CHAPTER THREE
DEMAND/CAPACITY AND FACILITY REQUIREMENTS

The forecasted aviation demands for Burlington International Airport (BTV) are presented in **Chapter Two**. The facility requirements described in this chapter are determined by evaluating each component of the airport to determine if the infrastructure has sufficient capacity to satisfy both the existing and forecasted aviation demand. This includes evaluating the airport's ability to meet the design and safety standards as established by the FAA in AC 150/5300-13 "Airport Design" and FAR Part 77 "Objects Affecting Navigable Airspace." The facility requirements for each airport component are identified by phase in an appropriate level of detail corresponding to the short-term (Years 0-5), mid-term (Years 6-10) and long-term (Years 11-20) planning periods. Some long term needs are presented in concept, recognizing that when growing demand reaches the capacity of these facilities, additional detailed planning may be required. The recommended development strategy will be presented in **Chapter Four** along with a brief evaluation of alternative development scenarios. This chapter addresses the following:

1. Runway Length Analysis
2. Taxiway Capacity and Location
3. Hangar Requirements
4. Terminal Area Layout and Space Requirements
5. Based and Transient Aircraft Apron Size
6. Obstruction Analysis/Approach Capability
7. Land Acquisition Needs

The number of based aircraft at BTV is anticipated to grow from 70 in 2008 to 94 in 2030. Annual enplanements are expected to increase from 759,021 in 2008 to 1,609,916 in 2030. Commercial operations are anticipated to grow from 29,506 to 56,502, and cargo operations from 1,252 to 2,282, during this planning period. General aviation operations are anticipated to grow from 53,870 to 72,280 over the planning period, and military operations are forecasted to increase from 9,000 to 15,000 during this time (See **Figure 2.27**). Demand may increase beyond these growth rates if market conditions change within the BTV airport service area.

A key goal of this Master Plan Update is to identify a general layout of future facilities in order to support the safe and efficient operation of the airport, while providing the flexibility for the airport to meet both anticipated and unforeseen demands. For these reasons, the facility requirements established by this Master Plan Update focus on: complying with design and safety standards; improving the utility of the facilities; and, accommodating the types of aircraft which are expected to use the airport in the future.

3.1 AIRPORT REFERENCE CODE AND CRITICAL AIRCRAFT

Airport planning begins with the determination of the appropriate FAA design criteria. These criteria establish basic design considerations for building restriction lines, setbacks, obstacle clearance requirements, runway protection zones, etc., necessary to accommodate the most "critical aircraft," or the most demanding aircraft type expected to use the facility over the planning horizon. FAA Advisory Circular 150/5300-13, "Airport Design," identifies these development criteria on the basis of aircraft size, weight, approach speed, and other operational characteristics.

Classic FAA planning criteria indicates that the determination of a critical aircraft or critical aircraft type is based on at least 500 estimated annual operations. The forecasts described in **Chapter Two** were developed using an operations-per-based-aircraft methodology (See **Figure 2.27**).

As of 2009, the overall critical aircraft at BTV is the Boeing 757, which is the aircraft anticipated to be used specifically for cargo over the planning horizon. The 757 is a C-IV aircraft (Approach Category C and Design Group IV- see **Figure 1.12** for Airport Reference Code Designations). This critical aircraft is not expected to change over the course of the planning period.

The critical aircraft for commercial facilities is the Airbus A-320, which is a C-III aircraft. This aircraft is not expected to change over the planning horizon.

The critical aircraft for the business/general aviation specific facilities is the CL-604 "Challenger," which belongs to the B-II family of aircraft. This aircraft is not expected to change over the planning horizon.

The critical aircraft for cargo facilities is the Boeing 757. Over the planning horizon, the cargo fleet will be replaced with higher-capacity (larger) aircraft: Airborne Express (ABX) will replace its DC-9-30 with Boeing 737's or similar-size aircraft, and FedEx will exchange its Boeing 727-200 for several new Boeing 757-200 aircraft. However because the Boeing 757 is occasionally used at the airport currently, it has already been designated as the critical aircraft for cargo facilities.

When evaluating or justifying facility projects, it is important to consider the lifespan of the proposed improvement as it relates to both existing and anticipated traffic demands. As a result, some specific facilities within the airport may be developed to accommodate different aircraft types. For example, the general aviation apron may be designed to accommodate

Group II aircraft while the commercial apron may be designed to accommodate Group IV aircraft.

The overall critical aircraft family, C-IV, includes a wide variety of aircraft that can accommodate 178 or more passengers. The ranges of these aircraft allow them to fly almost anywhere in the United States. Some of the typical aircraft that utilize or are expected to utilize the airfield are identified in **Figure 3.1**.

Figure 3.1: Typical Aircraft Expected to Use the Airport

ARC	Manufacturer	Model	Wingspan (ft)	MTOW (lbs)	Seats	Range (mi) w/ 45-min reserve	FAA T/O Field Length (ft)
A-III	De Havilland	DHC-8-300 (Dash 8)	90	4,300	50	1,413	3,865
B-II	Cessna	Citation II	52.4	14,800	7 to 10	2,186	3,600
B-II	Dassault	Falcon 50	61.9	39,700	19	3,757	4,890
C-II	Grumman	Gulfstream III	77.8	68,700	21	4,722	5,400
C-III	Airbus	A-320-200	111.1	169,800	179	3,527	5,900
C-III	Boeing	737-800	112.6	174,200	162	3,366	7,400
C-III	Embraer	ERJ-170	85.3	79,344	70	2,072	4,865
C-IV	Boeing	757-200	124.8	255,000	cargo	4,522	7,750

Sources: FAA AC 150/5300-13, Appendix 13; Jane's All the World's Aircraft (1998-1999); Aviation Week & Space Technology

3.2 RUNWAY AND TAXIWAY SYSTEM CAPACITY

The overall airfield capacity was evaluated using the methods and procedures recommended by FAA Advisory Circular 150/5060-5 "Airport Capacity and Delay." The capacity of the airfield is a function of the number of runways, the relative position and orientation of the runways, types of aircraft using the facility, exit taxiway locations, touch and go activity and weather conditions.

Although BTV has two functional runways, the intersecting configuration of Runway 15-33 and Runway 1-19 effectively limits the overall capacity of the airfield to a level only slightly greater than a single runway configuration. The intersecting geometry will not allow simultaneous arrivals or departures during Instrument Meteorological Conditions (IMC), however simultaneous arrivals are conducted during Visual Meteorological Conditions (VMC) when Air Traffic Control (ATC) implements land and hold short operations (LAHSOs). LAHSOs are not conducted during IMC due to the lack of precision instrument approach capability on Runway 1-19 and because of the increased safety margins implemented by ATC during IMC conditions. The availability of by-pass taxiways at the ends of Runways 15 and 33 does provide some relief for ground management during busy IMC periods.

Enhancements to the runway/taxiway system typically include additional exit taxiway locations, geometrical changes to the exit taxiways (i.e., changing right-angle exits to acute angle exit taxiways) or increasing runway instrumentation.

3.2.1 Fleet Mix Factor

Approximately 58-percent[a] of all airport operations at BTV were conducted by business/general aviation aircraft in 2008, which is significantly more than what was reported in the 2006 Airport Layout Plan Update (48-percent in 2003). Based on the approved forecast of operations presented in **Figure 2.27**, general aviation operations are expected to remain the majority of aircraft operations until 2030, when they are projected to comprise 49% of total operations. The majority of existing and future general aviation operations are attributed to small aircraft with maximum takeoff weights less than 12,500 pounds which are referred to in AC 150/5060-5 as Category A and B operations. This group essentially includes all single and multi-engine propeller/piston driven aircraft. The remainder of business/general aviation aircraft operations at BTV are attributed to aircraft with maximum takeoff weights between 12,500 and 300,000 pounds, referred to in AC 150/5060-5 as Category C operations. This group essentially includes turbo-prop and turbo-jet business/general aviation aircraft operations and helicopter operations.

While business/general aviation operations represented 58-percent of all airport operations in 2008, the remaining 42-percent of operations were conducted by commercial aircraft (31.5-percent), cargo carriers (1.3-percent) and military (9.6-percent). In determining the fleet mix factor, these[b] operations are considered to be Category C operations, since the types of aircraft conducting these operations have maximum takeoff weights greater than 12,500 pounds and less than 300,000 pounds. The forecasted operations conducted by Category C aircraft are anticipated to increase from 39,758 operations in 2008 to over 73,784 operations in 2030. The percentage of total operations conducted by Category C aircraft is anticipated to increase from 42-percent in 2008 to 51-percent in 2030.

It is possible that some Category D military aircraft will use the airport over the planning horizon. For the purposes of this capacity analyses, no Category D aircraft were included in the fleet mix factor.

3.2.2 Taxiway Capacity/Exit Taxiway Location

Another useful variable in determining the airport's future capacity is the number of qualifying exit taxiway locations. While the locations of the exit taxiways are important, these factors are not as important as the number of qualifying exits within the defined exit range provided in AC 150/5060-5. A qualifying exit location is considered any exit taxiway within the specified exit range that is separated by at least 750-feet from another exit taxiway. For a dual runway

[a] Equals GA Operations /Total Ops
[b] Cargo, Military, and Commercial

system with a fleet mix factor of 42-percent Category C aircraft, the specified exit range provided by AC 150/5060-5 is between 3,000 and 5,500-feet[c]. The optimum number of qualifying exit taxiways for a fleet mix of 42-percent is 3 or more exit locations in the exit range. The basic objective in optimizing exit locations is to minimize runway occupancy times to afford the most efficient arrival and departure activity during peak demand periods. During off-peak periods the location of connecting taxiways becomes more a function of access and flow preference than capacity. The planning for new exit locations is done to
achieve the best possible capacity rating, while complementing access and flow patterns to airport facilities

The existing connecting taxiway locations along Runway 15 theoretically provide only two qualified exits (Taxiway Alpha and Taxiway Bravo). Similarly, the connecting taxiways along Runway 33 provide only two qualified exits (Taxiway Alpha and Taxiway Hotel). This suggests that an additional exit taxiway would need to be provided for operations on both Runway 15 and Runway 33 in order to increase capacity.

The existing connecting taxiway locations along Runway 1 provide only two qualified exits (Taxiway Bravo and Taxiway Golf). Similarly, the connecting taxiways along Runway 19 provide only two qualified exits (Taxiway Bravo and Taxiway Alpha). As the types of aircraft forecasted to use Runway 1-19 are anticipated to remain predominately Category A and B, the provision of two qualifying exit locations on Runway 1-19 should be considered sufficient. However, should Runway 1-19 ever be extended so that it may function as a full crosswind runway, additional exit taxiways would need to be provided.

Airfield capacity can also be increased through effective taxiway placement and design. Appropriately designed taxiways minimize the number of runway crossings and changes in aircraft taxi speeds, which increase the efficiency of operations on the airfield.

For example, Taxiway Golf is a partial parallel taxiway from the end of Runway 15 to its termination at the intersection with Taxiway Alpha. It has a runway-centerline-to-taxiway-centerline separation of 600-feet. Construction planned for spring 2009 will extend Taxiway Golf from Taxiway Alpha to Taxiway Charlie with a 500-foot runway/taxiway centerline separation along its entire length. This involves the realigning of the existing northern section. This will establish an efficient corridor for a future Taxiway Golf extension to the planned South End Development (i.e., the area near the Runway 33 threshold and the existing alert hangar). The 500-foot runway/taxiway centerline separation meets FAA Design Standard for runways used by Category C/D aircraft.

3.2.3 Touch and Go Activity

The level of touch and go activity at the airport is anticipated to remain a low percentage of

[c] Source: FAA AC 150/5060-5. Mix Index of 42%

total operations. Touch and go activity is primarily associated with flight training and is conducted using single-engine/multi-engine aircraft under visual flight rules (VFR) during visual meteorological conditions (VMC). Military exercises may temporarily increase the level of touch-and-go activity; however it should not result in a significant increase. For the purposes of defining airfield capacity, touch-and-go operations are anticipated to represent between 11 and 20-percent of total operations.

3.2.4 Annual Service Volume and Hourly Runway Capacity

Based on the factors presented in **Section 3.2.1** and according to the FAA Airport Design computer program, the 2008 annual service volume for the runway system at BTV is 200,000 operations. The hourly runway capacity during VFR is approximately 77 operations, and is 57 operations under IFR. In 2030, because of the decrease in the percentage of general aviation aircraft at the airport, the annual service volume increases to 215,000, with a forecasted hourly runway capacity during VFR of 77 operations and 56 operations under IFR.

Typically the FAA recommends that the planning associated with runway/taxiway capacity enhancing projects begin when demand reaches 60-percent of the Annual Service Volume (ASV) of the airport so that the capacity enhancing project can be in place prior to demand reaching 80-percent of the ASV. The demand/capacity analysis presented in **Figure 3.2** supports the need for capacity improvement at the airport. Even with the moderate growth rates used in the development of the various activities forecasts, the Demand/Capacity ratio is expected to cross the 60-percent threshold during the planning period (during 2020-2025). Without capacity enhancements, the operating environment at BTV will be subject to increasing system delays as a result of activity levels approaching theoretical hourly capacities. The capacity analysis suggests that planning efforts to increase capacity at the airport should begin when the airport reaches 120,000 annual operations (around 2020), and construction efforts should be completed before the airport reaches 80% of its annual service volume, or 160,000 annual operations. Extrapolating the 2030 total operations figure by its historical (2008-2030) compounded annual rate of growth (2.04%) suggests that the airport will reach 160,000 annual operations in 2034.

As an alternative to constructing capacity enhancing projects, managing future demands to keep operational levels within capacity was also considered during this Master Plan Update effort. The airport's status in 2009 as the only primary commercial service airport in Vermont suggests that management strategies should focus on prioritizing commercial, cargo, military, and business general aviation airline traffic. Removing recreational general aviation operations would eliminate 37-percent of annual operations; however, because of the lack of comparably equipped business/general aviation facilities in the region, removing these facilities at BTV would cause recreational pilots to go elsewhere, inhibiting economic development. Previous studies conducted for military operations at BTV also suggest that there are no other acceptable airport locations for the Vermont Air National Guard (ANG). As ANG operations account for less than 10-percent of annual airport operations, the relocation of

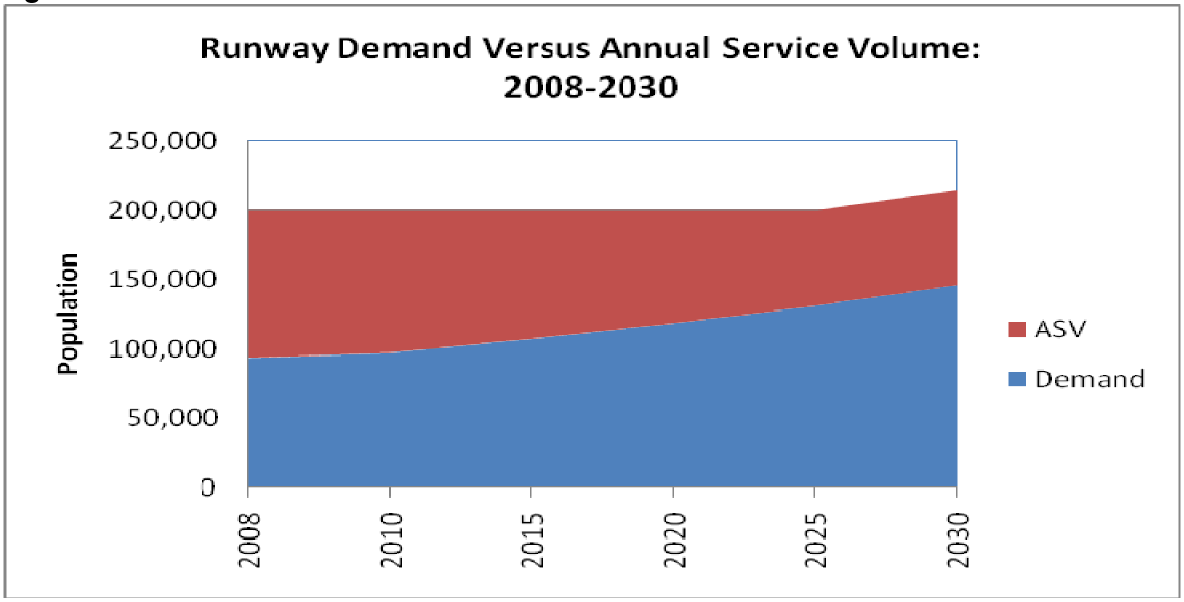
ANG to another facility would serve to only temporarily relieve capacity constraints. Therefore the removal of recreational general aviation or military operations at the airport in order to increase capacity is not recommended.

Figure 3.2: Annual Service Volume Analysis

Forecast Year	Annual Demand	Annual Service Volume	D/C Ratio
2008	93,628	200,000	46.81%
2010	97,004	200,000	48.50%
2015	107,214	200,000	53.61%
2020	118,502	200,000	59.25%
2025	130,990	200,000	65.50%
2030	146,064	215,000[d]	67.94%
		CARG	**1.71%**
Single Runway System Capacity (for comparison)			
2008	93,628	195,000	48.01%
2010	97,004	195,000	49.75%
2015	107,214	195,000	54.98%
2020	118,502	195,000	60.77%
2025	130,990	195,000	67.17%
2030	146,064	205,000	71.25%
		CARG	**1.81%**

[d] Increase is due to significant percentage change between commercial and general aviation aircraft at airport. See **Section 3.2.4**.

Figure 3.3



3.2.5 Aircraft Delay

The estimate of aircraft delay was generated using the Airport Design computer program created by the FAA and is based on the following factors:

- The airport operates with intersecting runways with runway use similar to orientation #9 in AC 150/5060-5;
- Total annual demand is equal to the forecasted operations presented in **Figure 2.27**, and;
- A majority of operations are business/general aviation operations until 2030.

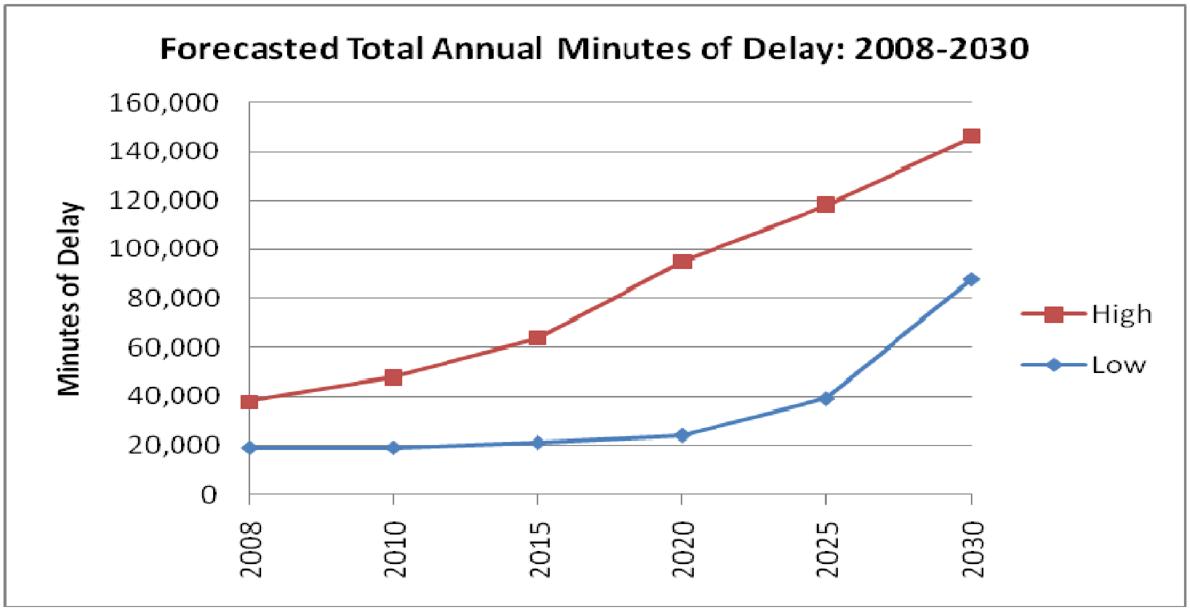
The percentage of Category C aircraft used in the analysis is forecasted to increase over time. In 2008, the percentage of airplanes over 12,500 pounds but not over 300,000 pounds is 42% and in 2030 that percentage is expected to grow to 51%.

