YEAGER AIRPORT

AIRFIELD MASTER PLAN

Final - July 2020

L&B TEAM

YEAGER AIRPORT

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Introduction

Yeager Airport (CRW) is owned and operated by the Central West Virginia Regional Airport Authority (CWVRAA). The Airport opened for commercial service in 1947 and has since played a vital role in the region and the state by providing access to the world economy through four major airlines and a booming general aviation facility with U.S. Customs facilities. In addition, CRW serves as a base for the West Virginia Air National Guard's 130th Airlift Wing. CRW, known as "West Virginia's Gateway," is West Virginia's largest and busiest airport, and generates over $174 million per year in economic impact to the state.[1]

In 2015, CRW experienced a catastrophic failure of a mechanically stabilized earth retention structure on the Runway 05 end. The slope failure destroyed the Engineered Materials Arresting System (EMAS), resulting in a decrease in Runway Safety Area (RSA) length, reductions in the declared distances for the runway, and the loss of vertical guidance. Operations at the Airport declined, some flights had to take weight penalties on certain destinations, and some airlines refused to initiate service at CRW due to the limited runway length available.

In order to address this issue, the CWVRAA conducted the 2017 Interim Runway Safety Area Study (2017 RSA Study) with the goal of identifying an interim solution to quickly improve safety and restore some of the lost operational capabilities. This $25 million solution was implemented in July 2019 and involved the construction of a retaining wall and new EMAS on Runway 05. It provided a tremendous improvement for the users of CRW; however, additional upgrades are still needed in order to fully meet Federal Aviation Administration (FAA) safety standards and provide the runway length the airlines need.

As a result, CWVRAA embarked on an Airfield Master Plan with a focus on future opportunities. The Master Plan has two primary goals: (1) provide an RSA that fully complies with FAA requirements and (2) meet the short- and long-term runway length needs of the users of the Airport. This technical report outlines the analysis and recommendations of the Airfield Master Plan and is organized as follows:

- Chapter 1, Inventory
- Chapter 2, Aviation Demand Forecast
- Chapter 3, Requirements
- Chapter 4, Alternatives
- Chapter 5, Implementation Plan
- Chapter 6, Airport Layout Plans

The Master Plan forecasts that CRW will serve around 630,000 annual passengers and 47,000 annual operations by 2037. As air service continues to grow in the region, demand for new markets serving

1 *The Economic Impact of Yeager Airport*, Final Report, October 14, 2016.

CRW is anticipated over the next twenty years, including the return of service to Orlando, Dallas, and Detroit.

The improvements necessary to serve the 20-year demand forecast and meet FAA requirements include:

