions |
|---|---|---|---|
| 75% fleet mix at 60% useful load | 4,600′ | 4,750′ | 5,463′ |
| **75% fleet mix at 90% useful load** | **6,500′** | **6,650′** | **7,000′** |
| 100% fleet mix at 60% useful load | 5,300′ | 5,450′ | 5,550′ |
| **100% fleet mix at 90% useful load** | **8,100′** | **8,250′** | **8,250′** |

Note: The runway lengths obtained from Tables 3-1 and 3-2 are increased at a rate of 10 feet for each foot of elevation difference between the high and low points of the runway centerline. The runway length for turbojet-powered airplanes obtained from the "60 percent useful load" tables are increased by 15 percent or up to 5,500 feet, whichever is less for wet conditions. The runway lengths for turbojet-powered airplanes obtained from the "90 percent useful load" curves are increased by 15 percent or up to 7,000 feet, whichever is less for wet conditions.

Source: FAA AC 150/5325-4B, Runway Length Requirements for Airport Design

Based on both 75 percent and 100 percent fleet mix at 90% useful load, which are justified since there are over 500 operations in each category, HEF's primary runway is shorter than needed to adequately accommodate the critical aircraft users in both categories. To verify the analysis from the general curves and ensure a future extension is needed at HEF, a sample of individual aircraft manufacturer manuals for aircraft known to operate at HEF were reviewed for specific runway length needs. The required takeoff lengths and projected operations for the next five years are shown in **Table 8.**

*TABLE 8*
*CRITICAL DESIGN AIRCRAFT FOR RUNWAY LENGTH RECOMMENDATIONS*

| Aircraft Name | MTOW (LBS) | Takeoff Length at HEF | Total Operations | | |
|---|---|---|---|---|---|
| | | | 2021 | 2026 | 2031 |
| **Embraer/ERJ-145** | 48,480 | 6,476' | 4 | 9 | 14 |
| **Learjet 35** | 18,000 | 6,404' | 32 | 39 | 49 |
| **Learjet 60** | 22,750 | 6,404' | 246 | 287 | 334 |
| **Global 6000/Express** | 99,500 | 6,464' | 30 | 35 | 45 |
| **Gulfstream 500** | 90,500 | 6,642' | 80 | 95 | 112 |
| **Total** | | | **392** | **465** | **554** |

Note 1: Individual Airport Planning Manuals referenced
Note 2: Airport Temperature: $87^0$ F
Note 3: Airport Elevation: 192.3' MSL
Note 4: Effective Runway Gradient: 150 ft