The anticipated delay per aircraft operation is expected to increase over the planning horizon. Using the forecasted operations presented in **Figure 2.27** and the annual service volumes presented in **Figure 3.2**, the demand/capacity ratio is anticipated to increase from 0.47 in 2008 to 0.68 in 2030. As a result of the increasing demand for limited airfield capacity, the average minutes of delay per operation is anticipated to increase from 0.3 minutes per operation to 0.8 minutes, by the end of the planning horizon. Annually this translates into a potential 146,000 minutes of delay for the airport if no capacity enhancing improvements are implemented (see **Figure 3.4**).

Other factors in the national airspace system could influence the amount of annual delay at

BTV. These factors include weather, en-route congestion, and ground holds due to congestion at the destination airport.

Figure 3.4



3.3 INSTRUMENT APPROACH CAPABILITY

As of February 2009, the airfield has ten published approach plates (See **Figure 1.28**). These include precision (ILS) approaches to Runways 15 and 33 and non-precision instrument approaches to Runway 1. There are no instrument approaches to Runway 19 (See **Figure 1.28**). The precision approaches to Runways 15 and 33 ensure the ability of the airfield to operate in all weather conditions. As is stated in **Section 1.9.6**, crosswind coverage analysis shows that Runway 19 offers the best approaches under VFR conditions, while Runway 1 offers the best approaches for non-precision and precision instrument weather, which confirms the existing approaches at the airport.

3.4 RUNWAY AND TAXIWAY PLANNING FACTORS

3.4.1 Runway Configuration

BTV has two functional runways, Runway 15-33 and Runway 1-19, which are arranged in an intersecting configuration. The existing orientation of the runways is appropriate and meets the FAA standards for crosswind coverage, as is shown in **Section 1.9.5.** Runway 15-33 is the primary commercial service and military runway while Runway 1-19 is used by general aviation aircraft.

3.4.2 Runway Length Analysis

Runway length is typically a function of either takeoff distance or landing distance for the critical aircraft. Several factors determine the takeoff distance required including takeoff weight, wind direction and speed, flap setting, engine performance, density altitude, runway gradient and temperature. Similarly, there are several factors that determine landing length including flap setting, landing weight, pavement conditions (i.e., wet or dry), and wind direction and speed. Generally-accepted FAA guidance is to provide sufficient runway length to accommodate 75% of the large aircraft group (based on representative aircraft within the national fleet mix) with up to a 60% useful payload.

Runway 15-33: The FAA Airport Design computer program was used to determine the required runway length for Runway 15-33. The results of the computer analysis indicate that the existing Runway 15-33 length of 8,322-feet is able to accommodate airplanes of more than 60,000 pounds (Class C aircraft)- (See **Figure 3.5**).

The existing length of Runway 15-33 was more specifically analyzed for the current overall critical aircraft, Boeing 757-200. This aircraft is considered a fair representation of the types of aircraft (i.e., single-aisle, narrow body, twin engine, turbofan aircraft) anticipated to serve the airport over the next 20-year time period. The Boeing 757 has a MTOW of 255,000 pounds. The runway length analysis used aircraft performance measures published by Boeing in an August 2002 document entitled, “Airplane Performance.” Six charts from this document were consulted to determine the runway field requirements:

- **Charts 3.3.2, 3.3.4, 3.3.6**: FAR Takeoff Runway Length Requirements- Standard Day + 25°F (RB211-535C, -535E4, -535E4B Engines, respectively)
- **Chart 3.3.10:** FAR Takeoff Runway Length Requirements- Standard Day + 25°F (PW2040 Engines)
- **Chart 3.4.1**: FAR Landing Runway Length Requirements (RB211-535C, -535E4, -535E4B Engines)
- **Chart 3.4.2:** FAR Landing Runway Length Requirements (PW2040 engines)

At MTOW, the 757-200 requires up to 7,900-feet of runway length. At maximum landing weight (210,000-pounds), the 757-200 requires up to 5,100-feet of runway in dry conditions, and 5,900-feet in wet pavement conditions. Therefore the existing 8,322-feet of Runway 15-33 are sufficient to accommodate the critical aircraft over the planning horizon.

Runway 1-19: The FAA Airport Design computer program was used to determine the required runway length for Runway 1-19. Data regarding mean maximum temperature during the hottest month, airport elevation, and maximum difference in runway centerline elevations presented in **Chapter One** were used as inputs into the runway length analysis (see **Figure 3.5**). As the types of aircraft currently using and forecasted to use Runway 1-19 are anticipated to be business/general aviation aircraft and possibly some smaller turboprop commercial aircraft, the analysis focused on both small general aviation (i.e. <12,500lbs MTOW) and large corporate (i.e. >12,500 lbs and < 60,000 lbs) aircraft. Typical corporate aircraft include Gulfstream, Cessna Citation, Falcon and Challenger families of aircraft. **Figure 3.5** presents the results of the Airport Design program.

Figure 3.5: Recommended Runway Length for Airport Design

Airport Elevation	334.9-feet
Mean daily maximum temperature of hottest month	81-degrees Fahrenheit
Maximum difference in runway centerline elevation	31.7-feet
Length of haul for airplanes more than 60,000 pounds	2,200 miles
RECOMMENDED RUNWAY LENGTH FOR AIRPORT DESIGN	
Small airplanes with approach speeds of less than 30 knots	310 feet
Small airplanes with approach speeds less than 50 knots	830 feet
Small airplanes with less than 10 passenger seats	
75-percent of these small planes	2,520 feet
95-percent of these small planes	**3,060 feet**
100 percent of these small planes	**3,650 feet**
Small airplanes with 10 or more passenger seats	4,170 feet
Large airplanes of 60,000 pounds or less	
75-percent of these large airplanes at 60-percent useful load	**4,950 feet**
75-percent of these large airplanes at 90-percent useful load	**6,440 feet**
100-percent of these large airplanes at 60-percent useful load	5,490 feet
100-percent of these large airplanes at 90-percent useful load	7,990 feet
Airplanes of more than 60,000 pounds	8,080 feet

Source: Airport Design Program v4.2D

Typically, runways are designed to accommodate aircraft up to the 90-percent useful load, which is the difference between zero fuel weight and maximum takeoff weight. Based on this analysis, the existing usable 3,386-feet of Runway 1-19 should be sufficient to accommodate small aircraft with less than 10 passenger seats during the hottest months of the year.

Considering that Runway 1-19 provides over 95% crosswind coverage in all weather conditions for all types of aircraft, and Runway 15-33 provides over 95% coverage during IMC conditions, there appears to be no significant justification for extending Runway 1-19 at this time. Furthermore the FAA requires that, to be technically considered a crosswind runway, the existing runway should be approximately 80-percent of the length of the primary runway. Applying the FAA guideline of 80-percent of the length of the primary runway to Runway 1-19 suggests that the existing 3,612-foot runway be extended to a total length of 6,656-feet. This theoretical runway extension would entail significant land acquisition, road relocations, and reconfiguration of several facilities on the airfield to accommodate the over 3,000-foot northerly extension and associated airport design and FAR Part 77 airspace protection surfaces needed for operations by ARC C-IV aircraft. Therefore, there is no significant justification for extension at this time.

Conclusion: As Runway 15-33 has sufficient length to accommodate long-range Boeing 757-type operations, no additional runway length is anticipated. This runway also has sufficient crosswind coverage to accommodate operations by the intended aircraft under all weather conditions. Runway 15-33 also provides the needed crosswind coverage for the smaller general aviation aircraft during IMC conditions. Runway 1-19 appears to be of sufficient length to accommodate the majority of the general aviation and smaller corporate aircraft fleet. Crosswind coverage also appears adequate for all classes of aircraft under all weather conditions.

The mix of aircraft types and the significant number of operations by the smaller aircraft justifies the existence and continued maintenance of both runways. While extending Runway 1-19 would be beneficial for accommodating commercial and cargo operations during periods when Runway 15-33 is unavailable, the associated costs and potential land use impacts may be higher than the expected benefits of the project. Expedited and phased construction schedules can be implemented during any future repaving of Runway 15-33 in an effort to minimize down-time.

3.4.3 Runway Width Analysis

The existing 150-foot width of Runway 15-33 meets the 150-foot design requirement of AC 150/5300-13, “Airport Design,” for Group IV aircraft that are forecasted to use the runway. The existing Runway 1-19 width of 75-feet also meets the FAA design requirement for the smaller general aviation aircraft that operate at the airport. However, the required width of Runway 1-19 could increase from 75-feet to 100-feet if the approach visibility minimums became less than 3/4-mile. This could be the case if Runway 1-19 were developed to serve as a secondary commercial service runway.

3.4.4 Runway Safety Area/ Runway Object-Free Area Analysis

The FAA describes the Runway Safety Area (RSA) as a “defined surface surrounding the runway, prepared or suitable for reducing the risk of damage to airplanes in the event of an undershoot, overshoot, or excursion from the runway.” Similarly, the Runway Object-Free Area (ROFA) prohibits above-ground objects within its boundaries which are not essential to air navigation. Runway 15-33 is designed to accommodate Design Group-IV aircraft, which requires a RSA of 1,000-feet in length past the runway threshold and 500-feet in width and a ROFA of 1,000-feet in length past the runway threshold and 800-feet in width. Runway 1-19 accommodates B-II aircraft, which requires a RSA of 300-feet in length and 150-feet in width and a ROFA of 300-feet in length by 500-feet in width.

An analysis was conducted to identify deficiencies that would require remedy as part of any proposed development plan for the airport. Both Group IV and Group II standards were used in this analysis- Group IV FAA Design Standards were applied to Runway 15-33 based on use by Category D aircraft while Group II FAA Design Standards were applied to Runway 1-19 based on use by Category A and B aircraft with visibility minimums greater than 3/4-mile.

Runway 15-33 Safety Area: The approach end of Runway 33 has vegetation (≈40-foot trees) within the outer portion of the ROFA and RSAs and limits the available ROFA/RSA beyond runway end to approximately 650-feet. Two trees were identified within the RSA, and seven trees were identified within the ROFA. This portion of the ROFA and RSA does not meet FAA standards for clearing and grubbing and for objects within the area. In 2004 an asphalt service road was removed, and a 200-foot retaining wall was constructed at the southeast corner of the RSA, in order to increase the RSA to better meet FAA standards. A Safety Area Determination conducted by the FAA in April 2004 concluded that the airport meets 98% of the RSA dimensional criteria on the 33 end. Given the small percentage (2%) of RSA to be gained on the Runway 33 end, it was determined that it would not be cost-effective or environmentally acceptable to gain the full (100%) dimensional criteria.

There are approximately 816-feet of existing airport perimeter road within portions of the RSA and ROFA to the approach end of Runway 15. The presence of the perimeter road within the safety area limits the available RSA/ROFA length beyond runway end to approximately 895-feet.

Runway 1-19 Safety Area: The approach end of Runway 1 has 75-linear feet of the existing perimeter road within portions of the ROFA. The presence of the perimeter road within the ROFA limits the available ROFA length beyond the runway end to approximately 160-feet. It does not appear that there is enough land available to realign the perimeter road so that it would be outside the limits of the existing ROFA and still be on airport property. The perimeter road is outside the limits of the RSA.

The RSA and ROFA to the approach end of Runway 19 are free of all objects other than those used for navigational aid (“fixed by function”).

3.4.5 Runway Protection Zone Analysis

Runway Protection Zones (RPZs) are trapezoidal-shaped areas that are centered upon the extended runway centerline and begin 200-feet beyond the end of each runway threshold.

The size and shape of the RPZ is dependent upon the type of aircraft and approach visibility minimums accommodated on that runway. A summary of the RPZ geometries and ownership is presented in **Figure 3.6**. The purpose of the RPZ is to promote compatible land uses in the immediate approach area and to protect people and property on the ground. As such, certain land uses that could result in the assembly of people within the RPZ are prohibited (i.e., residences, churches, hospitals, office centers, and shopping centers). The FAA strongly recommends that the airport acquire positive control of the land uses within the RPZ preferably through fee-simple ownership; easements may also be acceptable.

Runway 15 Protection Zone: The Runway 15 RPZ measures 1,000-feet in inner width, 1,750-feet in outer width, and is 2,500-feet long. The FAA standard RPZ as described in **Figure 3.6** is not anticipated to change in the future. The airport maintains positive control over 71% of the RPZ through both fee-simple ownership and aviation easements restricting both heights and development. Existing land uses within the Runway 15 RPZ include the South Burlington Waste Water Treatment Facility, industrial/warehouse development, the right-of-way to Interstate 89, and undeveloped wetland area associated with tributaries to the Winooski River.

The airport acquired an easement covering much of the RPZ limits between Airport Parkway and I-89 in 1979. While additional easements in this area may be acceptable (due to the limited ability of developing in the wetlands), it is recommended that the airport monitor and eventually pursue acquiring the RPZ property, including the existing easements, in fee-simple. Easements over the water treatment facility, or at a minimum a Letter of Agreement, should also be pursued.

Figure 3.6: RPZ Geometries

Runway	RPZ Geometry			Total RPZ Acreage	Acres Owned	Acres in Easement	Acres of Recommended Acquisition (Fee / Easement)
	Inner	Length	Outer				
1	500'	1,000'	700'	13.77	2.8	6.6	**10.9 / 0** (purchase existing easements)
19	500'	1,000'	700'	13.77	13.8	0.0	**0.0** RPZ within Airport's current Property
15	1,000'	2,500'	1,750'	78.91	31.7	24.5	**44.8 / 2.4** (purchase existing easements and acquire easement on water treatment facility)
33	1,000'	1,700'	1,510'	48.98	40	0.0	**0 / 8.98** (At a minimum purchase conservation easements w/ tree removal rights over Muddy Brook and its wetlands)

Source: AC 150/5300-13 "Airport Design" & Campbell and Paris, 2009

Runway 33 Protection Zone: As described in **Figure 3.6**, the standard Approach RPZ for Runway 33 is 1,000-feet by 1,700-feet by 1,510-feet and begins 200' beyond the Runway 33 threshold. The existing Departure RPZ for Runway 15 is much smaller (500-feet by 1,700-feet by 1,010-feet), begins 200' beyond the TORA and would be contained within the Approach RPZ. The Approach RPZ to Runway 33 is not anticipated to change in the future.

The airport maintains positive control over almost 82% of the RPZ through fee-simple ownership. Approximately 9 acres of the Runway 33 RPZ are beyond the limits of airport property. Existing land uses within and adjacent to the Runway 33 RPZ are primarily airport property, undeveloped steep grades and wetlands associated with Muddy Brook. These uses are generally considered compatible with FAA RPZ guidance. Conservation and/or avigation easements, with the right for the airport to maintain tree heights, along the Muddy Brook area should be pursued. If the approach minimum for RW 33 decreases to ½ mile, then the asphalt plant in the northeast corner of airport property will be included in the new RPZ. Therefore the acquisition of easements over the asphalt plant is recommended.

Runway 1 Protection Zone: Due to the declared distances established for Runway 1-19, the most critical RPZ beyond the end of Runway 1 is the Departure RPZ. The Departure RPZ begins 200-feet beyond the runway pavement end (which is also the RW 19 TODA) and is the same geometry as described in **Figure 3.6**. The Approach RPZ is the same size and geometry but begins 200-feet beyond the threshold. This geometry is not anticipated to change in the future. These RPZ would however change if the role of the runway changed or the instrument approach visibility minimums became less than 1-mile.

The airport maintains positive control over 69% of the RPZ with approximately 3 acres owned and 6 in easement. Existing land uses within the Runway 1 RPZ are primarily industrial with small portions of undeveloped wetlands and the right-of-way to Williston Road. These uses are generally considered compatible with FAA RPZ guidance. It is recommended that acquisition of all RPZ property, including the existing easements, be pursued.

Runway 19 Protection Zone: The FAA standard RPZ as described in **Figure 3.6** applies to Runway 19, and at this time is not anticipated to change over the planning horizon. The airport maintains positive control over the entire RPZ as it located completely within airport property. The dimensions of the RPZ would only change commensurate with a runway extension in this direction, a change in aircraft to be accommodated on the runway or an improvement to the instrument approach visibility minimums (i.e. <1-mile). No additional property or easement acquisition is necessary.

3.4.6 Runway Obstacle-Free Zone Analysis: The Runway OFZ is a defined volume of airspace centered above the runway centerline. The runway OFZ extends 200 feet beyond each end of the runway. Its width is 400-feet for both runways, which serve aircraft with approach speeds higher than 50 knots. (The overall critical aircraft, Boeing 757, has an approach speed of 135 knots; and the critical aircraft for general aviation is the Challenger CL-604, which has an approach speed of 136 knots.[e])

3.4.7 Pavement Analysis

The pavement at the airfield is in good condition. However, considering the design life of these pavement systems, a rehabilitation project for the runways as well as the taxiways and ramps will become necessary during the planning horizon. Runway 15-33 was rehabilitated in winter 2010 using bituminous concrete and Portland Cement Concrete on each runway end.

Runway 1-19 was overlaid in three sections- the first 650-feet of Runway 1 and the center 2,300-feet of Runway 1-19 were reconstructed in 1993 while the first 650-feet of Runway 19 was constructed in 1958 and overlaid in 1985. (**See Figure 1-17**).

As is discussed in **Section 1.7.3**, a taxiway rehabilitation project was completed at BTV in winter 2010, which included rehabilitating the pavement on Taxiway Charlie and extending Taxiway Golf the full length of Runway 15-33 in order to provide full parallel capability, and demolishing Taxiways Juliet and Kilo. A rehabilitation of the remainder of Taxiway Golf (toward the Runway

[e] Source: 2009 Aviation Week Source Book

15 end) and Taxiway Bravo is planned for 2012.

3.5 NAVIGATIONAL AID ANALYSIS

A review of the existing navigational aids at the airport was conducted to determine if required critical areas are maintained and appropriately identified on the airfield pavement. Items analyzed include the localizer critical areas, glideslope critical areas, rotating beacon, approach lighting system, and the airport surveillance radar (ASR-11).

3.5.1 Localizer Critical Areas

According to FAA Order 6750.16D, "Siting Criteria for Instrument Landing Systems," the ILS localizer consists of an antenna array, electronic equipment, integral detectors, and an equipment shelter. The localizer antenna array provides horizontal guidance information to pilots conducting an approach to an instrument runway. The localizer is typically located ±1,000-feet from the departure end of the runway that it serves (i.e., the localizer to the Runway 15 ILS approach is located ±1,000-feet beyond the Runway 33 threshold and vice versa).

There are specific grading and siting criteria for localizer antennas, as the electronic signal generated by the antenna can be distorted by nearby objects (i.e., terrain, buildings, aircraft, etc.). In order to protect the integrity of the localizer signal and to provide a safe and reliable horizontal guidance to approach aircraft, the FAA has established localizer critical areas. The dimensions of a localizer critical area are dependent upon the category of instrument approach (CAT I, II or III) and the type of equipment being installed.

Runway 15: The localizer antenna array for the ILS to Runway 15 is located ≈1,120-feet from the displaced Runway 33 threshold and ≈90-feet from the end of the paved blast pad to Runway 15. The ILS approach to Runway 15 is considered a Category I approach as the Runway Visual Range (RVR) is at least 2,400-feet (1/2-mile) and the decision height is greater than 200-feet (see **Section 1.10.3**). As such, the localizer critical area has a width of 400-feet up to 140-feet in front of the localizer, where the critical area then follows a 250-foot radius arc around the localizer antenna array. The overall length of the critical area is 2,250-feet; however, for Category I ILS systems, a full 250-foot arc is not required behind the localizer.

Should the sponsor desire to increase the instrumentation on Runway 15-33 to a CAT II or higher ILS approach, several changes to the localizer critical area would occur: 1) the width of the ILS critical area would increase from 400-feet to 500-feet; and, 2) a full 250-foot arc would be required.

Based on aerial photography conducted in 2008, there appear to be three vegetative obstructions and one electric utility pole within the existing Runway 15 localizer critical area. Each of these objects is located on airport property. (See **Figure 3.7**)

Runway 33: The localizer antenna array for the ILS to Runway 33 is located ≈950-feet from the relocated Runway 15 threshold. The ILS approach to Runway 33 is considered a Category I approach as the associated minimums for the approach are greater than 1/2-mile visibility (i.e. ¾ mile) and the decision height is greater than 200-feet. As such, the localizer critical area has a width of 400-feet up 140-feet in front of the localizer where the critical area then follows a 250-foot radius arc with around the localizer antenna array. The overall length of the critical area is 2,250-feet, however, for CAT I ILS systems, a full 250-foot arc is not required for the area behind the localizer antenna array, unless the localizer offers a backcourse approach procedure or is a CAT II or higher ILS system.