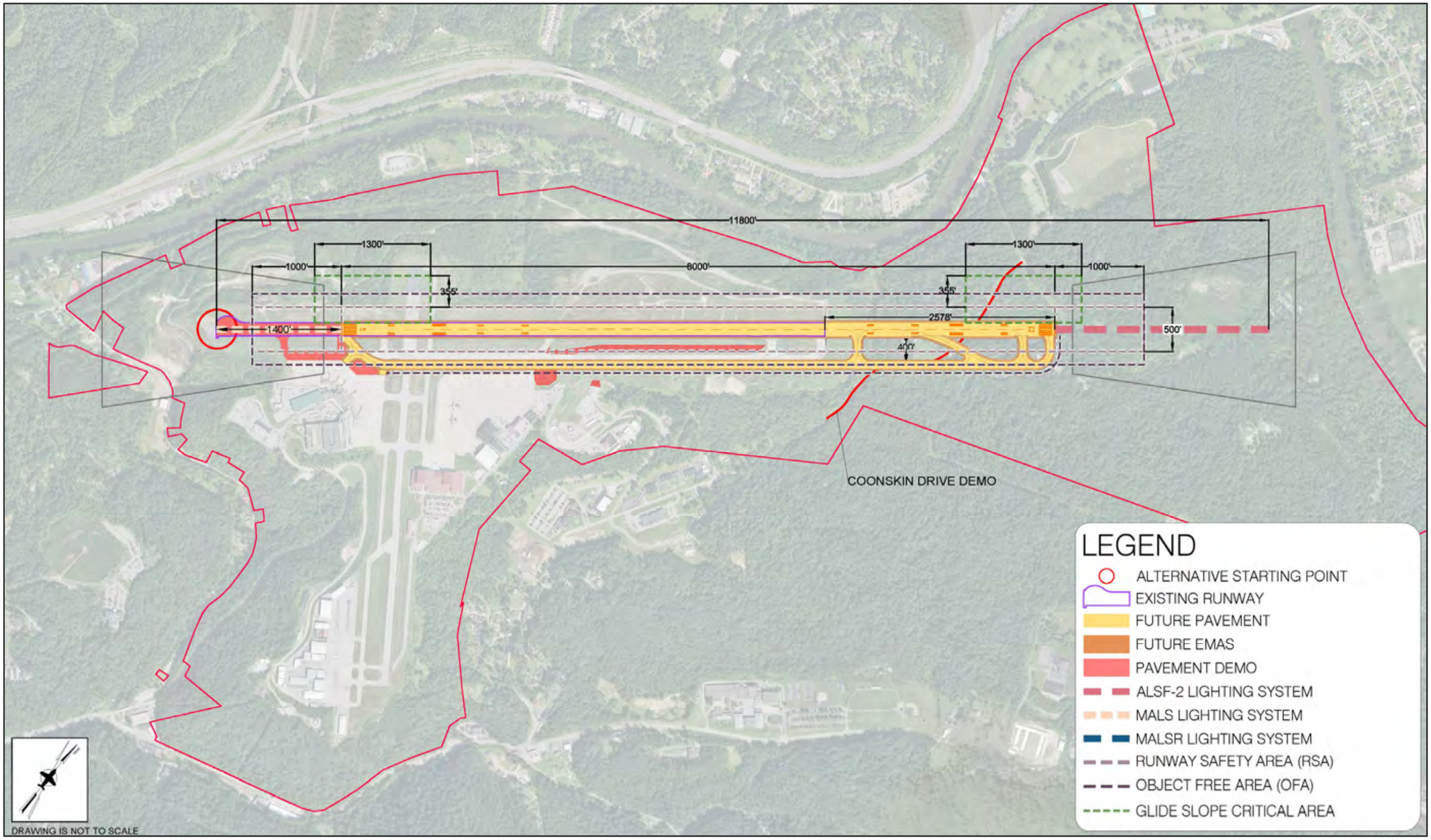
- Extend Runway 05-23 to 8,000 feet
- Provide standard RSA
- Improve approach lighting systems
- Increase separation between Runway 05-23 and its parallel taxiway

A total of 32 runway extension alternatives that meet these needs were developed as part of the Master Plan. These alternatives were evaluated based on a variety of factors including obstructions, Runway Protection Zone (RPZ) impacts, terminal impacts, construction phasing, navigational aid siting, grading requirements, and environmental and local impacts. The resulting recommended plan is shown on **Exhibit 1, *Recommended Development Plan***. This plan:

- Shifts Runway 05-23 to the east by 1,400 feet
- Extends Runway 05-23 to the east by 2,578 feet
- Provides a full-dimension RSA on both runway ends
- Provides a Category I Instrument Landing System (ILS) on the Runway 05 end
- Provides a Category II ILS on the Runway 05 end
- Relocates Taxiway A

While the Master Plan was underway, the FAA notified the Airport that the runway project needs to be completed in two phases. The first phase would focus on providing a standard RSA and meeting existing runway length needs, whereas the second phase would focus on meeting long-term needs. An RSA Study was completed in September of 2019 that identified the most appropriate way to meet the short-term needs. The preferred alternative from the August 2019 RSA Study is shown on **Exhibit 2, *Phase 1 RSA Project***. This Phase 1 project shifts Runway 05-23 to the east by 1,125 feet, extends Runway 05-23 to the east by 1,300 feet, and provides a full-dimension RSA on both runway ends.

EXHIBIT 1 RECOMMENDED DEVELOPMENT PLAN



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown and ADCI analysis.