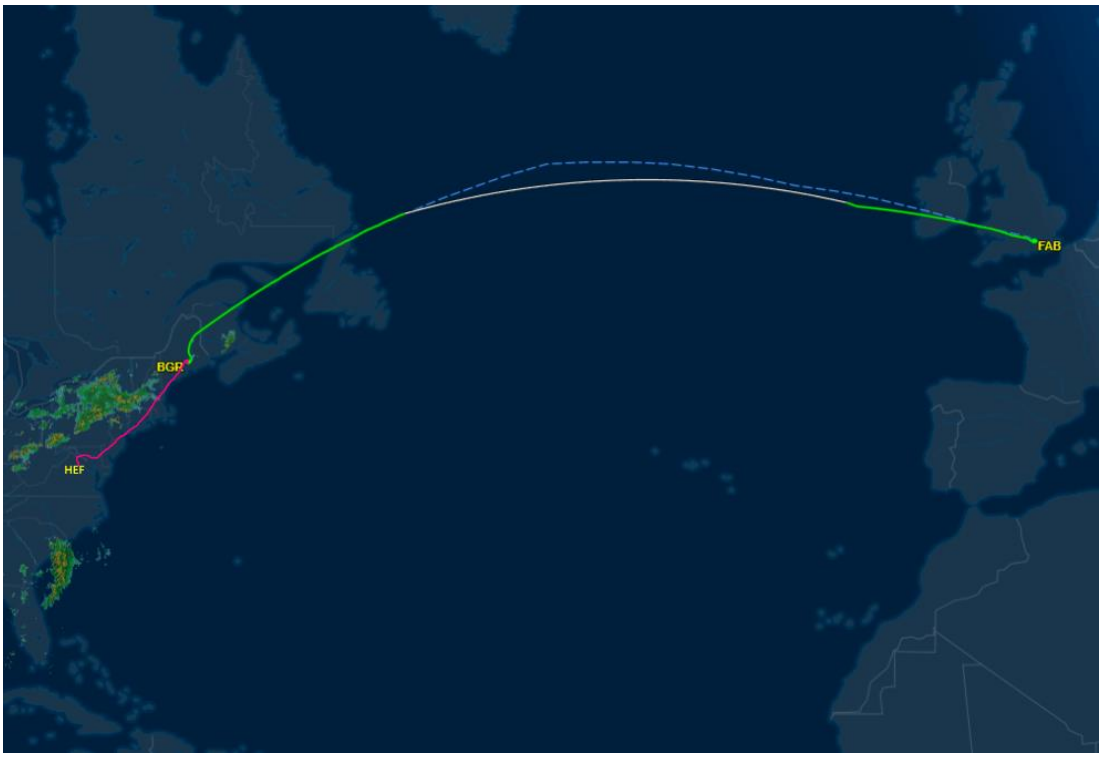
Additional details on the recommended runway length of 6,500 feet is provided in **Section 2.4 – Recommended Runway Length**.

## 1.3 CORRESPONDING VERIFICATION

### 1.3.1 Flight Tracking

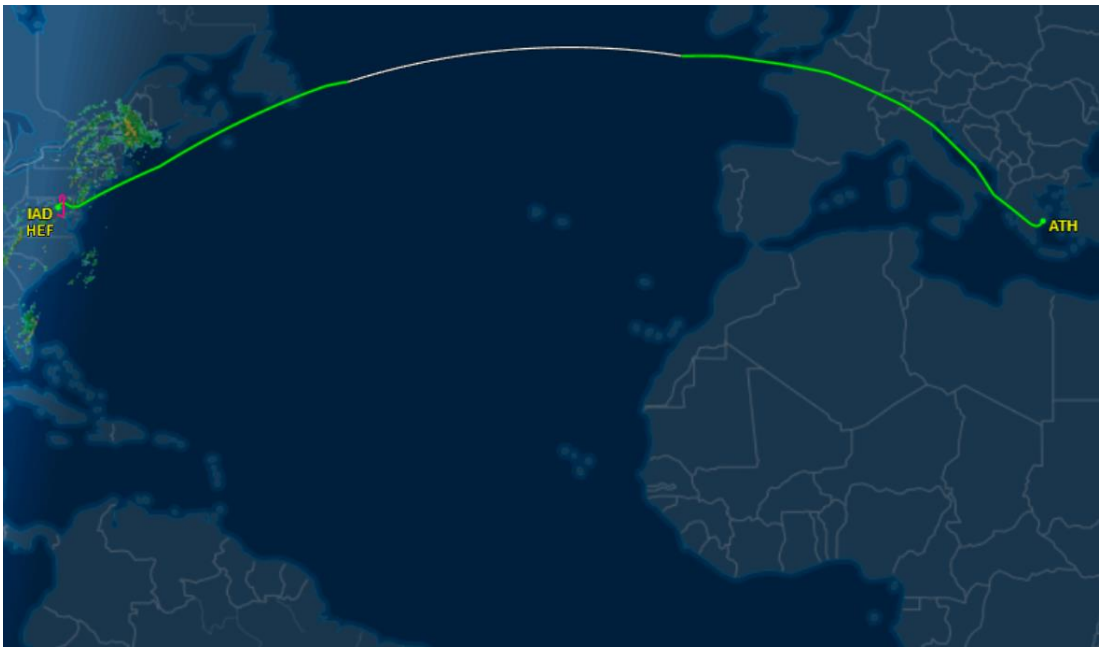
There is evidence of larger business jets repositioning to an airport with a longer runway prior to embarking on long-haul trips, indicative of MTOW. **Figure 3** depicts a trip by a Challenger 600 repositioning from HEF to Bangor International Airport (BGR) prior to flying over 3,150 nautical miles to Farnborough, England (FAB/EGLF). BGR has one runway with a length of 11,440 feet. Furthermore, **Figure 4** depicts a trip by a Gulfstream V repositioning from HEF to Washington Dulles (IAD) prior to flying over 4,500 nautical miles to Athens, Greece (ATH/LGAV). IAD has four runways with all runway lengths extending over 9,400 feet. Both flight operations occurred within the month of July and are indicative of summertime density altitudes resulting in restricted payloads.