Based on aerial photography conducted in 2008, the existing Runway 33 localizer critical area appears to be free of non-essential structures (See **Figure 3.8**). Should the sponsor desire to increase the instrumentation on Runway 15-33 to a CAT II or higher ILS approach, several changes to the localizer critical area would occur: 1) the width of the ILS critical area would increase from 400-feet to 500-feet and 2) a full 250-foot arc would be required.

3.5.2 Glideslope Critical Areas

As of 2009, BTV has two published precision instrument (ILS) approaches, one for Runway 15 and one for Runway 33 (see **Section 1.10**). The airport also has two Hi-ILS procedures, which are precision instrument approaches designed to transition aircraft from the high altitude en-route structure to the low altitude portion of an instrument final approach (i.e. ILS/LOC, Vortac or Tacan). These are commonly referred to as “Jet Penetrations” and are mostly used by fast moving, fighter/trainer military jets as they utilize a steeper glidepath and higher approach speeds.

A precision approach provides both horizontal (through a localizer) and vertical (through a glideslope) guidance. This is what differentiates it from a non-precision approach, which provides only horizontal guidance. Therefore there is a glideslope antenna installed at both ends of Runway 15-33.

There are specific grading and siting locations for glideslope antennas as the electronic signal generated by the antenna can be distorted by nearby objects (i.e., terrain, buildings, aircraft, etc.) including the ground surface as the glideslope generates a “ground bounce” signal. In order to protect the integrity of the glideslope signal and provide a safe and reliable vertical guidance to approaching aircraft, the FAA has established a glideslope critical area. The dimensions of the glideslope critical area are dependent upon the type of glideslope antenna used and by the operational characteristics at the airport.

Runway 15: The glideslope to Runway 15 is located approximately 815-feet from the Runway 15 threshold and 350-feet to the southwest of the runway centerline. The antenna is approximately 45-feet in height and is a null reference image system, which is the simplest of glide slope systems. However this type of glideslope is most affected by rising terrain. The glideslope critical area associated with the Runway 15 glideslope antenna was determined using FAA Order 6750.16D "Siting Criteria for Instrument Landing Systems."[f] The glideslope critical area is 3,100-feet long and 471-feet at its widest point.

Portions of both Taxiway Golf and Taxiway Golf-1 are located within the glideslope critical area for Runway 15. However, an ILS hold position marking is painted and signed to inform pilots where to hold short while taxiing when another aircraft is on ILS approach to Runway 15. The ILS hold position marking appears to be in conformance with FAA AC 150/5340-1H "Standards for Airport Marking" (see **Figure 3.7**).

Runway 33: The glideslope to Runway 33 is located 1,000-feet from the Runway 33 threshold and 325-feet to the northeast of the runway centerline. The antenna is 60-feet in height and is a capture effect image system, which is the most tolerant to rising terrain. The glideslope critical area associated with the Runway 33 glideslope antenna was determined using FAA Order 6750.16D "Siting Criteria for Instrument Landing Systems." The glideslope critical area for this system is 450-feet wide by 1,300-feet in length.

Portions of Taxiway Delta are located within the glideslope critical area for Runway 33. However, an ILS hold position marking is painted and signed to inform pilots of the location to hold short while taxiing while another aircraft is on ILS approach to Runway 33. The ILS hold position marking appears to be in conformance with FAA AC 150/5340-1H "Standards for Airport Marking" (see **Figure 3.8**).

3.5.3 Rotating Beacon

The existing 45-foot tall rotating beacon is located on top of the general aviation terminal near the intersection of Taxiway Alpha and Taxiway Charlie. Guidance in FAA AC 150/5300-13 states that the beam of a rotating beacon, aimed 2-degrees above the horizon, should not be obstructed by any natural or man-made objects. Based on the aerial photography and survey mapping conducted in 2008, vegetative obstructions (i.e., trees) appear to obstruct the light beam. These obstructions are located south of the beacon on both sides of Old Farm Road; east of the beacon in the cemetery adjacent to Airport Drive and in the residential neighborhood on Logwood Street; and north of the beacon on the corner of Ledoux Terrace and Airport Drive. Tree elevations range in height from 390.1-feet amsl to 470.8-feet amsl while the beacon clearance surface ranges in elevation from 387-feet to 492.6-feet amsl. At a minimum tree maintenance (i.e. topping) should be pursued, although tree removal is preferred as some of these trees penetrate the Part 77 transitional surface of Runway 1-19. Should tree maintenance not be feasible, relocating the beacon to another location should be pursued.

[f] Source: FAA AC 6750.16D, Cat I- ILS null reference glideslope.

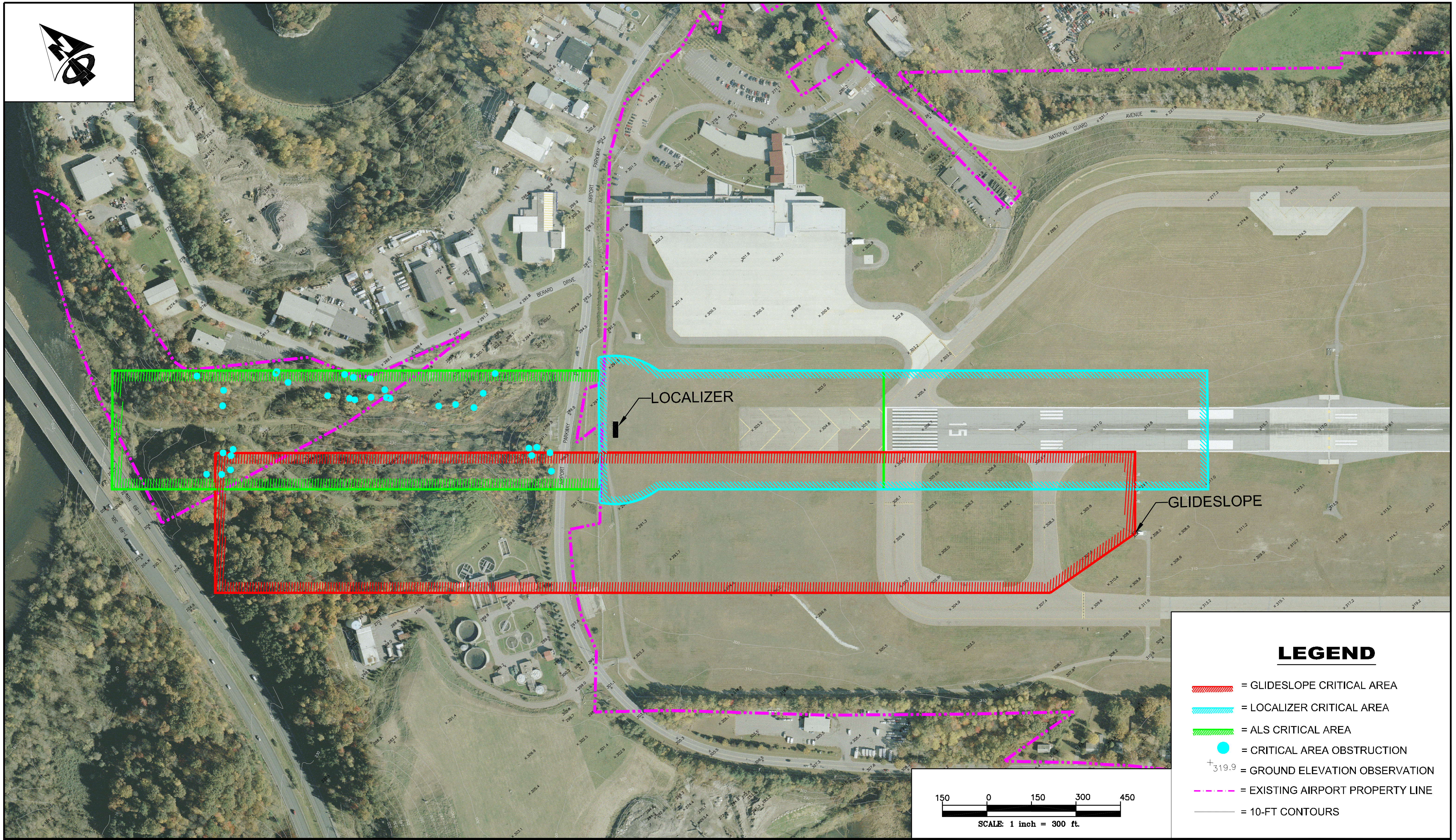


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FIGURE 3.7

RW 15 ILS and Glideslope Critical Areas, ALS Light Lane and Ground Contours

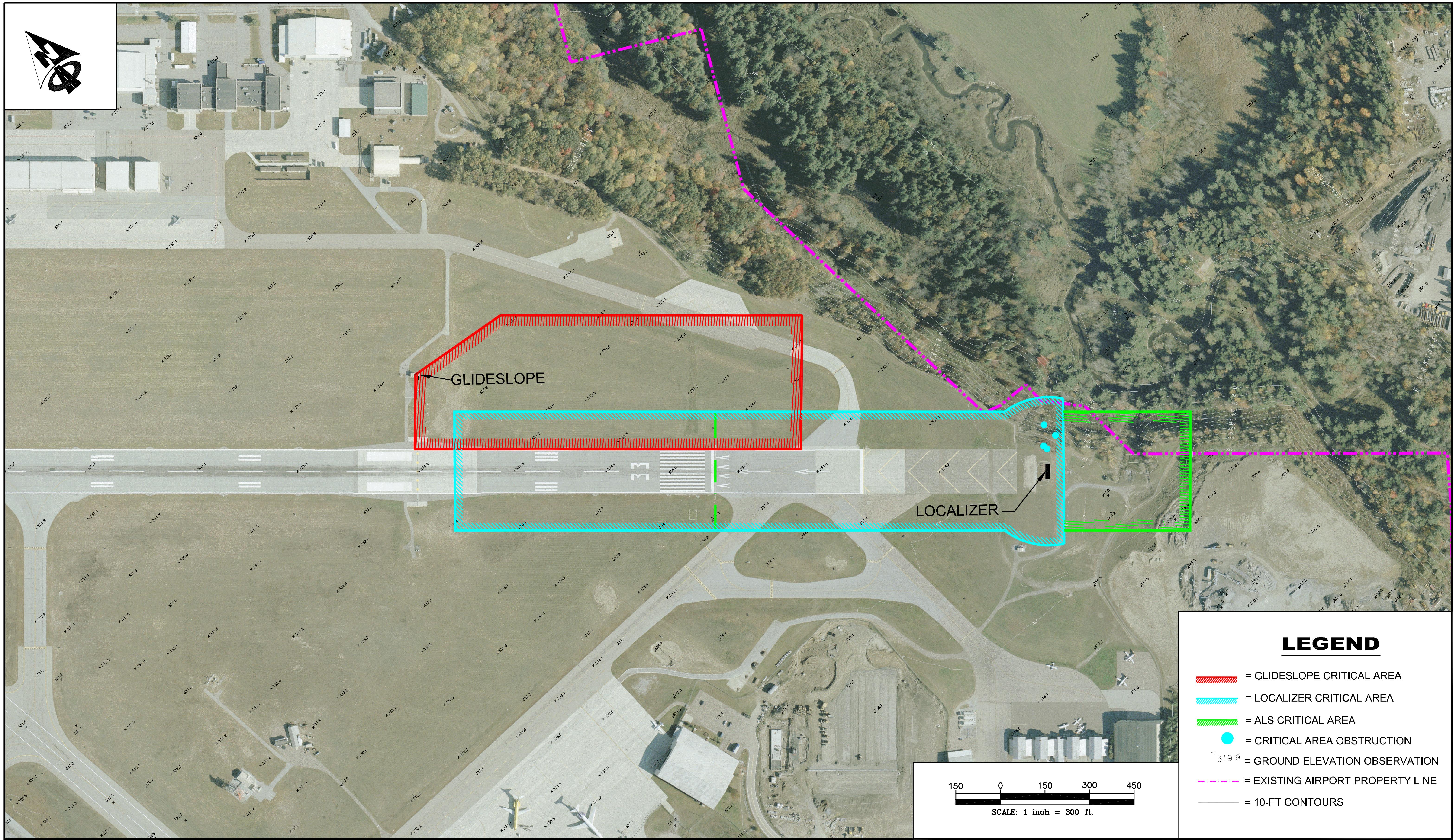

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FIGURE 3.8

RW 33 ILS and Glideslope Critical Areas, ALS Light Lane and Ground Contours

3.5.4 Approach Lighting System

As of 2009, BTV has two approach lighting systems (ALS): a MALS-R to Runway 15 and a MALS-F to Runway 33. The Federal Aviation Administration requires that pilots have a clear line of sight to an airport's ALS. To ensure that a clear line of sight exists, a "light lane" surrounds each approach lighting system. A light lane is centered on the runway centerline, begins at the threshold and extends 200-feet past the last light in the approach lighting system, and has a constant width of 400-feet. Ideally, the ALS lights are installed at the same elevation as the runway end. No objects are allowed to penetrate the light lane which would obstruct the pilot's view of the system. The light units, and corresponding light lane, can be installed with a maximum upward slope of 2% (i.e., 50:1) which means the surface extends 50-feet along the extended runway centerline for every foot change in surface elevation. Per FAA Order 6850.2 "Visual Guidance Lighting Systems", the light lane also has clearance requirements roadways similar to Part 77 surfaces.

Runway 15 MALS-R: The MALS-R to Runway 15 consists of 7 steady burning light stations extending 1,500-feet from the Runway 15 threshold and 5 sequential flashing runway alignment identification lights that extend an additional 900-feet from the Runway 15 threshold for a total system length of 2,400-feet. Thus the MALS-R light lane extends a total distance of 2,600-feet from the Runway 15 threshold and has a 400-foot width. Based on 2008 aerial photography, the existing MALS-R light lane to Runway 15 is penetrated by several trees (See **Figure 3.7**).

Runway 33 MALS-F: Due to terrain and property interests, the approach lighting system to Runway 33 at BTV is not a full MALS-R, but rather a shorter approach lighting system referred to as a MALS-F. The MALS-F to Runway 33 consists of 5 steady burning light stations extending 1,000-feet from the Runway 33 threshold and 2 sequential flashing runway alignment identification lights that extend an additional 400-feet from the Runway 33 threshold for a total system length of 1,400-feet. Thus the MALS-R light lane extends a total distance of 1,600-feet from the Runway 33 threshold and has a 400-foot width. Based on 2008 aerial photography, the existing MALS-F light lane to Runway 33 is free of penetrations (See **Figure 3.8**).

3.6 AIRSPACE PROTECTION

Protecting the airspace around a public-use airport is one of the most important aspects of maintaining the safety and utility on an airfield, as well as protecting the safety of the surrounding community. This responsibility rests with the airport sponsor, but relies heavily on the support and cooperation of the FAA, Vermont Agency of Transportation (VTrans) and surrounding local municipalities. The goal of protecting an airport's airspace is to prevent "obstructions" from penetrating the defined limits of the protected airspace. If the presence of an obstruction cannot be removed or prevented, an evaluation must be undertaken to determine if the potential effects of the obstruction can be mitigated (i.e., marking and lighting, or threshold displacement), or if approach minimums/procedures need to be altered.

There are two separate but related sets of FAA standards that must be considered when evaluating airspace protection concerns. These are Federal Aviation Regulations (FAR) Part 77, "Objects Affecting Navigable Airspace" and "Terminal Instrument Procedures" (TERPs). Obstructions are defined as "any existing or proposed manmade object of natural growth or terrain that is at a greater height than any of the 'imaginary surfaces' as defined by Part 77 or TERPS." Imaginary surfaces are three-dimensional planes with specific dimensions and slopes that are determined by the type of approaches available to each runway end. Specified clearance above public roads, railways and waterways is also required to account for any vehicles that traverse the area. Part 77 surfaces must provide at least 17-feet over an interstate highway, 15-feet over other public roads, 10-feet over private roads and 23-feet over railroads.

The airspace around the airport was analyzed to determine the location of obstructions to the existing FAR Part 77 imaginary surfaces. The limits of the Part 77 surfaces are defined by the visibility minimums associated with the existing approaches into the airport. The analysis checked the existing 50:1 precision approach surfaces to Runway 15 and Runway 33, the existing 34:1 non-precision approach surface to Runway 1 and the existing 20:1 visual approach surface to Runway 19. The future Part 77 surfaces are analyzed as part of the recommended development plan for BTV and the results of those analyses are documented in **Chapter Four**.

3.6.1 Primary Surface

The *primary surface* is a rectangular surface that is longitudinally centered on the runway centerline. The elevation of any point of the primary surface is equal to the elevation of the nearest point on the runway centerline. The width of the primary surface is dependent upon the type of approach either existing or planned for the runway and the associated visibility minimums. For runways with a specially prepared hard surface, the primary surface extends 200-feet beyond the physical ends of the runway or the far end of the TODA, whichever is greater in an effort to protect the departure procedures.

The primary surface width for Runway 15-33 at BTV is 1,000-feet. The primary surface for Runway 1-19 has a width of 500-feet. Based on aerial photography and site visits, there appear to be four penetrations to the existing 1,000-foot primary surface to Runway 15-33, one of which also penetrates the existing 500-foot primary surface to Runway 1-19.

3.6.2 Approach Surface

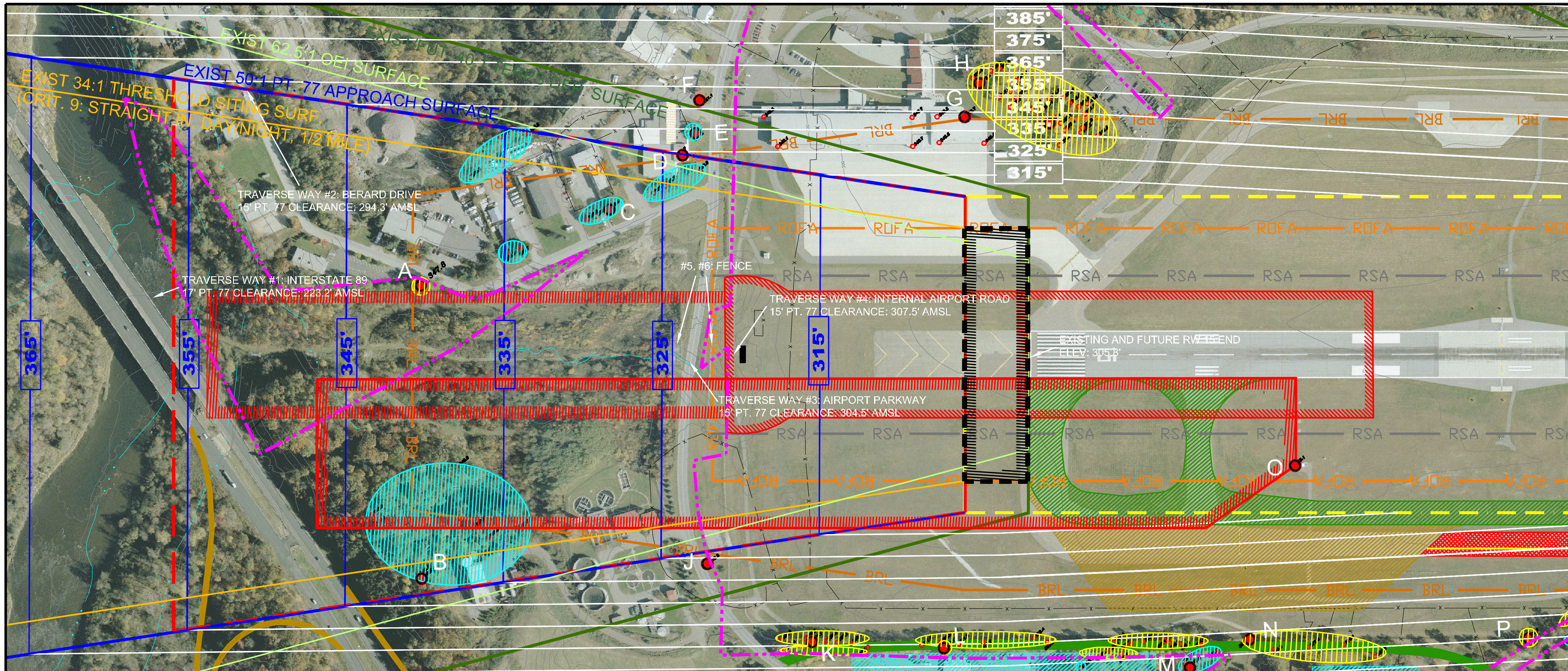
The *approach surface* is a trapezoidal shaped plane, longitudinally centered on the extended runway centerline and extends outward and upward from each end of the primary surface. The dimensions and slope of the approach surface are determined by the type of approach either existing or planned for the runway and the associated visibility minimums. While penetrations may exist to these surfaces, the airport has been able to maintain safe operations through the application of threshold siting criteria as described in AC 150/5300-13 "Airport Design." This is typically a temporary means of mitigating the effects of obstructions until such time as those obstructions can be removed.