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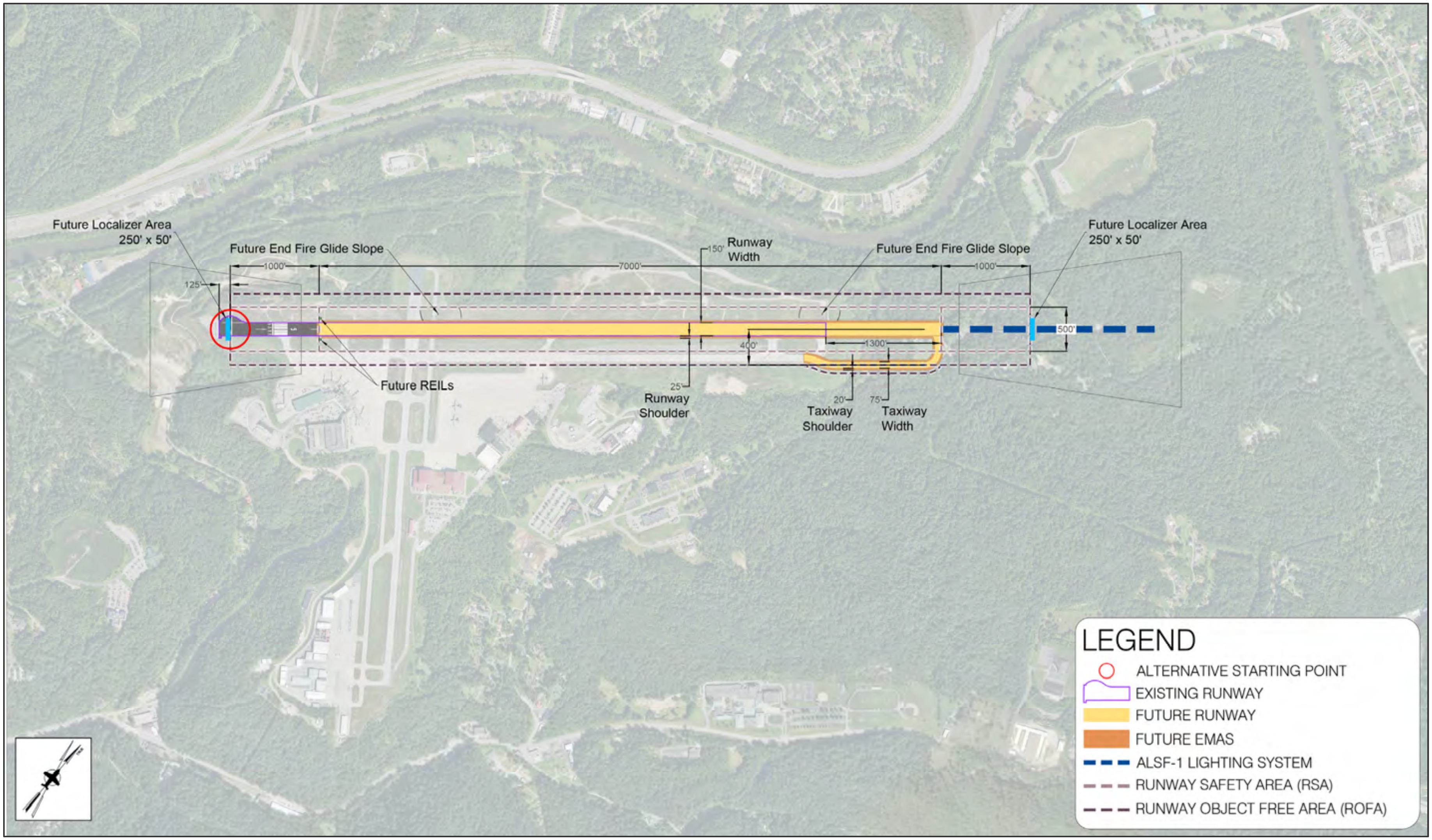
EXHIBIT 2 PHASE 1 – RSA PROJECT



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

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It was assumed that the environmental process for the Phase 1 project would begin in 2020. Mitigation and design would begin in 2022, with construction starting in 2023. The Phase 1 project would be complete in 2029. The cost of the Phase 1 project was estimated at $173 million in 2019 dollars, or about $209 million in current dollars. Of this total, $188 million was estimated to be eligible for federal funds. In addition, it was assumed that the West Virginia Department of Transportation (WVDOT) would fund $1.9 million and passenger facility charges (PFCs) would be used to fund $11 million, leaving $7.9 million to be funded from local Airport funds.

Next steps for the Phase 1 project include the initiation of the environmental process. The CWVRAA should also coordinate with the FAA regarding potential inclusion in the FAA Airports Capital Improvement Program (ACIP).