***FIGURE 3***
***CL60 TRIP: HEF TO BGR TO FAB/EGLF***




Source: Flightaware.com

***FIGURE 4***
***GLF5 TRIP: HEF TO IAD TO ATH/LGAV***




Source: Flightaware.com

### 1.3.2 Operator Surveys

To support the need for the runway extension Airport staff conducted operator surveys of business jets to identify aircraft that have operated with restricted payloads or stopped to refuel due to the current runway length at HEF. Operators were asked to provide the number of annual operations to the best of their ability, however not all operations data was submitted to the Airport staff. Airport staff primarily focused survey efforts to the two FBOs and corporate tenants located on-airport. The results of the operator surveys are depicted in **Figure 5** and **Figure 6.**

***FIGURE 5***
***CHANITILLY AIR – HEF RUNWAY LENGTH SURVEY***

**Manassas Regional Airport Runway Length Survey**

1. Please list the aircraft currently operated by you or your company out of Manassas Regional Airport, along with the aircraft's tail number:
   - N256GG: CL-300
   - N278PC: CL-300
   - N949MC: CL-605
   - N57MH: CL-605
   - N686GD: G-650
   - N614GG: CJ1
   - N881JJ: G-450
   - N881MJ: LR-45
   - N26NG: PC-12

2. What is the typical stage length (nm) flown out of Manassas Regional Airport for the aircraft listed above?
   - 1500-2000 NM average

3. What is the maximum stage length (nm) for the aircraft listed above?
   - 7500 NM

4. Have you experienced constrained (i.e. reduced payload for takeoff) operations while operating out of Manassas Regional Airport? Please provide more details on those constraints:
   - Yes- Summertime density altitudes restrict climb gradients for 16L/ 34R. Runway lengths restrict max fuel for Heavy category aircraft operated by Chantilly Air (G-650/ G-450).

5. Identify the number of annual operations at Manassas Regional Airport that required a reduced payload for takeoff because of the current runway length:
   - Approximately 10-12 operations a year have restricted payload for takeoff because of current runway length. Particularly in our Gulfstreams- international trip planning is restricted based off fuel capacity for necessary climb gradient.

6. Have you experienced an intermediate stop to refuel due to reduced payload constraints operating out of Manassas Regional Airport? Please provide more details on these instances:
   - Yes- see previous description.

Please provide your contact information in the event we have follow-up questions for you:

Name: Timothy Sullivan  Company: Chantilly Air, Inc.

E-mail: timsullivan@chantillyair.com  Phone: (571)370-9400

Source: HEF Operator Survey

***FIGURE 6***
***FLIGHTWORKS – HEF RUNWAY LENGTH SURVEY***

**Manassas Regional Airport Runway Length Survey**

1. Please list the aircraft currently operated by you or your company out of Manassas Regional Airport, along with the aircraft's tail number: Challenger 605 N110CP

2. What is the typical stage length (nm) flown out of Manassas Regional Airport for the aircraft listed above? 1,000-3,000nm

3. What is the maximum stage length (nm) for the aircraft listed above? 4,000nm

4. Have you experienced constrained (i.e. reduced payload for takeoff) operations while operating out of Manassas Regional Airport? Please provide more details on those constraints: Yes, when it is hot or snowing, we have to restrict the amount of fuel or sometimes make a fuel stop.