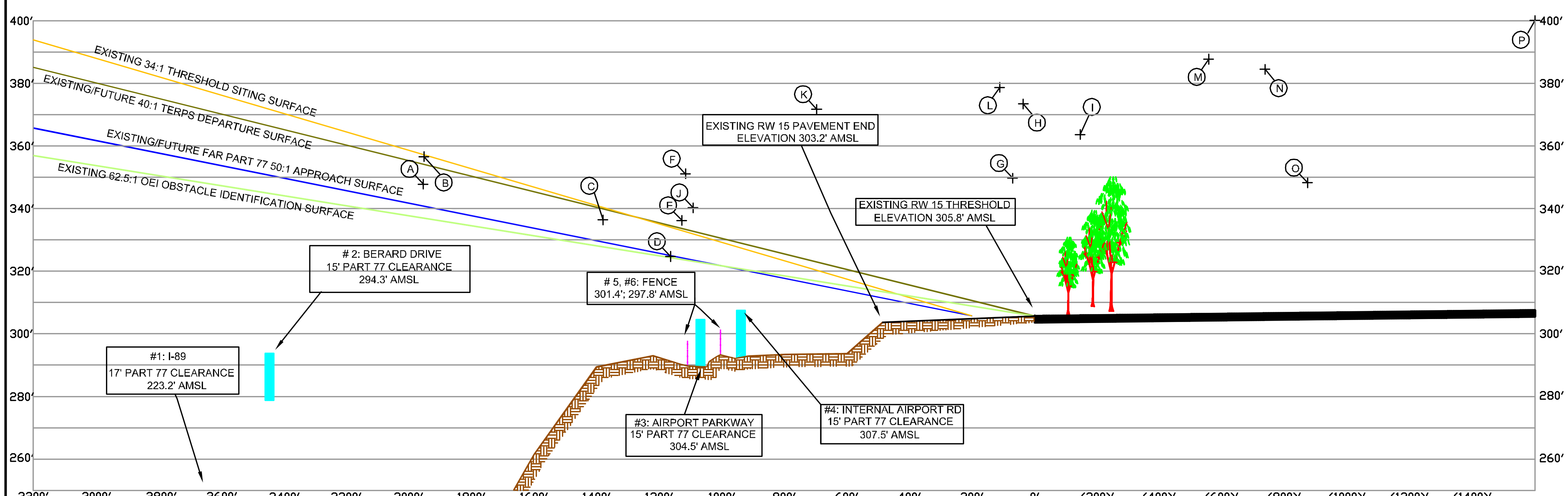
Runway 15: The precision instrument approach surface to Runway 15 begins 200-feet beyond the runway threshold at a width of 1,000-feet and extends for a distance of 50,000-feet to a width of 16,000-feet. The first 10,000-feet extend outward and upward at a slope of 50:1. The remaining 40,000-feet extend upward at a slope of 40:1. This surface begins at the threshold elevation of 305.8-feet msl and rises to an elevation of 1,505.8-feet msl. Based on evaluation of the aerial photogrammetric mapping conducted in October 2008 and published FAA obstacle data (dated 3/7/10), the precision instrument approach surface to Runway 15 is penetrated by natural objects (see **Figure 3.9**). These natural obstructions are vegetative in nature (i.e. trees) and are located between the water treatment facility and Interstate 89 and near the industrial buildings along Berard Drive. According to aerial mapping, these obstructions represent from 1-foot to 17-foot penetrations into the precision approach surface.

Runway 33: The precision instrument approach surface to Runway 33 has the same geometry as described for Runway 15 and begins 200-feet beyond the runway threshold. This surface begins at the threshold elevation of approximately 334.8-feet amsl and rises to an elevation of 1,534.8-feet amsl. Based on the evaluation of aerial photogrammetric mapping conducted in October 2008 and published FAA obstacle data (dated 3/7/10), the precision instrument approach surface to Runway 33 is penetrated by both man-made and natural objects (see **Figure 3.10**). The natural obstructions are vegetative in nature (i.e. trees) and present from 1-foot to 29-foot penetrations to the precision instrument approach surface to Runway 33. Other penetrations include the manmade structures associated with the asphalt plant.

Runway 1: The non-precision approach surface to Runway 1 begins 200-feet at the pavement end (which is the RW 19 TODA) at a width of 500-feet and extends for a distance of 10,000-feet to a width of 3,500-feet. It begins at the pavement end elevation of 334.5-feet amsl and extends outward and upward at a 34:1 slope to an elevation of 628.62-feet amsl. Based on the evaluation of aerial photogrammetric mapping conducted in October 2008 and published FAA obstacle data (dated 3/7/10); the non-precision instrument approach surface to Runway 1 is penetrated by natural objects (i.e., trees) (see **Figure 3.11**).

Runway 19: The visual approach surface to Runway 19 begins 200-feet in front of the threshold/runway end at a width of 500-feet and extends for a distance of 5,000-feet to width of 1,500-feet. It begins at the runway elevation of 329.4-feet amsl and extends outward and upward at a 20:1 slope to an elevation of 579.4-feet amsl. Based on the evaluation of aerial photogrammetric mapping conducted in October 2008 and published FAA obstacle data (dated 3/7/10) the visual approach surface to Runway 19 appears to be clear of penetrations (see **Figure 3.12**).





EXISTING OBSTRUCTION CONCERNS RELATIVE TO RUNWAY 15

POINT	TYPE	APPROX TOP ELEV. MSL (2008 aerial survey)	ESTIMATED PT.77 PENETRATION EXISTING PRECISION (50:1)	PROPOSED ACTION
A	TREES	347.8'	A ±7 (surf elev ±341')	REMOVE-ON AIRPORT
B	TREES	356.5'	A ±16.5' (surf elev ±340')	REMOVE-OFF AIRPORT
C	TREES	336.4'	A ±8.4' (surf elev ±328')	REMOVE-OFF AIRPORT
D	BLDG	324.7'	A ±1' (surf elev ±324')	LIGHT
E	TREE	336.2'	T ±3' (surf elev ±333')	REMOVE-OFF AIRPORT
F	POLE	351.1'	T ±2' (surf elev ±349')	LIGHT
G	ANG BLDG	349.7'	T ±6' (surf elev ±344')	LIGHT
H	TREES	373.5'	T ±14.5' (surf elev ±359')	REMOVE-ON AIRPORT
I	TREES	363.6'	T ±24' (surf elev ±340')	REMOVE-ON AIRPORT
J	POLE	340.3'	T ±13' (surf elev ±327')	LIGHT
K	TREES	371.7'	T ±9 (surf elev ±362	REMOVE-ON AIRPORT
L	TREES	378.7'	T ±13' (surf elev ±366')	REMOVE-ON AIRPORT
M	TREES	387.9'	T ±9' (surf elev ±379'	REMOVE-OFF AIRPORT
N	TREES	384.4'	T ±16' (surf elev ±368')	REMOVE-ON AIRPORT
O	GLIDESLOPE ANTENNA	348.1'	P ±39' (surf elev ±309')	NO CHANGE
P	TREES	400.1'	T ±25' (surf elev ±375')	REMOVE-ON AIRPORT

OTHER SIGNIFICANT ITEMS

1	I-89	223.2'	A ±0' (surf elev ±355')	
2	BERARD DRIVE	294.3'	A ±0' (surf elev ±350')	
3	AIRPORT PARKWAY	304.5'	A ±0' (surf elev ±323')	
4	INTERNAL ROAD	307.5'	A ±0' (surf elev ±320')	
5	FENCE	301.4'	A±0' (surf elev ±324')	
6	FENCE	297.8'	A±0' (surf elev ±320')	

A=Approach T=Transition P=Primary

Note: Referenced obstruction points represent tallest tree within the grouping. Other trees may be present. Elevations may have increased since 2008 survey.

SCALE: 1 inch = 400 ft.

SCALE: 1 inch = 40 ft.

LEGEND

- = ON AIRPORT OBSTRUCTION CLEARING
- = OFF AIRPORT OBSTRUCTION CLEARING
- = EXISTING PRIMARY SURFACE LIMITS
- = EXISTING APPROACH SURFACE LIMITS
- = EXISTING TRANSITIONAL SURFACE LIMITS
- = EXISTING AIRPORT PROPERTY LINE
- = 10-FT CONTOURS
- = EXISTING FAR PART 77 OBSTRUCTION
- = EXISTING THRESHOLD SITING SURFACE OBSTRUCTION
- = GRADING/FILLING

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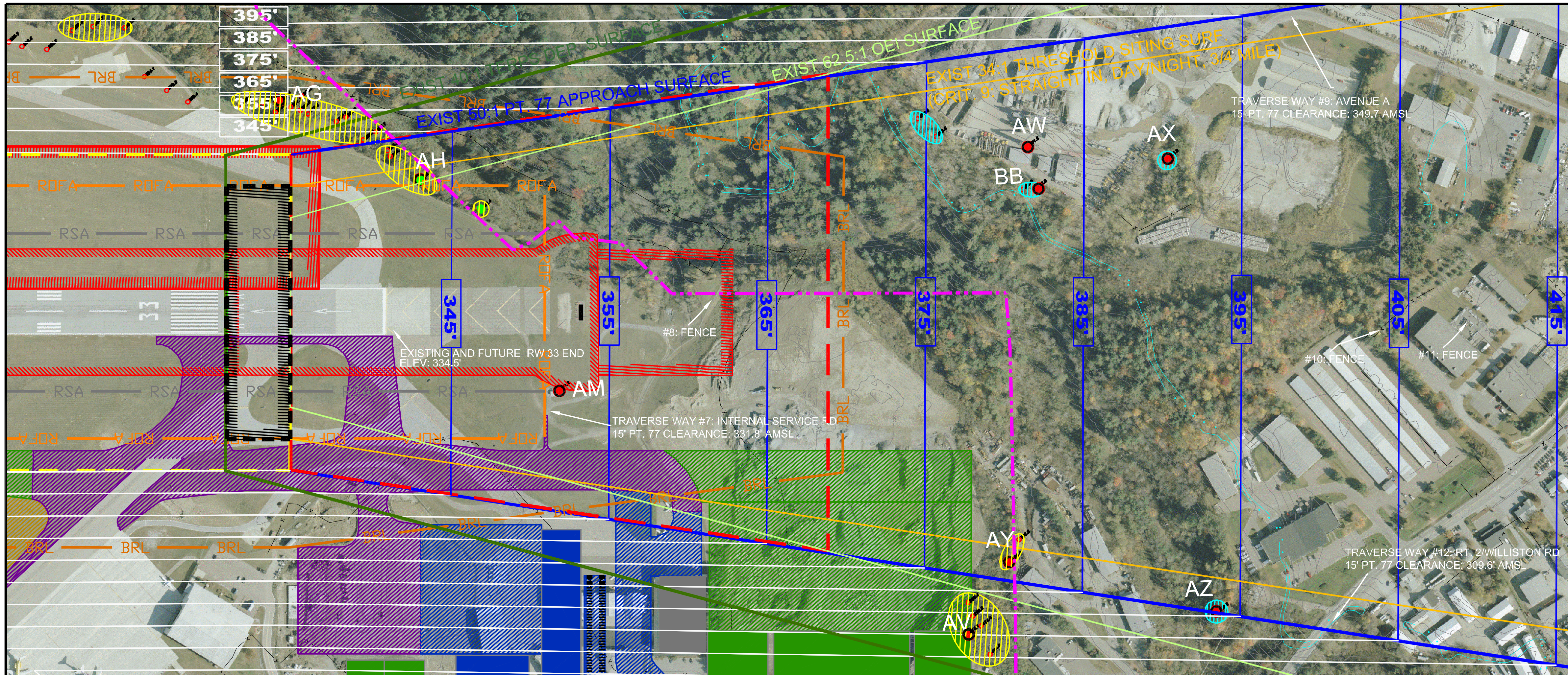
FIGURE 3.9

Existing Part 77 Obstructions and Limits of Clearing: Runway 15 Approach



EXISTING OBSTRUCTION CONCERNS RELATIVE TO RUNWAY 33

POINT	TYPE	APPROX TOP ELEV. MSL (2008 aerial survey)	ESTIMATED PT.77 PENETRATION: EXISTING PRECISION (50:1)	PROPOSED ACTION
AG	TREES	390.8'	T ±31' (surf elev ±368')	REMOVE- ON AIRPORT
AH	TREES	356.3'	A ±13' (surf elev ±343')	REMOVE- ON AIRPORT
AM	POLE	351.9'	A ±1' (surf elev ±351')	NO CHANGE
AV	TREES	416.1'	T ±12' (surf elev ±404')	REMOVE- ON AIRPORT
AW	BLDG	401.2'	A ±19' (surf elev ±382')	REMOVE
AX	TREE	392.9'	A ±3' (surf elev ±390')	REMOVE- OFF AIRPORT
AY	TREES	409.4'	A ±29' (surf elev ±380')	REMOVE- ON AIRPORT
AZ	TREE	393.9'	A ±1' (surf elev ±393')	REMOVE- OFF AIRPORT
BA*	BLDG	428.1'	T ±6' (surf elev ±422')	LIGHT
BB	TREES	386.8'	A ±5' (surf elev ±382')	REMOVE- OFF AIRPORT

*Note: BA is also FAA Obstruction Point 50-000069.

OTHER SIGNIFICANT ITEMS

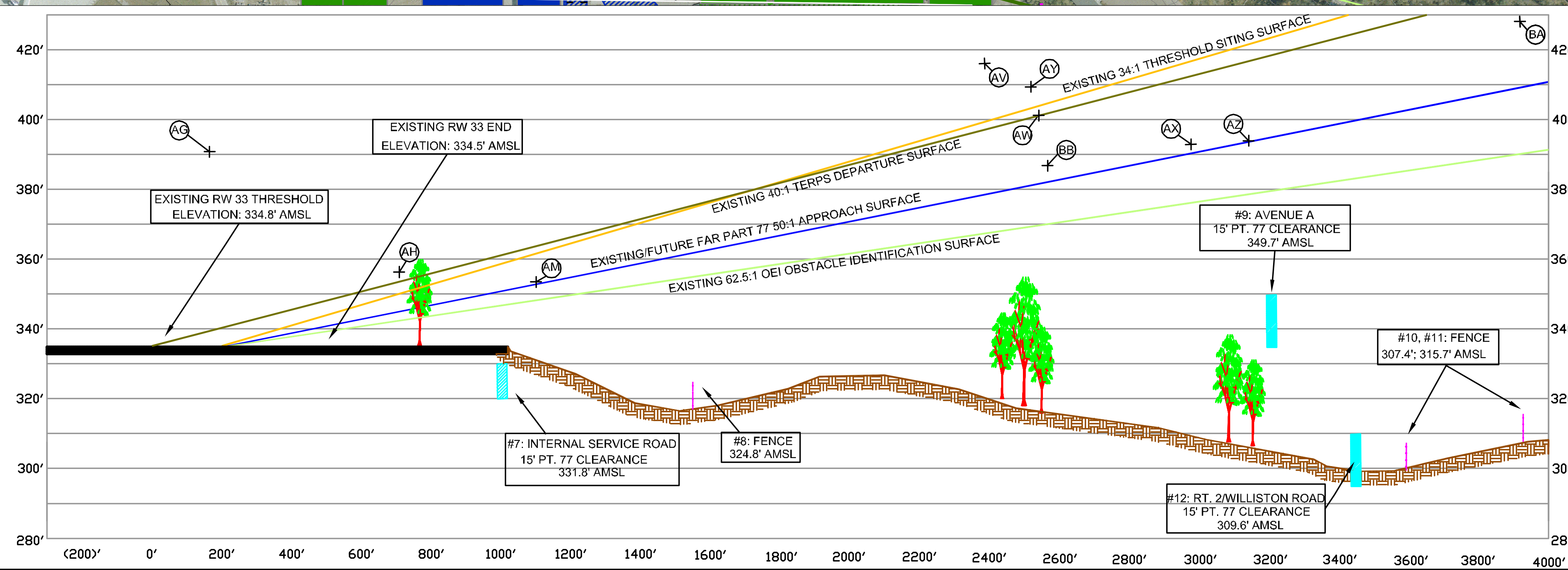
7	INTERNAL ROAD	331.8'	A ±0' (surf elev ±352')	
8	FENCE	324.8'	A ±0' (surf elev ±363')	
9	AVENUE A	349.7'	A ±0' (surf elev ±395')	
10	FENCE	307.4'	A ±0' (surf elev ±405')	
11	FENCE	315.7'	A±0' (surf elev ±410')	
12	RT.2/ WILLISTON	309.6'	A±0' (surf elev ±400')	

A=Approach T=Transition P=Primary

Note: Referenced obstruction points represent tallest tree within the grouping. Other trees may be present. Elevations may have increased since 2008 survey.

400 200 0 400
SCALE: 1 inch = 400 ft.

MAG. DECLINATION: 14°45'W ANNUAL DRIFT: 4' E NOVEMBER 2009 SOURCE: NOAA NESDIS



40 20 0 40
SCALE: 1 inch = 40 ft.

LEGEND

- = ON AIRPORT OBSTRUCTION CLEARING
- = OFF AIRPORT OBSTRUCTION CLEARING
- = EXISTING PRIMARY SURFACE LIMITS
- = EXISTING APPROACH SURFACE LIMITS
- = EXISTING TRANSITIONAL SURFACE LIMITS
- = EXISTING AIRPORT PROPERTY LINE
- = 10-FT CONTOURS
- = EXISTING FAR PART 77 OBSTRUCTION
- = EXISTING THRESHOLD SITING SURFACE OBSTRUCTION
- = GRADING/FILLING