An environmental overview was completed as part of the September 2019 RSA Study. This overview found that the following National Environmental Policy Act (NEPA) categories may require additional investigation as a result of the Phase 1 project:

- Air quality
- Biological resources
- Climate
- Department of Transportation (DOT) Act Section 4(f) resources
- Hazardous materials, pollution prevention, and solid waste
- Land use
- Noise and noise-compatible land use
- Visual effects
- Surface waters

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1 Inventory

The first step in the airport master planning process is an inventory of existing conditions. This step involves gathering information about an airport and its environs. An inventory is essential to the success of a master plan because the information provides a foundation or starting point for subsequent analyses. The inventory data for Yeager Airport (CRW) was collected from a variety of sources including airport management, airport tenants, the master plan consulting team, and the Federal Aviation Administration (FAA).

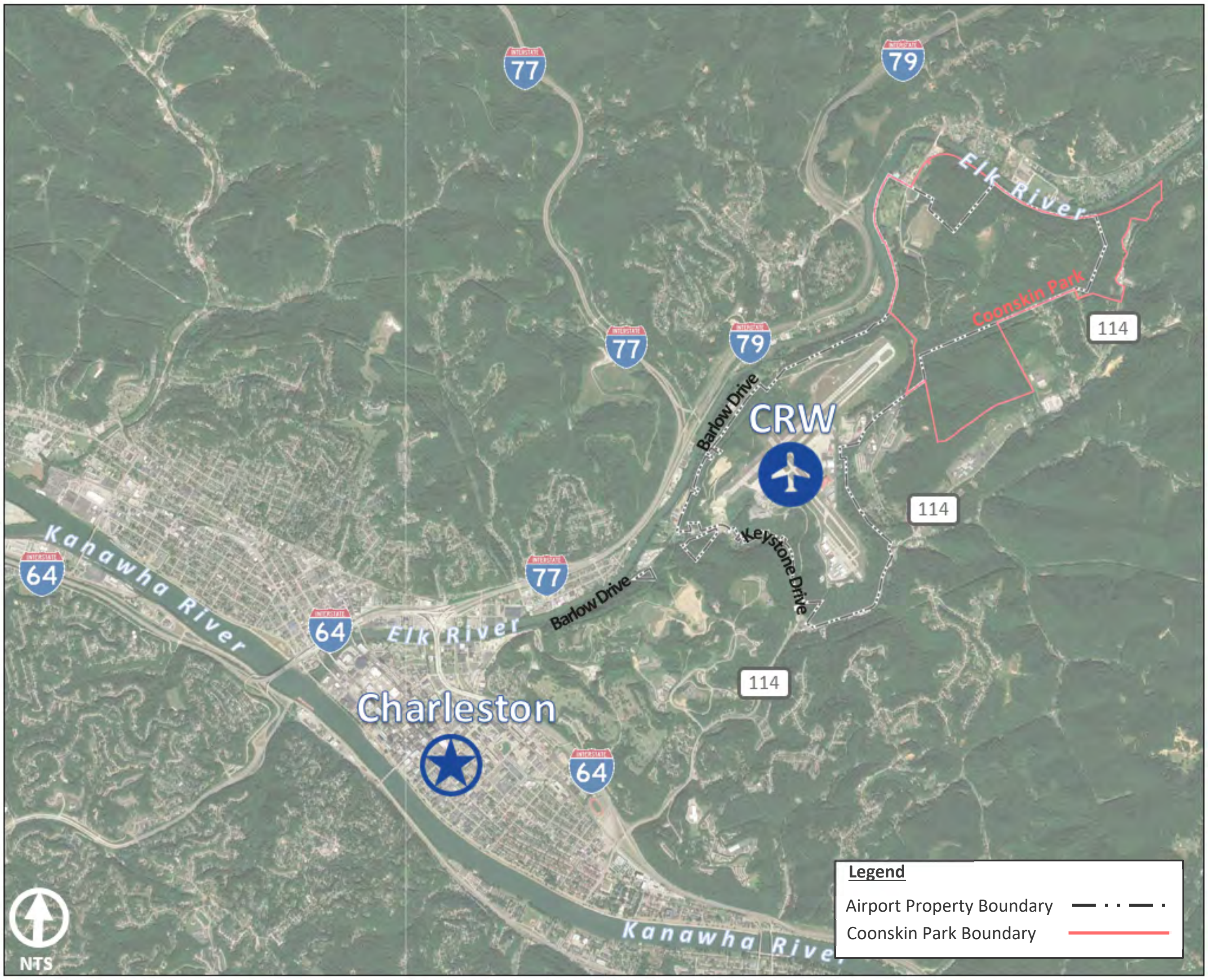
The objective of this chapter of the CRW Airfield Master Plan Update is to provide a summary of the information gathered in the inventory process and to provide a snapshot of Airport conditions in 2017. As such, this chapter provides a description of the Airport's location and setting, a discussion of the Airport's role, a brief history, a description of the local meteorological conditions, and CRW airfield amenities. Updates made to the airfield after November 2017 are not reflected in this inventory but will be taken into consideration in the airfield requirements analysis.