5. Identify the number of annual operations at Manassas Regional Airport that required a reduced payload for takeoff because of the current runway length: About 12 or so per year

6. Have you experienced an intermediate stop to refuel due to reduced payload constraints operating out of Manassas Regional Airport? Please provide more details on these instances:
This has only happened a few times in this aircraft. I do not have specific trips that I remember at this time.

Please provide your contact information in the event we have follow-up questions for you:

Name: Diego Bustamante Company: FlightWorks

E-mail: diegob7@gmail.com Phone: 240-505-1505

Source: HEF Operator Survey

## 1.4 RECOMMENDED RUNWAY LENGTH

The recommended future runway length is 6,700 feet (500-foot extension) as this length allows for an extension while limiting impact to environmental resources in conjunction with allowing more business jets to operate out of HEF without payload restrictions. Data supporting the recommended runway length is detailed in this section.

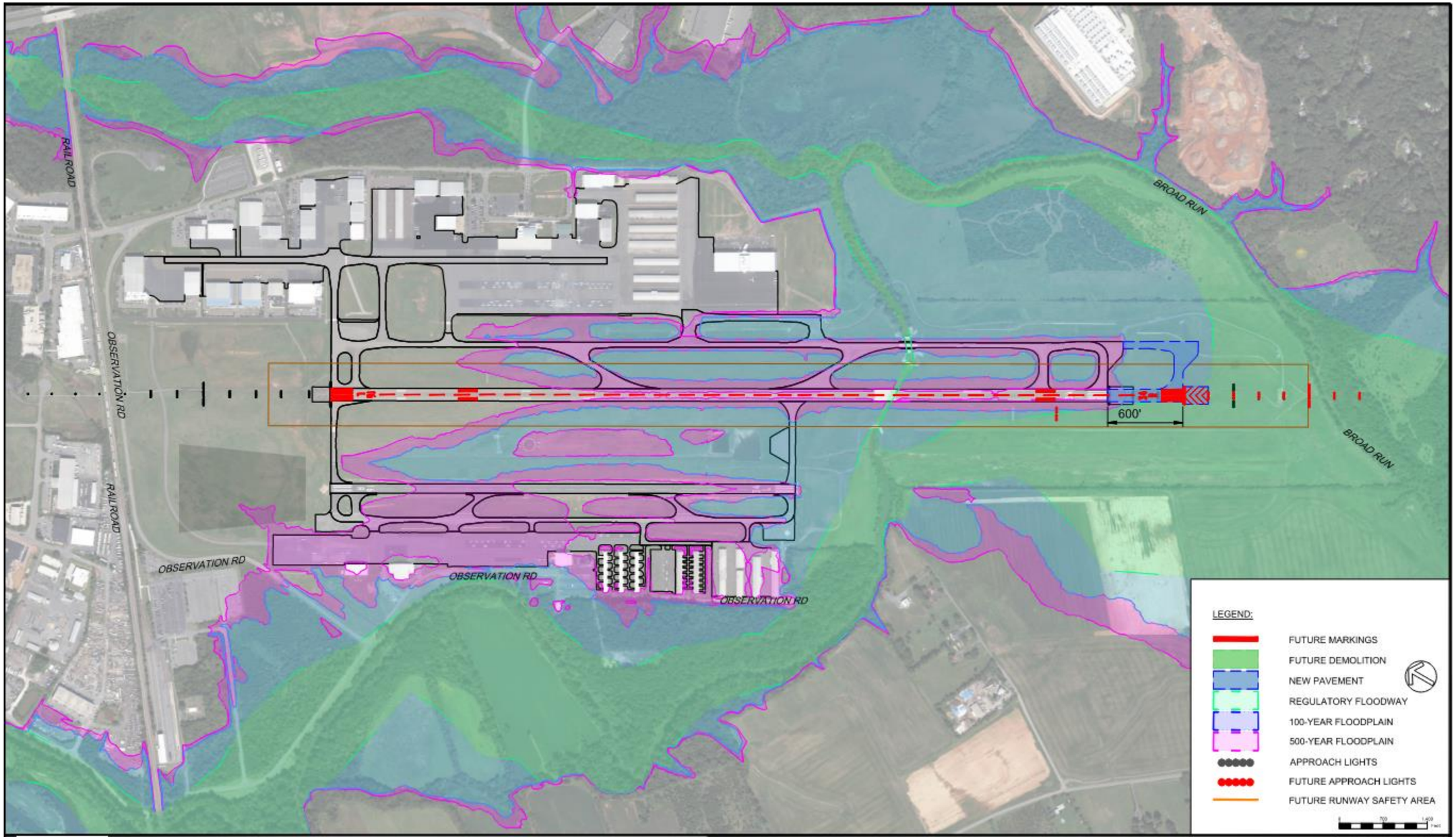
After following guidance in Advisory Circular 150/5325-4B, Section 2.2.5 reveals a maximum runway length of 8,250 feet can be rationalized for Runway 16L-34R. A final length of 8,250 feet would require an extension of 2,050 feet to accommodate the 100 percent fleet mix at 90% useful load that are restricted from operating at MTOW under hot weather conditions. The presence of Observation Road and Broad Run impose limitations on the possible length and direction of a runway extension. Airspace to the north and HEF's location in relation to the Washington DC Metropolitan Special Flight Rule Area (SFRA), as detailed in *Working Paper 2*, constrains the direction of an extension. The primary length constraint is attributed to the proximity of the extended runway's Runway Safety Area (RSA) to the surface variations presented by Broad Run. An RSA is defined as an area surrounding the runway consisting of a prepared surface suitable for reducing the risk of damage to aircraft in the event of an undershoot, overshoot, or excursion from the runway. RSA's must be cleared and graded with no potentially hazardous ruts, humps, depressions, or other surface variations while being capable of supporting Snow Removal Equipment, ARFF equipment, and the occasional aircraft without causing major damage to the aircraft. Considering the need to minimize significant airspace impact to the north, **Figure 7** depicts the maximum runway extension which could exist without the proposed RSA being impacted by Broad Run.