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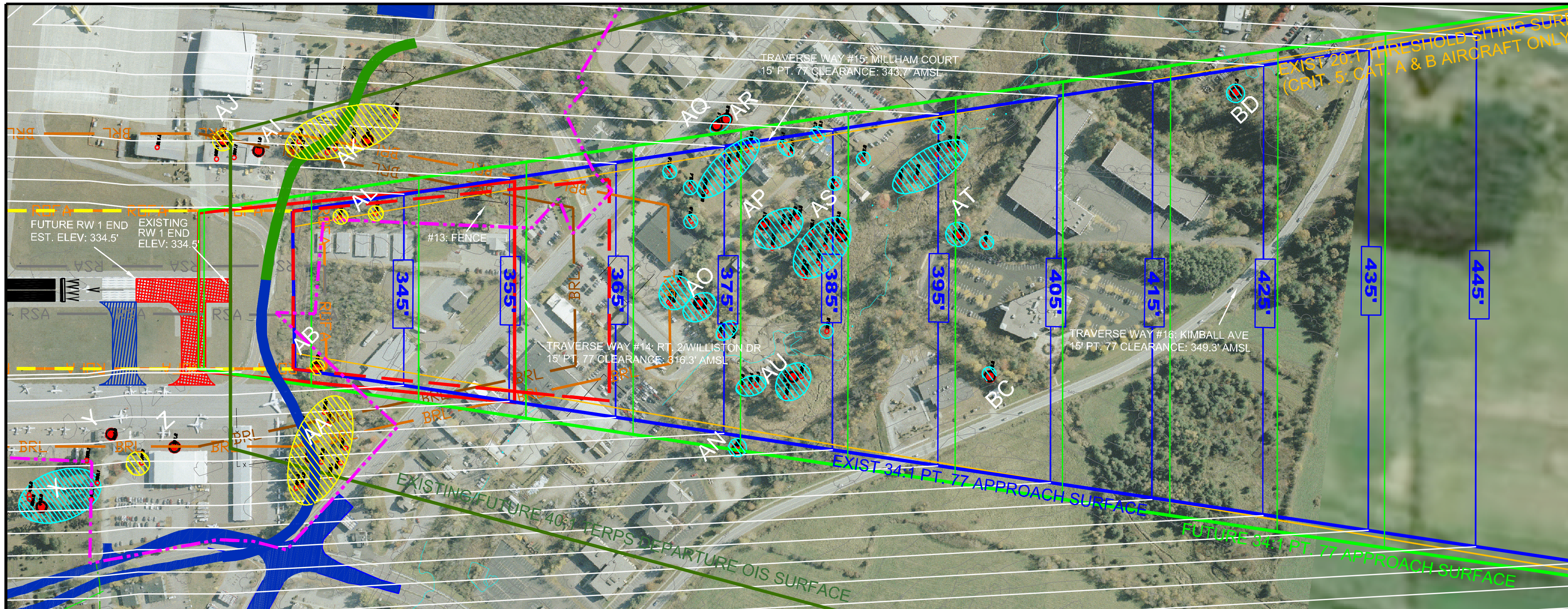
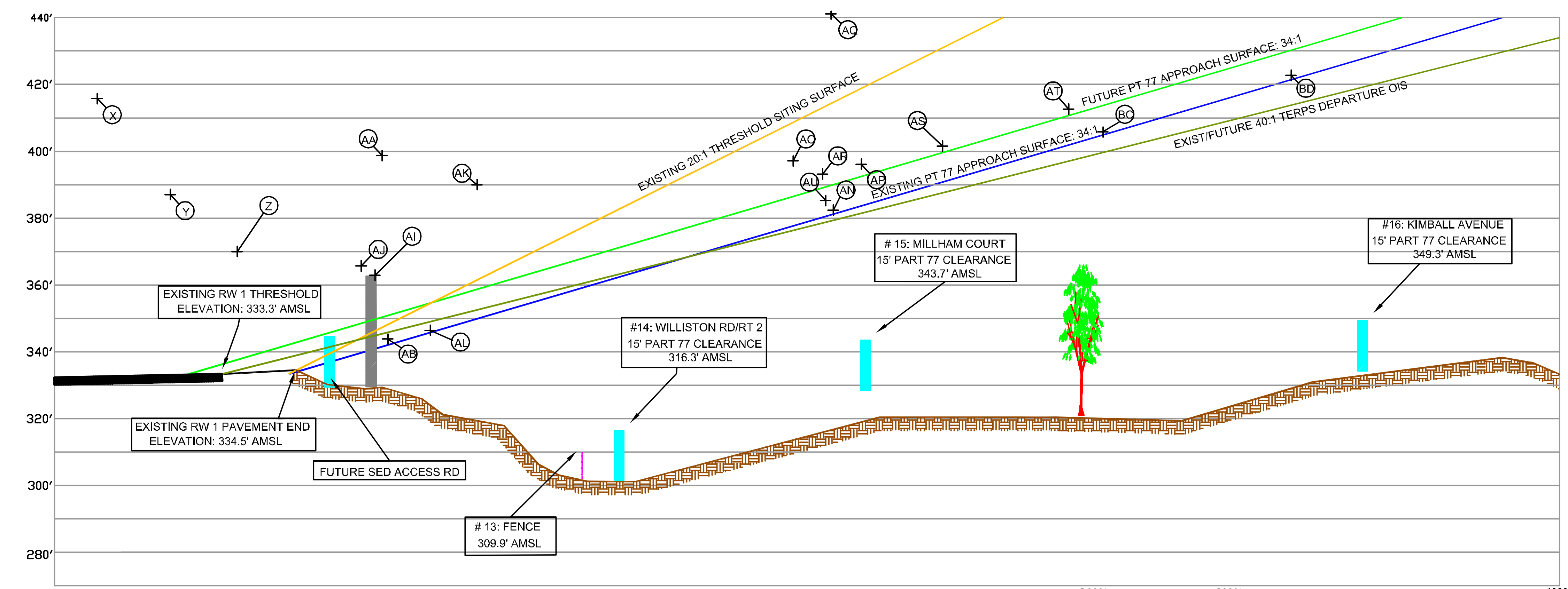
FIGURE 3.10

Existing Part 77 Obstructions and Limits of Clearing: Runway 33 Approach





EXISTING OBSTRUCTION CONCERNS RELATIVE TO RUNWAY 1

POINT	TYPE	APPROX TOP ELEV. MSL (2008 aerial survey)	ESTIMATED PT.77 PENETRATION: EXISTING NON-PRECISION (34:1)	ESTIMATED PT.77 PENETRATION: PROPOSED ACTION
X	TREES	415.9'	T ±22' (surf elev ±394')	REMOVE- OFF AIRPORT
Y	ROTATING BEACON	387.0'	T ±25' (surf elev ±362'	NO CHANGE
Z	TERRAIN?	371.6'	T ±3' (surf elev ±369')	REMOVE
AA	TREES	398.7'	T ±24' (surf elev ±375')	REMOVE- ON AIRPORT
AB	TREE	343.8'	A ±1' (surf elev ±343')	REMOVE- ON AIRPORT
AI	BLDG #10	361.5'	T ±1.5' (surf elev ±360')	NO CHANGE
AJ	BLDG #10	365.7'	T ±1' (surf elev ±365')	NO CHANGE
AK	TREES	389.9'	T ±21' (surf elev ±369')	REMOVE- ON AIRPORT
AL	TREES	344.6'	A ±2' (surf elev ±343')	REMOVE- ON AIRPORT
AN	TREE	382.4'	T ±0.4' (surf elev ±382')	REMOVE- OFF AIRPORT
AO	TREES	397.1'	A ±20' (surf elev ±377')	REMOVE- OFF AIRPORT
AP	TREES	396.1'	A ±13 (surf elev ±383	REMOVE- OFF AIRPORT
AQ	RESIDENCE	441.1'	T ±56' (surf elev ±385')	LIGHT
AR	TREE	393.2'	T ±5' (surf elev ±388')	REMOVE- OFF AIRPORT
AS	TREES	401.6'	A ±11' (surf elev ±391')	REMOVE- OFF AIRPORT
AT	TREES	412.6'	A ±11' (surf elev ±402')	REMOVE- OFF AIRPORT
AU	TREES	385.2'	A ±4' (surf elev ±381)	REMOVE- OFF AIRPORT
BC	TREE	400.8'	A ±1' (surf elev ±400')	REMOVE- OFF AIRPORT
BD	TREE	421.8'	A ±1' (surf elev ±421')	REMOVE- OFF AIRPORT
OTHER SIGNIFICANT ITEMS				
13	FENCE	309.9'	A ±0' (surf elev ±352')	
14	RT.2/ WILLISTON	316.3'	A ±0' (surf elev ±357')	
15	MILLHAM COURT	343.7'	A ±0' (surf elev ±380')	
16	KIMBALL AVE	349.3'	A ±0' (surf elev ±423')	

A=Approach T=Transition P=Primary

Note: Referenced obstruction points represent tallest tree within the grouping. Other trees may be present. Elevations may have increased since 2008 survey.

SCALE: 1 inch = 400 ft.

SCALE: 1 inch = 40 ft.

MAG. DECLINATION: 14°45'W
ANNUAL DRIFT: 4' E
NOVEMBER 2009
SOURCE: NOAA NESDIS

LEGEND

- = ON AIRPORT OBSTRUCTION CLEARING
- = OFF AIRPORT OBSTRUCTION CLEARING
- = EXISTING PRIMARY SURFACE LIMITS
- = EXISTING APPROACH SURFACE LIMITS
- = EXISTING TRANSITIONAL SURFACE LIMITS
- = EXISTING AIRPORT PROPERTY LINE
- = 10-FT CONTOURS
- = EXISTING FAR PART 77 OBSTRUCTION
- = EXISTING THRESHOLD SITING SURFACE OBSTRUCTION
- = GRADING/FILLING

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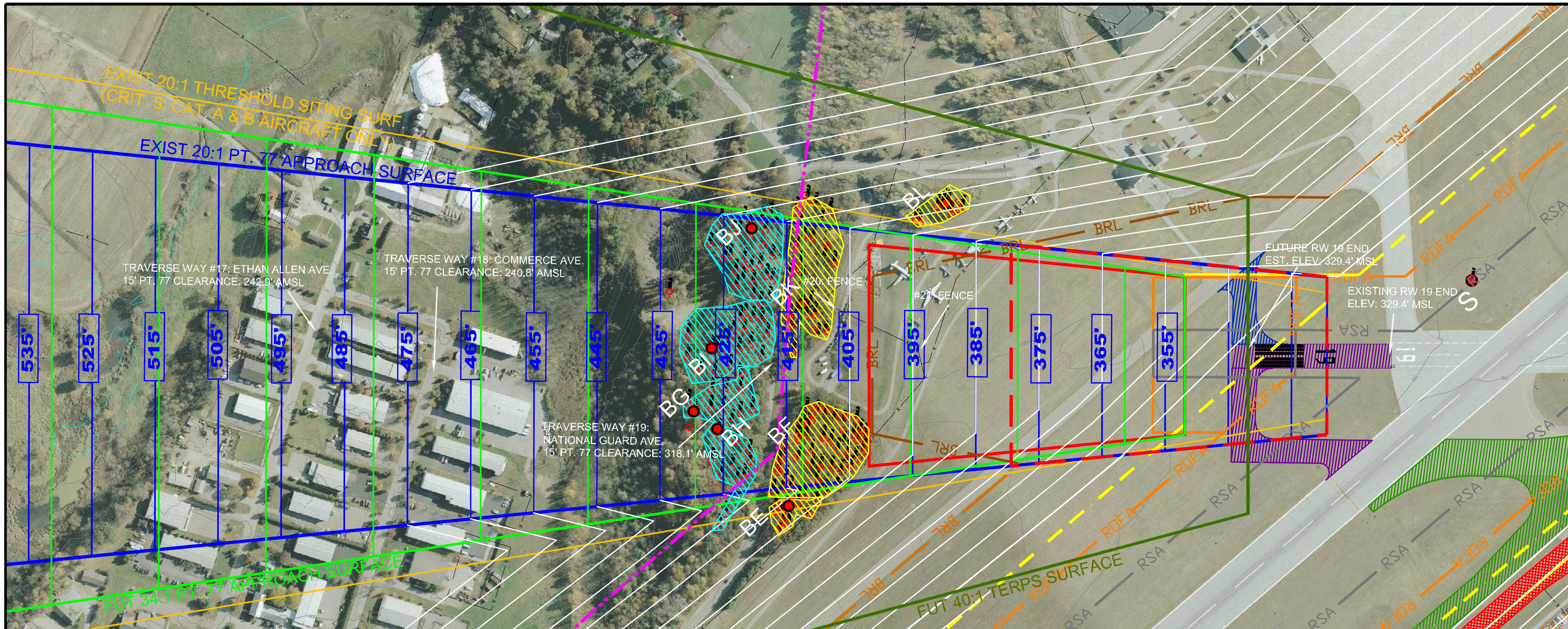
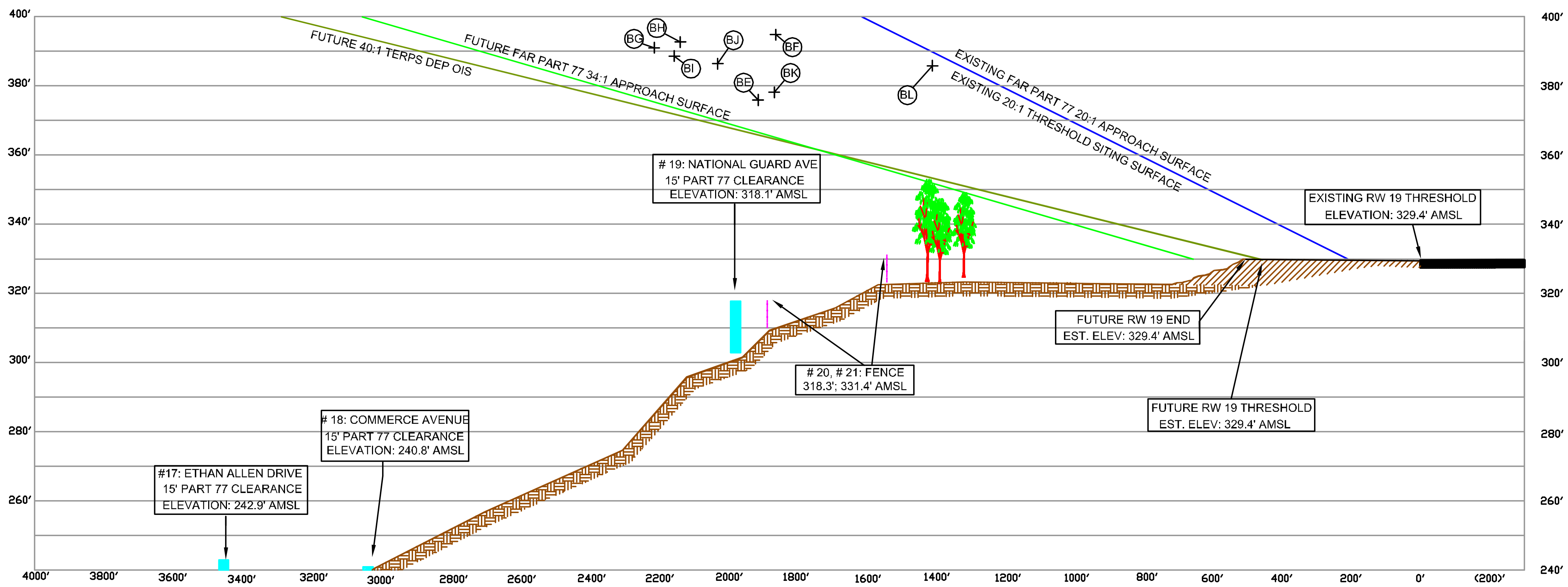
FIGURE 3.11

Existing Part 77 Obstructions and Limits of Clearing: Runway 1 Approach





SCALE: 1 inch = 40 ft.

SCALE: 1 inch = 400 ft.

MAG. DECLINATION: 14°45'W
ANNUAL DRIFT: 4' E
NOVEMBER 2009
SOURCE: NOAA NESDIS

EXISTING OBSTRUCTION CONCERNS RELATIVE TO RUNWAY 19

NO EXISTING OBSTRUCTIONS AS OF OCTOBER 2008

POINT	TYPE	APPROX TOP ELEV. MSL (2008 aerial survey)	ESTIMATED PT.77 PENETRATION FUTURE NON-PRECISION (34:1)	PROPOSED ACTION
BE	TREES	375.9'	T ±16' (surf elev ±369')	REMOVE-ON AIRPORT
BF	TREES	394.8'	A ±31' (surf elev ±364')	REMOVE-ON AIRPORT
BG	TREES	391.0'	A ±16' (surf elev ±375')	REMOVE-OFF AIRPORT
BH	TREES	392.7'	A ±20' (surf elev ±373')	REMOVE-OFF AIRPORT
BI	TREES	388.6'	A ±15' (surf elev ±374')	REMOVE-OFF AIRPORT
BJ	TREES	386.4'	A ±16' (surf elev ±370')	REMOVE-OFF AIRPORT
BK	TREES	378.1'	A ±13' (surf elev ±365')	REMOVE-ON AIRPORT
BL	TREES	385.8'	T ±12' (surf elev ±374')	REMOVE-ON AIRPORT

OTHER SIGNIFICANT ITEMS

17	ETHAN ALLEN DR	242.9'	A ±0' (surf elev ±490')	
18	COMMERCE AVE	240.8'	A ±0' (surf elev ±470')	
19	NATIONAL GUARD AVE	318.1'	A ±0' (surf elev ±417')	
20	FENCE	318.3'	A ±0' (surf elev ±418')	
21	FENCE	331.4'	A ±0' (surf elev ±394')	

A=Approach T=Transition P=Primary

Note: Referenced obstruction points represent tallest tree within the grouping. Other trees may be present. Elevations may have increased since 2008 survey.

LEGEND

- = ON AIRPORT OBSTRUCTION CLEARING
- = OFF AIRPORT OBSTRUCTION CLEARING
- = EXISTING PRIMARY SURFACE LIMITS
- = EXISTING APPROACH SURFACE LIMITS
- = EXISTING TRANSITIONAL SURFACE LIMITS
- = EXISTING AIRPORT PROPERTY LINE
- = 10-FT CONTOURS
- = EXISTING FAR PART 77 OBSTRUCTION
- = EXISTING THRESHOLD SITING SURFACE OBSTRUCTION
- = GRADING/FILLING

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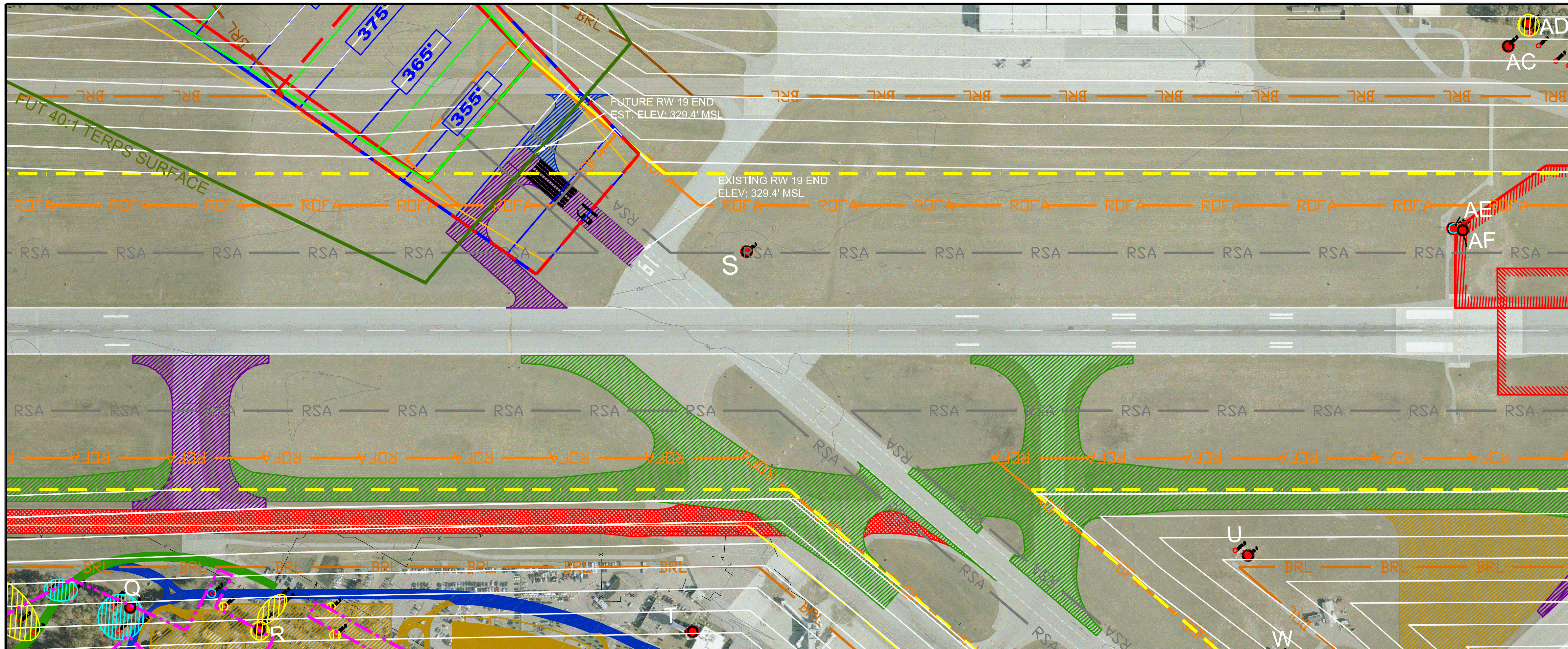
FIGURE 3.12

Existing Part 77 Obstructions and Limits of Clearing: Runway 19 Approach

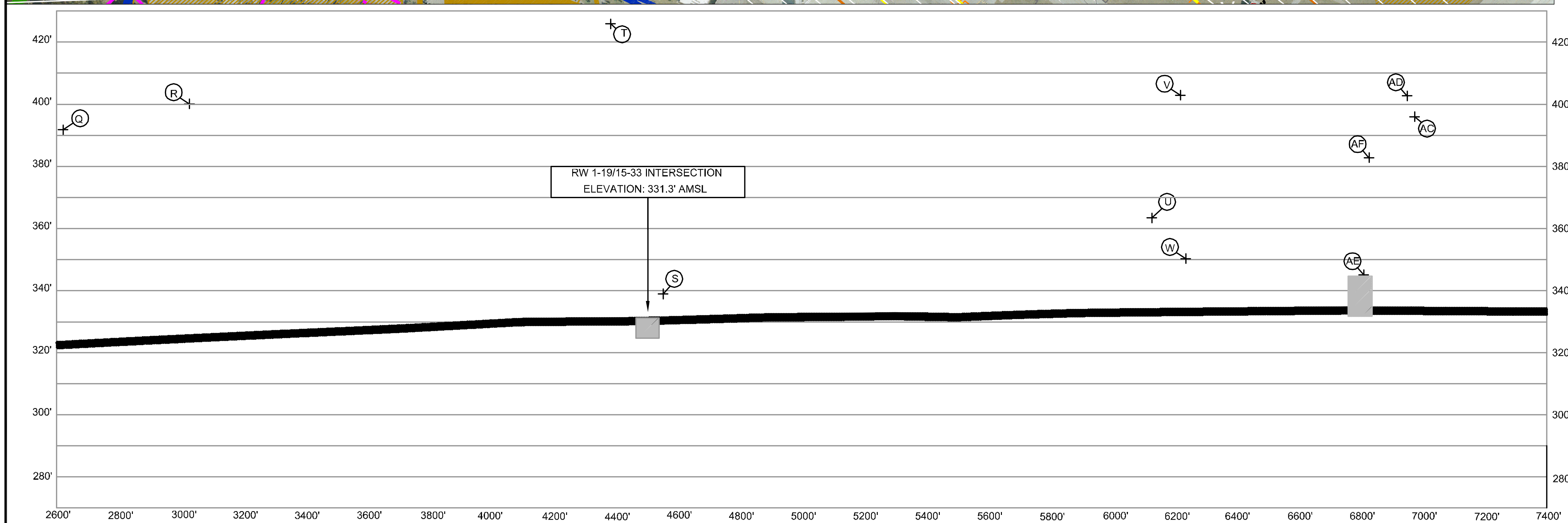


EXISTING OBSTRUCTION CONCERNS RELATIVE TO AIRPORT MIDFIELD				
POINT	TYPE	APPROX TOP ELEV. MSL (2008 aerial survey)	ESTIMATED PT.77 PENETRATION: EXISTING	ESTIMATED PT.77 PENETRATION: PROPOSED ACTION
Q	TREES	391.8'	RW 15 T ±14' (surf elev ±378')	REMOVE-OFF AIRPORT
R	TREES	400.1'	RW 15 T±10' (surf elev ±390')	REMOVE-ON AIRPORT
S	POLE	339.1'	RW 15 P ±8' (surf elev ±331')	LIGHT
T	ATCT	425.9'	RW 15 T ±32' (surf elev ±394')	NO CHANGE
U	POLES	363.4'	RW 33 T ±1' (surf elev ±363')	LIGHT
V	ASR-11 TOWER	402.9'	RW 1 T ±65' (surf elev ±338')	NO CHANGE
W	ASR-11 BLDG	350.3'	RW 1 T ±6 (surf elev ±344	NO CHANGE
AC	TERRAIN	395.9'	RW 33 T ±5' (surf elev ±391')	REMOVE
AD	TREES	402.7'	RW 33 T ±1' (surf elev ±402')	REMOVE-ON AIRPORT
AE	GLIDESLOPE BLDG	345.1'	RW 33 P ±10' (surf elev ±335')	NO CHANGE
AF	GLIDESLOPE	382.8'	RW 33 P ±48' (surf elev ±335')	NO CHANGE

A=Approach T=Transition P=Primary

Note: Referenced obstruction points represent tallest tree within the grouping. Other trees may be present. Elevations may have increased since 2008 survey.