1.1 Airport Location and Setting

CRW is located in Kanawha County; about three nautical miles east of Charleston, West Virginia (see **Exhibit 1-1, *Airport Location Map***). The Airport sits on top of a hillside, at an elevation of 947.2 feet Above Mean Sea Level (AMSL). The Airport is bordered by the Elk River, Coonskin Park, West Virginia Route 114 (WV-114), and Keystone Drive. CRW encompasses about 1,266 acres.

Access to CRW is provided via three major interstates, which intersect less than five miles from the Airport. The combination of Interstate 64 (I-64), I-77, and I-74 provide excellent access to CRW from West Virginia's capital of Charleston and the surrounding area.

EXHIBIT 1-1 AIRPORT LOCATION MAP



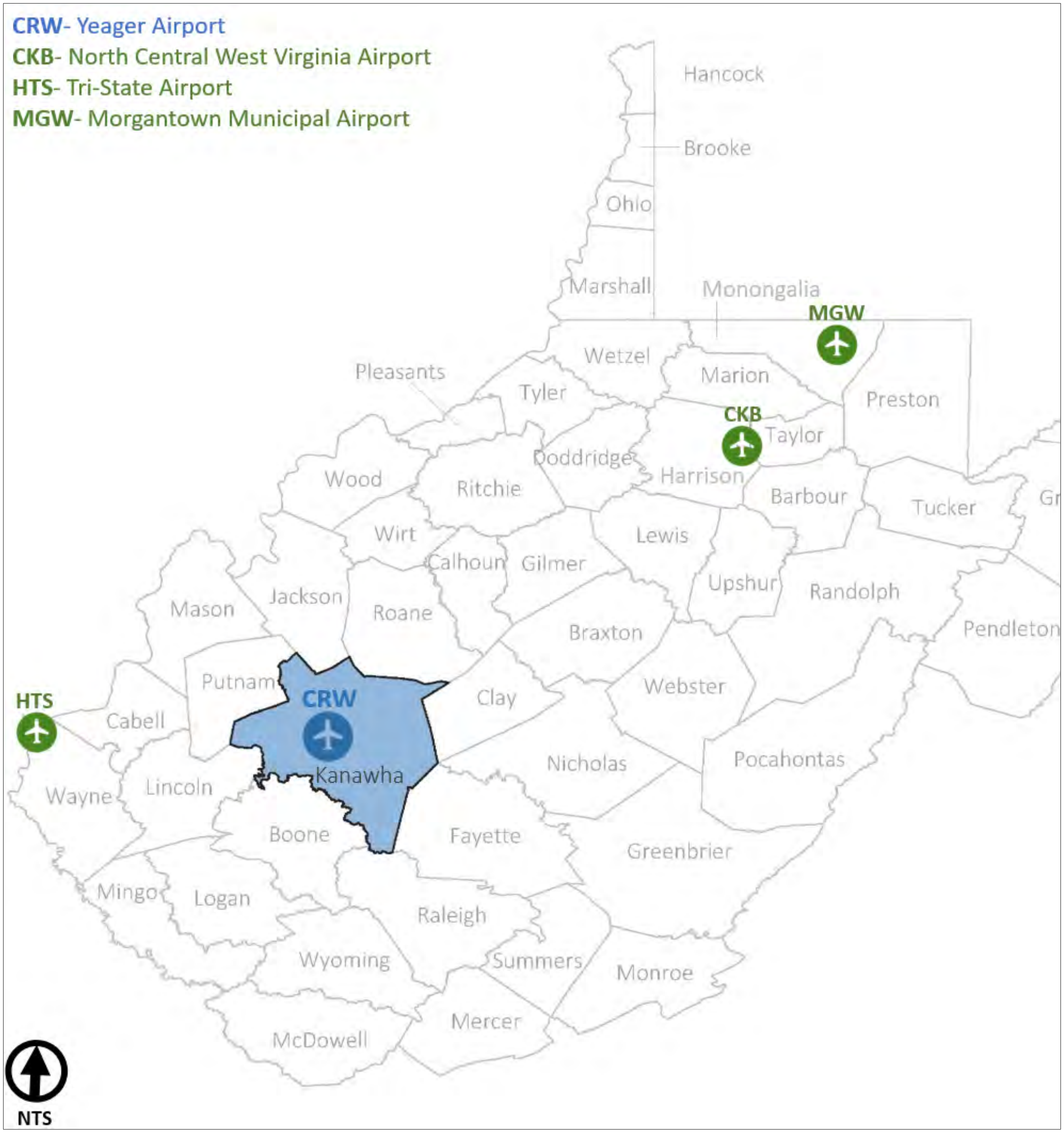
Source: Google Earth Pro, 2015; Landrum & Brown analysis.