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) encompassing the Airport, currently Runway 16L-34R sits within the 500-year floodplain while the 100-year floodplain and regulatory floodway fall just outside of the Runway 34R blast pad. Preliminary investigation of a maximum 600-foot extension to Runway 16L-34R indicates approximately 124,700 square feet of the extended pavement (runway, blast pad, and taxiway) would fall in the 100-year floodplain. Approximately 27,300 square feet of the extended pavement (runway and blast pad) would fall in the regulatory floodway with the 600-foot extension. Executive Order (EO) 11988, *Floodplain Management*, and EO 13690, *Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input*, requires federal agencies to avoid, to the extent possible, the long and short-term adverse impacts associated with the occupancy and modification of 100-year floodplains and to avoid direct or indirect support of floodway development where there is a practicable alternative.

Alternatively, a 500-foot extension to Runway 16L-34R was assessed since a runway length of 6,700 feet would accommodate a significant portion of business jets that have been payload restricted during hot weather conditions, reference **Table 8**, while limiting impacts to environmental resources. Although this alternative does impact environmental resources, it will have less environmental impact than a length of 6,800-feet. When considering the four principles of airport sustainability; Economic Viability, Operational Efficiency, Natural Resource Conservation, and Social Responsibility a runway length of 6,700 feet embodies the recommended and preferred runway length for Runway 16L-34R. A 6,700-foot runway meets the needs of 75 percent of the fleet at 90 percent useful load after gradient adjustments and all of

the 100 percent fleet mix at 60 percent useful load during the planning period while enhancing the level of service the airport provides to the flying public. The master plan Alternatives Chapter considered several established criteria and recommended a plan to meet the recommended runway length of 6,500-feet for Runway 16L-34R.

*FIGURE 7*
*RUNWAY 16L-34R: 6,800 FT LENGTH*




Source: RS&H Analysis