SCALE: 1 inch = 400 ft.



SCALE: 1 inch = 40 ft.

LEGEND

- = ON AIRPORT OBSTRUCTION CLEARING
- = OFF AIRPORT OBSTRUCTION CLEARING
- = EXISTING PRIMARY SURFACE LIMITS
- = EXISTING APPROACH SURFACE LIMITS
- = EXISTING TRANSITIONAL SURFACE LIMITS
- = EXISTING AIRPORT PROPERTY LINE
- = 10-FT CONTOURS
- = EXISTING FAR PART 77 OBSTRUCTION
- = EXISTING THRESHOLD SITING SURFACE OBSTRUCTION
- = GRADING/FILLING

MAG. DECLINATION: 14°45'W ANNUAL DRIFT: 4' E NOVEMBER 2009 SOURCE: NOAA NESDIS

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FIGURE 3.13

Existing Part 77 Obstructions and Limits of Clearing: Airport Midfield

3.6.3 Transitional Surface

FAR Part 77 transitional surfaces extend perpendicularly, outward and upward from the edges of the primary and approach surfaces. They rise at a slope of 7:1 until they reach 150-feet above the airport elevation (i.e. intersection with the horizontal surface). The transitional surfaces at BTV are penetrated by both vegetative and man-made objects. **Figures 3.9 through 3.13** depict the transitional surface and its penetrations. There are four distinct areas of penetrations:

- **Area A:** located to the north of the ATCT and west of the Runway 15-33 centerline in the existing residential neighborhood. This area totals 5.4 acres of tree canopy with a minority located off-airport property in the existing residential neighborhood. The sponsor has been acquiring property in this area as they become available on the market. The sponsor should remove vegetation from existing off-airport areas after property acquisition is complete.

- **Area B:** located north of the ATCT and east of the Runway 15-33 centerline near the Army Guard site. The Army Guard building does obstruct the transitional surface to Runway 15 in several places, by up to 13-feet.

- **Area C:** located to south of the existing Air National Guard hangars near the intersection of Taxiway Delta and Runway 33. This area totals 1.5 acres of tree canopy and is located on airport property. However, as the majority of this site is along the banks of Muddy Brook, it could be difficult to gain environmental approval to remove the vegetation. The remaining area should be cleared as the area is under airport control. FAA Obstruction #50-000069 (Building) is an obstruction to the existing transitional surface within Area C.

- **Area D:** located near the intersection of Taxiway Alpha and Runway 1. This area totals 1.3 acres of tree canopy with a majority located on-airport property, which should be cleared as it is under airport control.

In total, there are approximately 22 acres of vegetative obstructions to the approach and transitional surfaces at BTV. Please see **Figure 3.14** for a break-down of this acreage.

Figure 3.14: Vegetative Obstructions to Approach and Transitional Surfaces (Oct. 2008)			
Runway	On-Airport (acres)	Off-Airport (acres)	Total (acres)
15	6.32	5.97	12.29
33	2.91	0.38	3.28
1	2.39	4.1	6.47
19	0	0	0
TOTAL	**11.61**	**10.43**	**22.04**

3.6.4 Horizontal Surface

The horizontal surface is established at an elevation of 484.9-feet amsl which is 150-feet above the established airport elevation (334.9-feet). The horizontal surface is constructed by a series of 10,000-foot arcs centered on the end of the primary surface for each runway, and then joining those arcs by tangent lines.

Based on the evaluation of aerial photogrammetric mapping conducted in October 2008 and published FAA obstacle data (dated March 7, 2010), there are 8 published FAA Obstacles known to penetrate the horizontal surface. The obstacles are identified below. The sponsor should monitor development in the local area and coordinate with the City of South Burlington, City of Burlington and Chittenden County planning organizations to require an FAA 7460 (Notice of Proposed Construction) determination prior to permits beings issued.

Figure 3.15 Horizontal Surface Penetrations			
FAA Obstacle ID	**Elevation (amsl)**	**Type**	**Horizontal Surface Penetration**
50-000066	524’	Dome	39’
50-000050	540’	Tank	55’
50-000007	635’	Tower	150’
50-000081	556’	Tank	71’
50-000032	642’	Tower	25’
50-000068	512’	Tower	27’
50-000072	559’	Tower	25’
50-000103	503'	Windmill	18'
Source: FAA Digital Aeronautical Information, March 2010			

3.6.5 Conical Surface

The conical surface begins at the perimeter of the horizontal surface and extends outward and upward at a 20:1 slope for 4,000-feet. Thus, the elevation at the perimeter of the conical surface is 684.9-feet, which is 200-feet higher than the elevation of the horizontal surface and 350-feet above the established airport elevation. Based on the evaluation of aerial photogrammetric mapping conducted in October 2008 and published FAA obstacle data (dated March 7, 2010); there are no obstructions to the conical surface.

3.7 LOCAL ZONING ORDINANCES

The City of South Burlington has established for BTV a zoning district called "Airport" (AIR) (See **Figure 1.11**). According to the January 2009 South Burlington Land Development Regulations, the Airport District is formed to facilitate the development and operation of BTV and associated facilities, and the Vermont Air National Guard. In addition, the city has established Airport Approach Cones, the boundaries of which include all approaches to the runways at BTV. The South Burlington Land Development Regulations prohibit uses within the Approach Cones which: produce electrical interference with radio communication or radar operations at the airport; obstruct the aerial approaches to the airport; do not comply with applicable FAA or other federal or state regulations; and, which produce lights or glare which could interfere with vision or cause confusion with airport lights. The exact dimensions of the approach cones are described in the 1991 Airport Master Plan Update for BTV. Because the runway approaches have changed since the 1991 MPU was written, it is recommended that the airport provide the City of South Burlington with the new approach dimensions from this report, which dictate the size of the Approach Cones.

Within the AIR district, the minimum lot size is 3 acres; the maximum site coverage for buildings only is 30% and for buildings, parking, and other impervious surfaces is 50%.

3.8 COMMERCIAL FACILITY REQUIREMENTS

The facility requirements for the commercial passenger terminal facility were determined by a sub consultant to the Campbell & Paris Planning Team, Price Studios. (See **Figure 3.16** for the Terminal Area Program and refer to **Appendix H** for the entire Terminal Area Master Plan). After existing terminal infrastructure and projections of future traffic growth expectations were analyzed, the final delineation of terminal space needs was conducted using industry-accepted formulas. Many of the space planning factors used in this report are based on peak month, design day, and peak design hour (PDH) figures calculated by Price Studios.

3.8.1 Commercial Terminal Facilities

Each of the primary functional areas of the terminal was reviewed to determine if the existing terminal building could accommodate the forecasted passenger enplanements presented in **Chapter Two.**

Ticketing:

Counter Positions: As of 2009, there are 32 ticket counter positions at the airport. The recommended number of ticket counter positions was determined by dividing the peak design hour total enplanements by 2.3. Twenty-six counter positions are recommended in the base year 2009 (which is less than existing) and 51 are recommended in 2030.

Counter Length: The existing amount of ticket counter at the airport totals approximately 150 linear feet (LF). The required ticket counter length was determined by applying 10 linear feet to the number of existing or proposed counter positions. The amount of recommended ticket counter length at the airport is 256-feet in 2009, and increases to 512-feet in 2030. Therefore an additional 362-feet of ticket counter length is recommended throughout the planning period, keeping in mind that continued technological changes in check-in procedures (i.e., common use self service kiosks, online check-in, etc.) may reduce the need for the conventional counter facilities.

Control Area: The recommended size of the control area at the airport was determined by applying 10 square-feet to the amount of counter frontage. This results in a recommendation of 2,560-square feet in 2009 and 5,120-square feet in 2030. As of 2009, the control area measured 3,668-square feet (more than recommended for that year).

Queuing Area: The recommended amount of queuing area was determined by applying a space factor of 15-20-square feet to the amount of counter frontage. Therefore the recommended queuing area in 2009 is up to 5,120-square feet, which increases to 10,240-square feet in 2030. The existing queuing area at the airport measures 3,000-square feet. The existing queuing area is compressed and restricts nearly half of the lobby depth. Kiosk ticketing in the future could help to alleviate congestion caused by queuing.

Airline Office/Operations: The space calculation to determine airline office/operations area is 30-40-square feet times the amount of counter frontage. This amounts to a recommendation of up to 10,240-square feet in the base year (2009) and a recommendation of up to 20,480-square feet in 2030. As of 2009, the airport has 5,855-square feet dedicated to airline office/operations use.

Baggage Make-up**:** The baggage make-up area, or outbound baggage area, is located in the secure area of the terminal where the airlines consolidate checked baggage for loading on to the aircraft. The role of the outbound baggage area has changed in the post-September 11 environment as more security checks are performed on bags in the outbound baggage area. In accordance with recommendations from the Transportation Security Agency, the ticket counters at the airport were moved forward into the queuing area, approximately 6 to 8 feet, to accommodate the installation of Explosives Detection System (EDS) machines. This allows the baggage screening function to be located behind the ticket counter and out of the pedestrian areas of the terminal.

The required baggage make-up area was determined by applying a space factor of 30-40 square feet to the amount of counter frontage.

The recommendation for baggage make-up area in 2009 is up to 10,240-square feet, which increases to up to 20,480-square feet in 2030. The existing baggage make-up area totals approximately 5,177-square feet. This analysis suggests that additional bag make-up area is immediately necessary to accommodate the existing and forecasted increase in passenger enplanements over the planning horizon. However, the increased use of carry-on baggage, especially for the regional jet type aircraft operations, may tend to offset some of the traditional demand for this space.

Baggage Claim

Baggage Claim Belt: The required length of baggage claim belt was determined by applying a planning factor of 1-LF per peak design hour terminating passenger. The required baggage claim belt length in 2009 is 512-feet, which increases to 1,024-feet by the end of the planning horizon. The installation of the third baggage claim facility in 2005 (the North Terminal Expansion project) increased the total baggage claim belt length at the airport to approximately 240 feet. It is recommended that this length be increased again in order to accommodate the existing and forecasted passenger demands through the 20-year planning horizon.

Baggage Claim Area: The baggage claim area is provided so that deplaning passengers can 1) wait for bags to arrive to the baggage claim belt and 2) identify and retrieve their baggage. The required baggage claim area was determined by providing a 20- to 25-foot deep area along the entire length of the baggage claim belt. The required baggage claim area in 2009 is approximately 13,000-square feet, which increases to almost 25,600-square feet by the end of the planning horizon.

The existing baggage claim area is located on the first floor near the rental car agencies. As of January 2009, there are 10,998 square-feet of baggage claim lobby area at the airport. Therefore additional baggage claim area is necessary. In addition to accommodating the increased enplanements, additional space is also required to accommodate the recommended increase in belt length.

Concession Area: The concession area provides space for such items as news/sundries, food and beverage sales, tobacco stands, telephone banks, lockers, gifts/apparel, advertising displays, and vending. The space requirements for the concession area are 20-30 square feet times the peak design hour enplanements total. The total recommended concessions area supported by the forecasted passenger enplanements totals 12,347-square feet in the base year and increases to more than 30,000-square feet by the end of the planning period.

As of 2009, the terminal has a restaurant/cocktail lounge facility (4,715-sf) located in the second floor of the terminal building and a smaller snack bar area (613-sf) located on the first floor. Combined, these areas total 5,328 square feet. The terminal also has several areas for newspapers and gift/apparel stores with the largest being located near the ticketing counter on the first floor of the terminal building. These areas total approximately 1,775-square feet.

Airport management has introduced small concession "islands" within the post-screening (i.e., secure) areas of the airport. However the overall terminal size, gate layout and passenger demand profiles have not supported the need for substantial secure area concession space. Increased passenger activities may require a re-evaluation of this concept at some point in the planning horizon. It is worthwhile to note that the 30-ft "bump-out" space (≈ 1,800-sf) provided with the North Terminal Phase 2 expansion program for additional second floor seating in the secure hold room area could possibly provide limited space for small concessions in the north concourse should this need be realized.

Nevertheless this general analysis tends to support the need to provide additional concession (food/gifts) space over the planning horizon. This could occur either through expanded restaurant space on the second floor or a larger snack bar facility on the first floor.

Circulation: Public circulation areas are provided for the circulation of passengers and visitors around the terminal building and focus on four primary areas: ticketing, baggage claim, concourse and other non-secure (i.e. pre-security screening) areas. This space is separate from other circulation spaces (i.e., passenger ticketing queue, baggage claim area, etc), which are provided for the efficient movement of large influxes of people. Public circulation in the concourse is one of the largest components of an airport terminal.

The space factor to determine circulation requirements is 30% of the net terminal area, which amounts to up to 30,720-square feet in 2009 and up to 61,440-square feet in 2030. The circulation requirements increase throughout the planning period as the terminal construction phases progress and therefore the size of the terminal increases.

Public Restrooms: Public restrooms are provided in both non-secure and secure areas of the terminal building. Space for public restrooms was determined by applying a space planning factor of 8 to11-square feet for each peak design hour ticketing passenger. Applying this formula results in a requirement of up to 5,632-square feet of public restroom space in 2009, which increases to 11,264-square feet in 2030. The existing terminal building has approximately 2,117 square feet of non-secure restroom space and 1,200 square feet of secure restroom space. This simple space planning analysis would suggest that additional public rest room space in both the secure and non-secure areas will be necessary as passenger levels increase over the planning horizon.

Rental Cars: As of 2009 there are five rental car companies at the airport: Hertz, Avis, Alamo/Ntl, Enterprise, and Budget. Together these agencies utilize 21 counter positions. Taking into account counter frontage (LF), counter area (SF), queuing area (SF), and office/storage (SF), the total area recommended for rental cars within the airport terminal in 2009 is 2,436-square feet, increasing to up to 3,132-square feet throughout the planning period. As of 2009 rental car agencies utilize 3,172-square feet, more than what is recommended for the base year and even for 2030. This suggests an inefficient use of space by rental car agencies at the airport.

Parking: As of 2009, BTV currently has a three-level, 2,100 space parking garage for users of the airport. Rental car companies use 310 spaces in the garage; the remaining 1,790 spaces are for terminal users. The parking garage is connected to the existing terminal building via two climate-controlled walkways, which provide comfort to airport users during inclement weather. Plans exist to expand the parking garage by 1,370 spaces and to add a "green roof" to the structure, which would help to reduce the airport's energy costs. Pending funding approval, construction on this project should begin in spring 2010.

Approximately 3,000 parking spaces serve the airport in the terminal area. Besides the 2,100 parking garage spaces, these include 165 employee parking spaces, 340 rental car cleaning/prep spaces, 230 long-term spaces, and 75 short-term on-street spaces along Airport Drive.

According to a 2009 Landside Transportation Assessment generated by Gorove/Slade Associates, Inc., there will be terminal user parking demand for approximately 5,827 parking spaces in 2030 (see **Appendix G**).

There also seems to be a demonstrated need for a cell-phone lot for short-term parkers. According to the 2009 Landside Transportation Assessment, an average of 300 cars per day park in the garage for less than 30 minutes. See **Appendix F-2** for concourse extension concepts which include the option of a cell-phone lot.

Figure 3.16: Terminal Area Program

	Existing	Program		Phase I (2012)		Phase II (2020)		Phase III (2030)		Comments
Airline Enplanements	768,000	768,000		907,000		1,180,000		1,536,000		Per Forecasts
Peak Month Total	79,872	76,800		90,700		118,000		153,600		Actual (or Estimated 10%)
Design Day Total	2,662	2,560		3,023		3,933		5,120		Actual (Peak Month ÷ 30)
Peak Design Hour (PDH) Total	519	512		605		787		1,024		Actual (20% Design Day)
Ticketing										
Counter Positions	32	26		30		39		51		Actual (or PDH ÷ 3.3)
Counter	150	256		302		393		512		10 LF x # of Counter Positions
Control Area	3,668	2,560		3,023		3,933		5,120		10 SF x Counter Frontage
Queuing Area	3,000	3,840 -	5,120	4,535 -	6,047	5,900 -	7,867	7,680 -	10,240	15-20 SF x Counter Frontage
Airline Office/ Operations	5,855	7,680 -	10,240	9,070 -	12,093	11,800 -	15,733	15,360 -	20,480	Actual (or 30-40 SF x Counter Frontage)
Baggage Make up	5,177	7,680	10,240	9,070	12,093	11,800	15,733	15,360	20,480	Actual (or 30-40 SF x Counter Frontage)
Hold Rooms										
# of Gates	14	14		16		18		26		
Hold Room Waiting	18,550	10,240 -	12,800	12,093 -	15,117	15,733 -	19,667	20,480 -	25,600	Actual (or 20-25 SF x PDH)
Baggage Claim										
Claim Lobby Frontage	246	512		605		787		1,024		1LF x PDH
Claim Lobby Area	10,998	10,240 -	12,800	12,093 -	15,117	15,733 -	19,667	20,480 -	25,600	20-25 SF x Claim Frontage
Rental Cars										
Positions	21	21		23		25		27		
Counter Frontage (LF)		126		138		150		162		6 LF Per Position
Counter Area (SF)		1,008		1,104		1,200		1,296		8 SF x Counter Frontage
Queuing Area (SF)		756 -	1,008	828 -	1,104	900 -	1,200	972 -	1,296	6-8 SF x Counter Frontage
Office/Storage (SF)		252 -	294	276 -	322	300 -	350	324 -	378	12-14 SF x Counter Frontage
Total Area	3,172	2,142 -	2,436	2,346 -	2,668	2,550	2,900	2,754	3,132	Total
Concessions										
Total: Food/Gifts (SF)	12,347	10,240 -	15,360	12,093 -	18,140	15,733 -	23,600	20,480 -	30,720	20-30 SF x PDH
Public Restrooms										
Total (SF)	3,406	4,096 -	5,632	4,837 -	6,651	6,293 -	8,653	8,192 -	11,264	8-11 SF x PDH
Public Lobby										
Total (SF)	2,127	10,752 -	12,800	12,698 -	15,117	315 -	433	410 -	563	21-25 SF x PDH
Security										
Passenger Screening (SF)		3,072	3,072	3,628	3,628	4,720	4,720	6,144	6,144	6-6 SF x PDH
Security Queuing (SF)	4,811	3,072		3,628		4,720		6,144		6 SF x PDH
TSA Office Support (SF)	1,492	1,500		1,500		1,500		1,500		Actual (or 500-1500 SF)
Meeter Greeter Waiting (SF)	832	1,536 -	1,536	1,814 -	1,814	2,360 -	2,360	3,072 -	3,072	3-5 SF x PDH
Administration										
Offices/ Conference (SF)	7,587	3,072 -	10,240	3,628 -	12,093	4,720 -	15,733	6,144 -	20,480	6-20 SF x PDH
Summary										
Net Terminal Area (SF)		76,800 -	102,400	90,700 -	120,933	118,000 -	157,333	153,600 -	204,800	Actual (or 150-200 SF x PDH)
Circulation (SF)		23,040 -	30,720	27,210 -	36,280	35,400 -	47,200	46,080 -	61,440	Net Terminal Area x 30%
Mechanical Support (SF)		9,216 -	12,288	10,884 -	14,512	14,160 -	18,880	18,432 -	24,576	Net Terminal Area x 12%
National Weather Service	-6,569	0	0	0	0	0	0	0	0	
FIS		7,500	10,000	10,000	10,000	10,000	10,000	10,000	10,000	FIS 7,500-10,000
Gross Terminal Area (SF)	139,666	116,556 -	155,408	138,794 -	181,725	177,560 -	233,413	228,112 -	290,816	Sum of Terminal Area
Parking										
Public (Short Term/ Long Term # of Spaces)	1,648	1,536 -	2,560	1,814 -	3,023	2,360 -	3,933	3,072 -	5,120	3.5-5 x PDH
Rental Car (# of Spaces)	310	384	512	454	605	590	787	768	1,024	.75-1 x PDH
Employee (# of Spaces)	94	358	410	423	484	551	629	717	819	.7-.8 x PDH
Curbside Frontage	847	922	1,024	1,088	1,209	1,416	1,573	1,843	2,048	1.8-2.0 x PDH

3.8.2 Commercial Aircraft Gates

Four methodologies were used to determine the number of commercial aircraft gates required at BTV throughout the planning horizon:

- **Daily Utilization:** Guidance provided in FAA AC 150/5360-13 "Planning and Design Guidelines for Airport Terminal Facilities." This methodology uses the average day of the peak month commercial departures per gate to determine future gate requirements based on the approved commercial operations presented in **Figure 2.27**.

- **Peak Hour Utilization**: Guidance provided in FAA AC 150/5360/13 "Planning and Design Guidelines for Airport Terminal Facilities." This methodology uses the forecasted design year peak hourly aircraft movements and the selected gate utilization factor (based on airline station characteristics) to determine future gate requirements.

- **Annual Utilization:** Guidance provided in FAA AC 150/5360-13 "Planning and Design Guidelines for Airport Terminal Facilities." This methodology attempts to establish a relationship between total annual passengers and number of gates by defining an average number of passenger enplanements per gate.

- **Small-Hub Gate Survey**: Research was conducted on 45 small-hub airports throughout the U.S. and the resulting data was used to determine an average number of enplanements per gate. This average was used to determine the number of gates required at BTV to accommodate the forecasted number of enplanements.

Daily Utilization Method: The daily utilization method is based on the average day of the peak month aircraft departures which was then divided by a particular utilization level. The utilization level is typically expressed as an average number of departures per gate during the average day of the peak month. As of spring 2009, the airport has 10 active gate positions.

The average day of the peak month has approximately 45[g] commercial departures from 10 gate positions, which yields an average daily utilization of 4.5 commercial departures per gate position. This is consistent with guidance in AC 150/5360-13 which states that Origin/Termination airports typically have between 4 and 7 daily departures per gate based on a 12-hour operating period. Based on the forecasted commercial operations presented in **Figure 2.27**, the average day of the peak month commercial departures is forecasted to increase from 45 in the base year to 86.5 by the end of the planning horizon. Assuming the daily utilization factor remains at 4.5 daily departures per gate position, the number of departures during the average day of the peak month would require a terminal facility having approximately **20 (19.22) gates** by the end of the planning horizon.

[g] Average Day-Peak Month Ops (90 ops, see **Figure 2.27**) divided by 2 equals 45 departures

Peak Hour Utilization: The peak hour utilization method outlined in AC 150/5360-13 determines future total gate requirements by dividing the forecasted design year peak hourly aircraft movements by the appropriate gate utilization factor. Peak hourly aircraft movements, which are estimated to be 14 in 2008 and which increase to 27 by 2030, were taken from **Figure 2.27**. The gate utilization factor for BTV was provided by AC 150/5360-13, which states that domestic peaks at Origin/Termination airports average between 0.9 and 1.1 hourly aircraft movements per gate. For the purposes of this report, a gate utilization factor of 1.1 was used. Therefore, the number of peak hour operations for 2008, 14, requires 13 gates, and the forecasted number of peak hour operations for 2030, 27, requires **25 gates**.

Annual Utilization Method: The annual utilization method outlined in AC 150/5360-13 attempts to establish a relationship between two factors: 1) the existing number of annual passengers processed through each active gate position; and, 2) the ratio between the 20-year forecasted enplanements and the base year enplanements. The relationship between these two factors results in a forecasted number of passengers processed through each gate position which is then used to determine the total number of gate positions required throughout the planning period.

Approximately 759,021 passengers were recorded at BTV in 2008. Based on the 10 active gate positions at the airport in 2008, this results in 75,902 passengers processed through each gate. The approved forecasted level of passenger enplanements in 2030 is approximately 1,609,916, which represents a 2.1 forecast-to-base year ratio. Based on this relationship, the number of passengers processed by each gate position is anticipated to increase to 175,000 passengers by 2030. Applying the suggested 175,000 passengers to the forecasted passenger enplanements results in a demand for **10 (9.2) commercial gates** by the end of the planning horizon.

Small-Hub Gate Survey: Research was conducted on the number of enplanements and gates at 45 small hub airports throughout the U.S. in 2008. This data provided an average number of enplanements per gate of 65,970. The application of this average to the forecasted number of enplanements at BTV in 2030 produces a requirement of **25 gates** in 2030.

Conclusion: The four methodologies used to determine commercial gate requirements at BTV range from 10 to 25 gates. This suggests that the terminal should have up to 25 gates in order to accommodate the 20-year forecast of 1,609,916 passenger enplanements. The average of the results of the four methodologies, 20 gates, is used to determine future hold room requirements (see the following section).

Additional gates may be required during the planning horizon as a result of continued peaking of operations during the early morning and late afternoon hours. It is feasible that the demand for gate space during the peak periods of the day could result in the need for more gates. However, efficiencies could be gained by increasing the gate utilization from the existing 4.5

departures per gate by having some gate operations occur during non-peak times. This would result in a more efficient use of limited development space and terminal infrastructure. It is important to note that while the airport currently has only 10 active gates, there are a total of 15 gates listed at the airport. However, many of the 15 gates utilize the same doors and ramps as the other gates.

Figure 3.17: Forecasted Gate Requirements

Forecast Year	Total Commercial Operations	Average Daily Departures	Gate Methodology			
			Daily Utilization	Peak Hour Utilization	Annual Utilization	Small-Hub Gate Survey
2008	29,506	45	10	13	7	12
2010	30,454	46.5	11	13	7	12
2015	35,554	54	12	16	8	15
2020	41,302	63	14	19	8	18
2025	47,784	73	17	21	9	21
2030	56,502	86.5	20	25	10	25

3.8.3 Passenger Holdrooms

Passenger holdrooms are located immediately adjacent to the departure gates and typically include a location for ticketing, enplaning passenger queue, and sitting area. The size of the passenger hold room is dependent upon several factors: 1) the size of the aircraft using the gate, 2) a representative load factor for the aircraft, and, 3) the number of passengers at the gate 15 minutes prior to aircraft boarding. A certain percentage (typically around 25-percent) of passengers will either arrive at the gate during the boarding process or elect to stand until boarding commences. A passenger hold room is typically designed for a 75-percent load factor with 75-percent of passengers choosing to use the seats provided.

Each of the gates at BTV were sized based on 1) the largest aircraft (in terms of seats) anticipated to use the gate, 2) a higher-than-average passenger load factor and 3) a higher than industry standard stand/sit ratio.

Existing gates 6, 8, and 10 are anticipated to accommodate the Airbus A-320, which can hold 179 passengers. The remaining existing gates were sized to accommodate the E-190, a regional jet with capacity for 98 passengers. (See **Appendix L** for a description of gate locations and numbers.) At least five additional gates are recommended over the planning period and are included in this forecast. It is assumed that two of these gates will accommodate the Airbus A-320 and three will accommodate the E-190. By sizing the gates for the largest aircraft expected to use it, the airport will have room for excess seating, should the need arise, or for potential concession space within the secure holdroom area.

Total seating by gate area is presented in **Figure 3.18** and is based on a 95-percent load factor and 80-percent of all passengers choosing to use seats and a forecasted number of departures per gate position during the peak hour. The peak hour departures per gate were determined by applying the forecasted compounded annual rate of growth in commercial operations, 3%, to the 2008 departures per gate position during the peak hour (5:30am-6:30am), based on the June 2008 flight schedule, (which is the peak month 2008 in departures). Based on this analysis, a total of 1,797 seats are recommended for the hold rooms at BTV. The five gates on the North Concourse (created during the NOTE-2 expansion project) are served by a common holdroom, which is recommended to provide 571seats in order to accommodate the anticipated number of passengers over the planning horizon.

Price Studios developed a separate recommendation for the square-footage of the hold room area at the airport, which is up to 12,800-square feet in 2009 and which increases to up to 25,600-square feet in 2030. This represents approximately 14-square feet per seat, which is reasonable.

Figure 3.18 Passenger Hold Room Seating Requirements

Gate	Forecasted Aircraft Type	Seating Capacity	Peak Hour			Seat Factor	Required Seats
			Departures*	Seats	Passengers		
1	E-190	98	1	98	93	80%	74
2	E-190	98	1	98	93	80%	74
3	E-190	98	1	98	93	80%	74
4	E-190	98	1	98	93	80%	74
5	E-190	98	1	98	93	80%	74
6	A-320	179	1	179	170	80%	136
7	E-190	98	1	98	93	80%	74
8	A-320	179	1	179	170	80%	136
9	E-190	98	1	98	93	80%	74
10	A-320	179	1	179	170	80%	136
11	E-190	98	1	98	93	80%	74
12	E-190	98	1	98	93	80%	74
13	E-190	98	1	98	93	80%	74
14	E-190	98	1	98	93	80%	74
15	E-190	98	1	98	93	80%	74
16	E-190	98	1	98	93	80%	74
17	E-190	98	1	98	93	80%	74
18	E-190	98	1	98	93	80%	74
19	A-320	179	1	179	170	80%	136
20	A-320	179	1	179	170	80%	136
TOTAL		2,365	20	2,365	2,247		1,797

*Rounding up peak-hour numbers and assuming 1 departure/peak hour for those gates with 0 departures in June 2008.

3.9 CARGO FACILITY REQUIREMENTS

The forecast of cargo demand conducted in **Section 2.3.2** anticipates cargo tonnage to increase from 10,709 tons in 2008 to 19,249 tons by the end of the planning horizon which yields a 2.7% compounded annual rate of growth.

3.9.1 Cargo Building

Two methodologies were used to determine the amount of cargo building space required to meet the anticipated air cargo demand at BTV. The first was through the application of an industry standard building utilization rate of 1.2 square feet for every annual ton of cargo handled at the facility. The second methodology used a blended building utilization rate, derived by analyzing the 2001 building square footage available and cargo traffic volumes at 91 airports in the United States.

Industry Building Utilization Rate: Applying the industry standard to the forecasted cargo demand results in an initial cargo facility of 13,000 square feet in size. Airports with similar cargo facilities include Gulfport-Biloxi International Airport (GPT) in Gulfport, Mississippi, Blue Grass Airport (LEX) in Lexington, Kentucky and Fresno/Yosemite International Airport (FAT) in Fresno, California. Anticipated demand for cargo services should increase the size of the cargo building to 23,000 square feet by 2030.

Blended Building Utilization Rate: The blended building utilization rate was determined by analyzing the 2001 cargo warehouse space available at 91 airports and the total amount of cargo (expressed in short tons) in 2001 handled by the airport. Interestingly, this analysis confirmed the industry standard of 1.2 square feet per annual ton of cargo; however, substantial differences existed between airports based on the amount of cargo moved. To determine the amount of difference, the airports were divided into five categories: 0 to 75,000 short tons of annual cargo, 75,000 to 150,000 short tons of annual cargo, 150,000 to 250,000 short tons of annual cargo, 250,000 to 500,000 short tons of annual cargo and 500,000+ short tons of annual cargo (see **Figure 3.19**). The differences in cargo building utilization rates for each group illustrate the underlying trend of airports developing cargo facilities to accommodate larger volumes of cargo activity than is currently at the airport. This positions the airport to actively market existing facilities to potential tenants without incurring delays in planning, designing, permitting and constructing a facility.

Figure 3.19: Cargo Building Utilization Rates by Amount of Annual Cargo Moved

Annual Cargo Moved (short tons)	Building Utilization (SF/ST)
0 short tons to 75,000 short tons	**2.37**
75,000 short tons to 150,000 short tons	**1.33**
150,000 short tons to 250,000 short tons	**1.46**
250,000 short tons to 500,000 short tons	**1.19**
500,000 + short tons	**1.19**
INDUSTRY AVERAGE	**1.20**

Source: Campbell and Paris, 2004

The building utilization rates presented in **Figure 3.19** were applied to the respective forecasted cargo tonnage for each planning period. Applying these building utilization rates results in an initial cargo building requirement of approximately 25,400 square feet, with subsequent demand increasing the building size to 26,000 square feet by 2010, 34,300 square feet by 2020, and 45,600 square feet by 2030.

Recommended Cargo Building: The recommended initial cargo building uses the Industry Building Utilization Rate and the Industry Average from the Blending Building Utilization Rate (1.2 square feet per ton of cargo), and recommends a cargo building of 30,000 square feet in size. This building would accommodate 25,000 tons of cargo. This building requirement is consistent with the cargo building recommended in the 2001 South End Development (SED) Planning Document and the subsequent recommended development plan. The ultimate size of cargo facilities will be determined to some extent by the length of the building necessary to accommodate the number of aircraft parking positions for the types of aircraft anticipated to use the facility.

3.9.2 Cargo Apron

Regardless of the size of cargo buildings constructed at BTV, the apron system should be designed to accommodate narrow body twin-engine aircraft. The provision of an apron capable of accommodating the peak demand for apron parking will, to a certain extent, determine the linear frontage of the cargo building. Thus, the cargo facilities constructed should strive to balance acceptable building utilization and apron square yardage to accommodate the anticipated fleet mix during peak demand periods.

As is discussed in **Section 2.3.3**, the forecast of cargo operations anticipates that the DC-9 and Boeing 727 aircraft operating at the airfield will be replaced with newer narrow body twin-engine aircraft such as the Boeing 737 (Group III aircraft) and Boeing 757 aircraft (Group IV aircraft).

The probability of having multiple cargo carriers on the cargo apron at the same time is high due to the nature of the cargo industry. Existing cargo operations reflect this situation with the apron occupied by two aircraft from early morning (approximately 7:40 a.m.) to mid-evening (approximately 8:30 p.m)[h]. Thus, an initial cargo apron should be designed to accommodate up to three narrow-body twin-engine aircraft. This size of apron would provide enough capacity to accommodate the existing two parking positions and provide additional capacity should a third cargo operator begin operations at BTV. A typical Group IV cargo aircraft currently in operation is the Boeing 757 aircraft which has a wingspan of approximately 124-feet. Applying modified standard FAA taxi lane wingtip clearance for Group IV aircraft of 25-feet results in a requirement for at least 422-linear feet of building frontage to accommodate three parking positions.

The total area of the cargo apron should be approximately 28,000 square yards. This apron size

[h] Source: Sept. 2008 BTV schedule

accommodates a 60-foot distance from the cargo building to nosewheel for push-back operations, depth for a Boeing 757 aircraft, a 25-foot wide travel lane behind the aircraft parking positions, a standard Group IV taxi lane object free area (112.5-feet from the edge of the travel lane) and 75-foot wide taxi lane/taxiway width.

It is recommended that the initial cargo apron development be of sufficient size to accommodate three Group IV narrow-body twin-engine aircraft parking positions using standard FAA design criteria and providing adequate airside circulation. This is consistent with the recommended development plan for the South End Development.

3.9.3 Truck Docking

Truck docking is typically a function of the linear frontage of the cargo building with the standard truck parking position being 15-feet in width by 75-feet in length. An additional 75-feet of pavement is provided that serves as a travel aisle and maneuvering area so that trucks can easily access the loading bay.

Based on providing standard 15-foot parking spaces along the entire 300-foot building length, the initial cargo building should include space for 20 parking spaces. The 20 parking spaces are sufficient for the anticipated cargo activity at the airport. Considering that the average cargo truck can carry 10-15 tons of cargo at maximum capacity and that the average tonnage per cargo aircraft departure is anticipated to total 16.9 tons by the end of the planning horizon; the 20 truck parking spaces provide sufficient space to accommodate future cargo demand. This is consistent with the recommended development plan for the South End Development.

3.10 BUSINESS/GENERAL AVIATION FACILITY REQUIREMENTS

Planning factors have been developed for the major business/general aviation facilities. Space requirements for aircraft parking positions assume nested tie-downs and power in/out transient type positions. Each have been analyzed based on the size of the various general aviation aircraft types (i.e., single-engine, multi-engine (includes turboprop), turbo-jet, and helicopter) expected at BTV. Hangar space requirements for storage and maintenance have been developed similarly including associated office support space needs and automobile parking requirements. Fuel consumption associated with based and transient aircraft operations have been estimated using historical activity at the airport.

The existing business/general aviation facilities at the airport are located near the existing commercial terminal facility. This location restricts the ability of the airport to offer an efficient operating environment for the commercial airlines serving the Burlington region. A considerable amount of effort has been expended by the airport sponsor, local and regional governments, the State of Vermont and the Federal Aviation Administration in identifying a suitable on-airport location for a consolidated business/general aviation facility. These efforts began with the 1990 Master Plan Update for the airport which identified the South End of the airport as the preferred location for a consolidated business/general aviation and cargo complex. The conclusions reached in the 1990 Master Plan Update were reinforced in the 2001 South End Development (SED) Planning Report, which conducted a comprehensive examination of alternative on-airport and off-airport locations for the South End Development. In 2005 these efforts received favorable review from the FAA, Vermont Agency of Natural Resources and the U.S. Army Corps of Engineers through the issuance of Finding of No Significant Impact (FONSI) and agency Section 401/404 wetland disturbance permits as the result of a comprehensive Environmental Assessment. The existing business/general aviation facilities located near the commercial terminal facility will presumably be removed in the future and the area used in a more compatible manner with the commercial terminal.

3.10.1 Apron

The consolidated business/general aviation facilities in the South End should provide adequate space for apron tie-downs for both based and transient aircraft. Apron tie-down positions are typically provided for Group I (wingspans less than 49-feet) and Group II (wingspans less than 79-feet) aircraft owners who choose not to house their aircraft in a t-hangar. Additionally, hardstand positions should also be provided for transient Group II and Group III aircraft near the planned FBO/Corporate Jet Center. The number of apron tie-downs is based on providing space for:

- 20-percent of based single-engine aircraft;
- 100-percent of transient turbo-props, turbojets and helicopters.
  - 60-percent of transient tie-down space allocated for single-engine aircraft;
  - 18-percent of transient tie-down space allocated for multi-engine aircraft, and;
  - 22-percent of transient tie-down space allocated for turbo-prop/turbo-jet aircraft.

Applying these assumptions to the forecasted fleet mix presented in **Figure 2.21**, the number of apron tie-down positions required totals approximately 21 in 2008 which increases to 25 by the end of the planning horizon. Based and transient Group I aircraft will initially require 17 tie-down positions and are forecasted to require 19 positions by the end of the planning horizon (see **Figure 3.20**). As of January 2009 there were 22 apron tie-downs at BTV.

Figure 3.20: Apron Tie-Down Requirements by Planning Phase and Aircraft Type

Forecast Year	Based Population	Transient Population			Total Tie-Downs
	SE (Group I)	SE (Group I)	ME (Group II)	TP/TJ (Group III)	
2008	10	7	2	2	21
2010	10	7	2	2	21
2015	10	7	2	3	22
2020	11	7	2	3	23
2025	11	8	2	3	24
2030	11	8	3	3	25

3.10.2 Executive (60 x 60) Hangars

A percentage of based aircraft owners prefer to store their aircraft in executive hangars. These hangars are typically 60-feet by 60-feet in length and usually store multi-engine piston driven aircraft that are too large to be stored in traditional t-hangar units. To provide for an adequate number of executive hangars, the following planning factors were applied to the approved forecast of based aircraft:

- 3-percent of based single-engine aircraft;
- 40-percent of based multi-engine/turbo prop aircraft.

Based on these facility planning factors and the forecasted based aircraft fleet mix presented in **Figure 2.21,** the initial facility requirement for executive hangar space is approximately 6 units (21,600 square feet). This is anticipated to remain constant throughout the planning horizon. This stagnant demand for executive hangars is in line with the national trend of declining growth rates of the number of multi-engine pistons in the national fleet (the FAA Aerospace Forecast FY 2008-2025 projects the number of multi-engine pistons to decrease by an average annual rate of 0.05% through 2025.) It should be noted that other than the Alert hangars the airport currently has no executive hangars.[i] The Alert Hangars are to be demolished as part of the South End Development. As such the airport should anticipate the demand for 6 new executive hangars over the planning horizon.

3.10.3 Corporate Hangars

The larger and more sophisticated aircraft types (large twins, turboprops, turbojets and helicopters) are usually stored in more traditional group hangars. Typical dimensions are 100-feet deep and 100- to 200-feet wide (10,000 square feet to 20,000 square feet). Door heights on the large corporate hangars are typically 30-feet to allow for sufficient tail clearance for the larger corporate aircraft. Typical turbo-prop and turbo-jet aircraft have 90-foot wingspans and are around 70-feet in length. To provide for an adequate size hangar that can accommodate aircraft and maintenance activity, the following space factors were considered:

- Multi-engine (i.e., Beech King Air 350): 7,500 square feet each
- Turbojet (i.e., Gulfstream 550): 7,500 square feet each
- Helicopters (i.e., Robinson): 4,000 square feet each
- Office space: 20-percent of total open hangar space

Based on these facility planning factors and the forecasted multi-engine, turbojet and helicopter based aircraft figures presented in **Figure 2.21**, the initial facility requirement for large corporate hangar space is 135,300 square feet. This is anticipated to increase to 298,680 square feet by the end of the planning horizon. Assuming an average hangar size of approximately 30,000 square feet, the preferred development plan for BTV should provide

[i] Source: Campbell & Paris, 2006

space for approximately ten (10) large corporate hangars. Similar to the t-hangar and small corporate hangar facility requirements, the development plan should provide space to allow for additional large corporate hangar space that may be required beyond the current planning horizon. The results of the corporate hangar analysis are summarized in **Figure 3.21**.

The South End Development Plan for BTV provides for a 60,000 square foot corporate jet center and a 32,000 square foot corporate hangar near the consolidated cargo facilities. The 92,000 square feet of corporate hangar space in the SED LEDPA is not sufficient to accommodate demand over the planning period. In order to meet demand for just 2008, the airport will need 43,000 additional square feet of corporate hangar space; and in order to meet demand projected for 2030, the airport must provide an additional 207,000 square feet of corporate hangar space. Currently the airport has 174,000-sf of corporate hangar space available.

Figure 3.21: Corporate Hangar Requirements By Planning Phase

Forecast Year	Total Aircraft Stored	Open Hangar Space (SF)	Office Space (SF)	Total Hangar Space (SF)	Total Hangar Buildings (@30,000 sf/ea)
2008	16	112,750	22,550	**135,300**	5
2010	17	120,400	24,080	**144,480**	5
2015	20	143,050	28,610	**171,660**	6
2020	22	161,950	32,390	**194,340**	6
2025	28	203,750	40,750	**244,500**	8
2030	34	248,900	49,780	**298,680**	10

Source: Campbell and Paris, 2009

3.10.4 Maintenance Hangars

Maintenance space requirements were based on the frequency of maintenance activities required for the different types of aircraft. The small and infrequently used recreational aircraft (typically the single-engine aircraft) may only require a few days of maintenance each year. The corporate turbo-prop and turbojets, however, may need several days of "cycle maintenance" each month. The assumptions to generate the maintenance space requirements are presented below.

- Based single-engine aircraft need maintenance space **5** days per year for annual inspection/routine maintenance;
- Based multi-engine aircraft need maintenance space **12** days per year for annual inspection/routine maintenance/Part 135 (100 hour) maintenance;

- Based turbo-props, turbojets and helicopters need maintenance space 5 days per month for cycle maintenance/Part 135 (100 hour)/routine maintenance;
- All space requirements equal two times the storage factors
- 80-percent of based aircraft will have maintenance performed on airport;
- Based aircraft requirements are increased 20-percent to accommodate transient demands;
- Total square footage is increase by 20-percent to provide general office space.

Based on these assumptions, total forecasted based aircraft at BTV would initially require 1,160 days per year of maintenance, which is anticipated to increase to 2,048 days per year of on-airport maintenance by the end of the planning period. Maintenance space should be provided to accommodate 6 to 10 based aircraft per day, which would require between 68,000 square feet and 127,000 square feet. Recognizing that some transient aircraft would require maintenance, the required space for based aircraft was increased by 20-percent to an initial total of 82,000 square feet of maintenance hangar space which would increase to 152,000 square feet by the end of the planning horizon. Office space and "lean-to" space in the maintenance hangar would add an additional 20-percent to the total open bay hangar space. Thus, the initial maintenance building square footage is anticipated to total 98,400 square feet which increases to 182,300 square feet by the end of the planning horizon.

3.10.5 T-Hangars

T-hangar facilities requirements were generated on the basis of providing units for at least 75-percent of the based single-engine and 10-percent of the based turbo-prop/multi-engine aircraft. Typically, t-hangars consist of approximately 8 to 10 1,200 square foot units with door openings of 45-feet to 48-feet, which accommodates virtually all Group I aircraft in the active business/general aviation fleet. The demand for t-hangar units is generally dependent upon the climate of the region and the rental rate of a t-hangar. Typically, harsher climates (i.e., hot and cold regions of the country) have higher demand as the protection afforded by a t-hangar unit is more desirable. In addition, the cheaper cost makes the t-hangar attractive to an aircraft owner.

Considering the harsh winter climate in Northern Vermont, the facility requirements for t-hangars was based on a 75/10 demand factor, which recognizes that owners of multi-engine aircraft may choose to place their aircraft in smaller executive hangars (i.e., 60-foot x 60-foot hangars) or in a larger group hangar.

The application of the 75/10 demand factor results in the need for 39 t-hangars in the short-term planning period. The short-term need is anticipated to increase over the planning horizon as the based single-engine population increases. The demand for additional t-hangar units is anticipated to total 43 units by the end of the planning horizon. Assuming 10-units per building, the airport should plan for 5 buildings over the planning horizon.

3.10.6 Support Facilities

Automobile parking positions that should be provided in the business/general aviation complex is based on the following assumptions:

- 1 parking space for each 1,000 square feet of storage and maintenance space;
- 1 parking space for each 300 square feet of office support space;
- 1 space per t-hangar and apron tie-down position.

Applying these assumptions to the forecasted hangars, aircraft storage and maintenance spaces results in an initial parking need of approximately 420 parking spaces which is anticipated to increase to 772 spaces by the end of the planning horizon (see **Figure 3.22**). Spaces should be provided near the t-hangar units and tie-down aprons with pedestrian access to the apron through a pedestrian gate. Spaces should also be provided adjacent to the FBO/Corporate Jet Center and corporate/maintenance hangars.

Figure 3.22: Automobile Parking Requirements

Forecast Year	Exec./Corporate/ Maintenance Hangar Space (SF)	Office Space (SF)	Required Office Spaces	T-Hangar Unit Spaces	Apron Tie-Down Spaces		Total Parking Spaces
					Transient	Based	
2008	216,365	43,273	144	39	11	10	**420**
2010	228,123	45,625	152	39	11	10	**441**
2015	262,912	52,582	175	40	12	10	**500**
2020	289,935	57,987	193	41	12	11	**546**
2025	353,104	70,621	235	42	13	11	**655**
2030	422,438	84,488	282	43	14	11	**772**

Source: Campbell and Paris, 2009

Figure 3.23: General Aviation Demand/Capacity Assumptions

Assumption Category	Assumption/Assumption Value	
1. Transient Operations	Percentage of transient operations	15%
2. T-hangar demand for based aircraft	Single-engine (SE)	75%
	Multi-engine (ME)/Turbo-Prop (TP)	10%
	#T-Hangar Buildings (10-units per building)	4
3. Conventional 60 x 60 Executive hangar demand for based aircraft	SE	3%
	Turbo-prop (includes ME)	40%
4. Conventional large Corporate hangar demand for based aircraft	Single-engine	2%
	Turbo-prop (includes ME)	50%
	Turbo-jet	100%
	Helicopter	100%
	Square-footage of hangars for ME, TJ	7,500-sf
	Square-footage of hangars for Helicopters	4,000-sf
5. Maintenance hangar space demand	Based SE need maintenance space 5 days/year for annual inspections/routine maintenance	80%
	Based TP (includes ME) need maintenance space 12 days/year for annual inspections/routine maintenance/Part 135 (100-hour)	80%
	Based turbojet and helicopter need maintenance space five days/month (60 days/year)	80%
	Based aircraft demand increase for transient demand	20%
	Hangar space requirements increase for office space	20%
	260 maintenance days/year (5-day work week)	
5. Tie-down apron demand for based aircraft (nested parking)	Based Single Engine	20%
	Transient TP, TJ, and Helicopters	100%
	Transient SE	60% of transient space
	Transient ME	18% of transient space
	Transient TP/TJ	22% of transient space
6. Office Support Space	Percentage of office support space of conventional hangar space demand	20%
7. Auto parking requirements	One space per 1,000 sf of storage and maintenance space	
	One space per 300 square feet of office support space	
	One space per t-hangar and apron tie-down position	

Figure 3.24: Demand/Capacity & Facility Requirements

	Existing 2008			2010		2015		2020		2025		2030	
	Existing	Demand	Need	Demand	Need	Demand	Need	Demand	Need	Demand	Need	Demand	Need
T-Hangar Units*	24	39	15	39	15	40	16	41	17	42	18	43	19
60 x 60 Executive Hangar Units**	0	6	6	6	6	6	6	6	6	6	6	6	6
Large Corporate Hangar Units***	6	5	(1)	5	(1)	6	0	6	0	8	2	10	4
Subtotal Hangar Units	30	50	20	50	20	52	22	53	23	56	26	59	29
Subtotal Hangar Space (SF)	179,500	**139,150**	(40,350)	**146,800**	(32,700)	**169,450**	(10,050)	**188,350**	8,850	**231,350**	51,850	**276,500**	97,000
Apron Tie-Downs	22	21	(1)	21	(1)	22	0	23	1	24	2	25	3
Total Spaces/Units	52	71	19	71	19	74	22	76	24	80	28	84	32
Maintenance Hangar Units	2	3	1	3	1	4	2	4	2	5	3	6	4
Maintenance Hangar Space (SF) (includes transient)	66,000	**82,015**	16,015	**86,123**	20,123	**98,262**	32,262	**106,385**	40,385	**127,784**	61,784	**151,938**	85,938
Executive Hangar Office Space (SF)	4,600	4,320	280	4,320	280	4,320	280	4,320	280	4,320	280	4,320	280
Corporate Hangar Office Space (SF)	29,400	22,550	(6,850)	24,080	(5,320)	28,610	(790)	32,390	2,990	40,750	11,350	49,780	20,380
Maintenance Hangar Office Space (SF)	13,200	16,403	3,203	17,225	4,025	19,652	6,452	21,277	8,077	25,551	12,351	30,388	17,188
Total Office Space	47,200	**43,273**	(3,927)	**45,625**	(1,575)	**52,582**	5,382	**57,987**	10,787	**70,621**	23,421	**84,488**	37,288
Hangar Parking Spaces (Exec, Corp, Maint)	72	216	**144**	228	**156**	263	**191**	290	**218**	353	**281**	422	**350**
Office Parking Spaces	157	144	**(13)**	152	**(5)**	175	**18**	193	**36**	235	**78**	282	**125**
T-Hangar Unit Parking Spaces	24	39	**15**	39	**15**	40	**16**	41	**17**	42	**18**	43	**19**
Apron Tie-Down Parking Spaces	22	21	**(1)**	21	**(1)**	22	**0**	22	**0**	24	**2**	25	**3**
Total Auto Parking Spaces (GA)	275	**420**	145	**441**	165	**500**	225	**546**	271	**655**	379	**772**	497
Terminal Building (SF)	139,666	**216,434**	76,768	**222,535**	82,869	**256,167**	116,501	**295,620**	155,954	**341,825**	202,159	**395,854**	256,188
Fuel Storage (10-day supply)	72,000	240,201	168,201	245,790	173,790	310,421	238,421	337,580	265,580	367,509	295,509	412,799	340,799
AvGas (gallons)	12,000	2,956	(9,044)	3,023	(8,977)	2,989	(9,011)	2,979	(9,021)	3,152	(8,848)	3,209	(8,791)
Jet-A (gallons)	60,000	237,245	177,245	242,767	182,767	307,432	247,432	334,601	274,601	364,357	304,357	409,590	349,590

*Buildings #17 (Hexagon Hangars) and #25 are each assumed to have 12 t-hangar units.

**While Building #19 (Alert Hangars) is considered Executive, it was not included in "Existing" because it will be demolished during SED-area construction.

***Buildings #6, 9, 14, 15, and 16 are considered to be Corporate hangars. Their total square footage was divided by 30,000-sf to determine the number of "units.

3.11 AIRCRAFT RESCUE AND FIRE FIGHTING REQUIREMENTS

Requirements for Aircraft Rescue and Firefighting (ARFF) facilities are determined through the ARFF Index of the airport. The number of daily aircraft operations by aircraft length determines the appropriate ARFF Index for an airport:

- Index A aircraft have total lengths less than 90-feet;
- Index B aircraft have total lengths between 90-feet and 126-feet;
- Index C aircraft have total lengths between 126-feet and 159-feet;
- Index D aircraft have total lengths between 159-feet and 200-feet, and;
- Index E aircraft have total lengths greater than 200-feet.

The ARFF Index is typically determined by the index group of aircraft that conducts more than 5 daily departures at the airport. If the airport has aircraft in more than one index group conducting 5 or greater daily departures, then the ARFF index is determined by the most critical (i.e., the longest aircraft) conducting 5 daily departures. Based on the March 2009 airline schedule, BTV had 21 daily CRJ-200 departures (an Index A aircraft) and 21 daily DH8 departures (an Index B aircraft). Thus, the ARFF Index for BTV is Index B. This index is not expected to change as the types of aircraft anticipated to use BTV are Index B or lower. As of 2006, Index C aircraft may use the airport (i.e., B757) but not at a frequency to support moving to Index C.

The future index rating for the airport is anticipated to remain at Index B, which requires the following ARFF Equipment:

- One vehicle carrying at least 500 pounds of sodium-based dry chemical, halon 1211, or clean agent and 1,500 gallons of water and the commensurate quantity of ARFF for foam production, or;
- Two vehicles, one carrying 500 pounds of sodium based dry chemical, halon 1211, or clean agent or 450 pounds of potassium-based dry chemical and water with a commensurate quantity of AFFF to total 100 gallons of simultaneous dry chemical and AFFF application. The second vehicle would carry an amount of water and commensurate AFFF so the total quantify of water for foam production carried by both vehicles is at least 1,500 gallons.

3.12 FUEL STORAGE REQUIREMENTS

Fuel storage requirements for the anticipated level of activity at BTV used the methodology from the 2006 ALP prepared by Campbell and Paris. The data contained in the 2006 document was updated to reflect the change in aircraft types serving the airport and any variations in fuel consumption. Fuel consumption data and aircraft utilization (i.e. average flight hours) from the FAA Aerospace Forecast FY 2008-2025 was used. Additionally, the fuel storage requirements for non-business/general aviation activity used the March 2009 airline schedule and the following assumptions:

- All cargo aircraft will require 80-percent fuel;
- Commercial operations over 1,500 nautical miles will require 80-percent fuel;
- 10% of all commercial aircraft will take-on fuel while at BTV;
- Fuel storage system should have enough capacity for a 10-day reserve.

Based on these demand assumptions, and the forecasted operations by aircraft type used to determine total commercial, cargo and business/general aviation operations; an estimated level of fuel storage capacity can be determined. Average daily demand for JetA is anticipated to reach approximately 40,959 gallons by 2030, which equates to 10-day storage of 409,590 gallons of JetA storage capacity. The demand for AvGas is anticipated to grow to 321 gallons per day during the planning horizon. This results in a ten day AvGas storage capacity of approximately 3,210-gallons.

This methodology estimated a 10-day storage requirement for Jet-A of 237,245 gallons in 2008. This forecast is in line with actual 2008 Jet-A sales at the airport, which totaled 9,612,772 gallons. This breaks down to an approximate 10-day storage requirement of 263,364 gallons.

As of 2009, the airport has the capacity to store 60,000 gallons of Jet-A fuel (in three, 20,000-gallon
tanks) and 12,000 gallons of AvGas (in one tank).

Figure 3.25. BTV Fuel Storage Requirements (2030)

Based aircraft Av-Gas usage/10-days (2030)	**3,210**
Based aircraft Jet-A usage/10-days (2030)	42,886
Commercial aircraft Jet-A usage/10-days (2030)	219,792
Cargo aircraft Jet-A usage/10-days (2030)	146,912
TOTAL Jet-A Usage/10-days (2030)	**409,590**

3.13 OTHER AIRFIELD CONSIDERATIONS

3.13.1 Remote Aircraft De-Icing

Remote aircraft de-icing locations are required to meet design, safety and environmental needs. Aircraft de-icing is currently conducted on the terminal apron prior to aircraft taxiing to the departure runway threshold. Separate studies are currently examining the size, orientation and location of remote de-icing pads placed near the Runway 15 and Runway 33 thresholds- specifically, the approved 2006 ALP drawing depicts a potential future de-ice/hold pad on the western end of Taxiway Golf planned for Phase II construction (within 6-10 years); and a potential de-ice/hold area near the intersection of Taxiways Golf and Charlie. The preferred development plan for the airport will include any recommendations resulting from the remote de-icing study as well as any conclusions reached during **Chapter Four**, **Alternative Development Plans.**

In any case, the pad will need to factor in cargo and business/general aviation de-icing demand. Based on the existing flight schedule and forecasted operation levels, the remote de-icing pads should initially be constructed to accommodate two aircraft parking positions (for at least Group III wingspan) with the possibility of expanding to three aircraft parking positions.

3.13.2 FAA Air Traffic Control Tower and Flight Service Stations

The location of the existing Federal Aviation Administration Air Traffic Control Tower (ATCT) and Flight Service Station (FSS) near the existing commercial terminal building restricts the expansion of the terminal area. The ATCT/FSS occupies valuable airside space though direct airside access is not required. Future terminal expansion will likely occur toward the south end of the terminal to avoid re-location of the ATCT/FSS facility.

3.14 OTHER LANDSIDE CONSIDERATIONS

3.14.1 Potential Hotel

A Hotel Feasibility Study was conducted in June 2009 to explore the possibility of constructing a hotel in the 1.8-acre site northwest of the terminal building, next to the existing parking garage. The analysis concluded that, while a hotel in that area could be financially successful, there may be a higher and better use for this site, and that a hotel would be hard to justify in the space-constrained environment.

If the Airport Authority believes that a hotel would have extrinsic benefits, such as making the airport more attractive to visitors, then the report offers guidance on schematic-level design efforts in order to integrate the hotel to the terminal building and existing parking garage. See **Appendix E** for the Hotel Feasibility Study in its entirety.

3.14.2 Potential Landside/Airside Support Development

An approximately 157,000-square foot area below the Runway 15 end (under the proposed de-ice/hold pad) has been dedicated for future landside/airside support development. Possible uses for this area include a rental car wash facility or an employee parking area. Automobile access to this area will be facilitated by the development of the newly realigned Airport Parkway.