1.2 Airport Role

The FAA develops the National Plan of Integrated Airport Systems (NPIAS) every five years. The NPIAS classifies public-use airports into two categories: Primary and Non-Primary. Primary airports are public airports with scheduled air carrier service that have 10,000 or more enplaned passengers per year. Primary airports are further categorized as Large, Medium, Small, and Nonhub by the level of passengers they serve. Non-Primary airports may have some commercial service, but are mainly used by general aviation aircraft.

According to the 2017-2021 NPIAS Report, Yeager is classified as a Nonhub Primary airport because it enplanes less than 0.05% of all commercial passenger enplanements but has more than 10,000 annual enplanements. As shown on **Exhibit 1-2**, ***West Virginia Airports***, the State of West Virginia has three other Nonhub Primary Airports – North Central West Virginia (CKB) near Clarksburg; Tri-State Airport (HTS) in Huntington; and Morgantown Municipal Airport (MGW) in Morgantown. CRW, “West Virginia’s Gateway,” is West Virginia’s busiest airport, with over 200,000 annual enplanements, outnumbering CKB, HTS, and MGW combined. In addition to the four Nonhub Primary airports in West Virginia, the state has 19 Non-Primary airports.

EXHIBIT 1-2 WEST VIRGINIA AIRPORTS



Source: West Virginia Broadband Mapping Program, 2009; Landrum & Brown analysis.

1.3 Airport Background and History

CRW is owned and operated by the Central West Virginia Regional Airport Authority (CWVRAA) and is governed by a 15-member board. The board is comprised of representatives from Kanawha, Putnam, Lincoln, Boone, and Nicholas Counties, as well as, the City of Charleston.

CRW is a joint use civil aviation/Air National Guard airport. It is served by four airlines (Delta Air Lines, American Airlines, United Airlines, and Spirit Airlines) with service to eight cities. In addition to the airline activity, CRW serves general aviation aircraft. General aviation includes such activity as recreational flying, flight training, for-hire charter activity, news reporting, environmental surveys, police patrols, and other non-commercial and non-military activities. CRW is also home to the West Virginia Air National Guard (WVANG) 130th Airlift Wing (130 AW). The WVANG operates C-130s at CRW.

Initial planning for the development of CRW began in 1937 as part of an effort to replace Charleston's first airport (Wertz Field), which was too limited to accommodate the larger passenger aircraft being flown by the air carriers at that time. Kanawha Airport (as CRW was originally known) opened in 1947 on a site known as "Coonskin Ridge," a series of hills near the City of Charleston. The construction of the Airport took over three years and involved moving over nine million tons of earth and rock. The Airport was renamed Yeager Airport in 1985 to honor Brigadier General Chuck Yeager.

1.4 Meteorological Conditions

Weather conditions play an important role in the operational capabilities of an airport. For example, temperature is a key factor in determining the length of runway required by aircraft for takeoffs and landings. In addition, wind speed and direction determine runway orientation and dictate the amount of time a runway can be in use. Periods of low visibility due to weather conditions such as fog or snow are a major factor in determining the need for navigational aids.

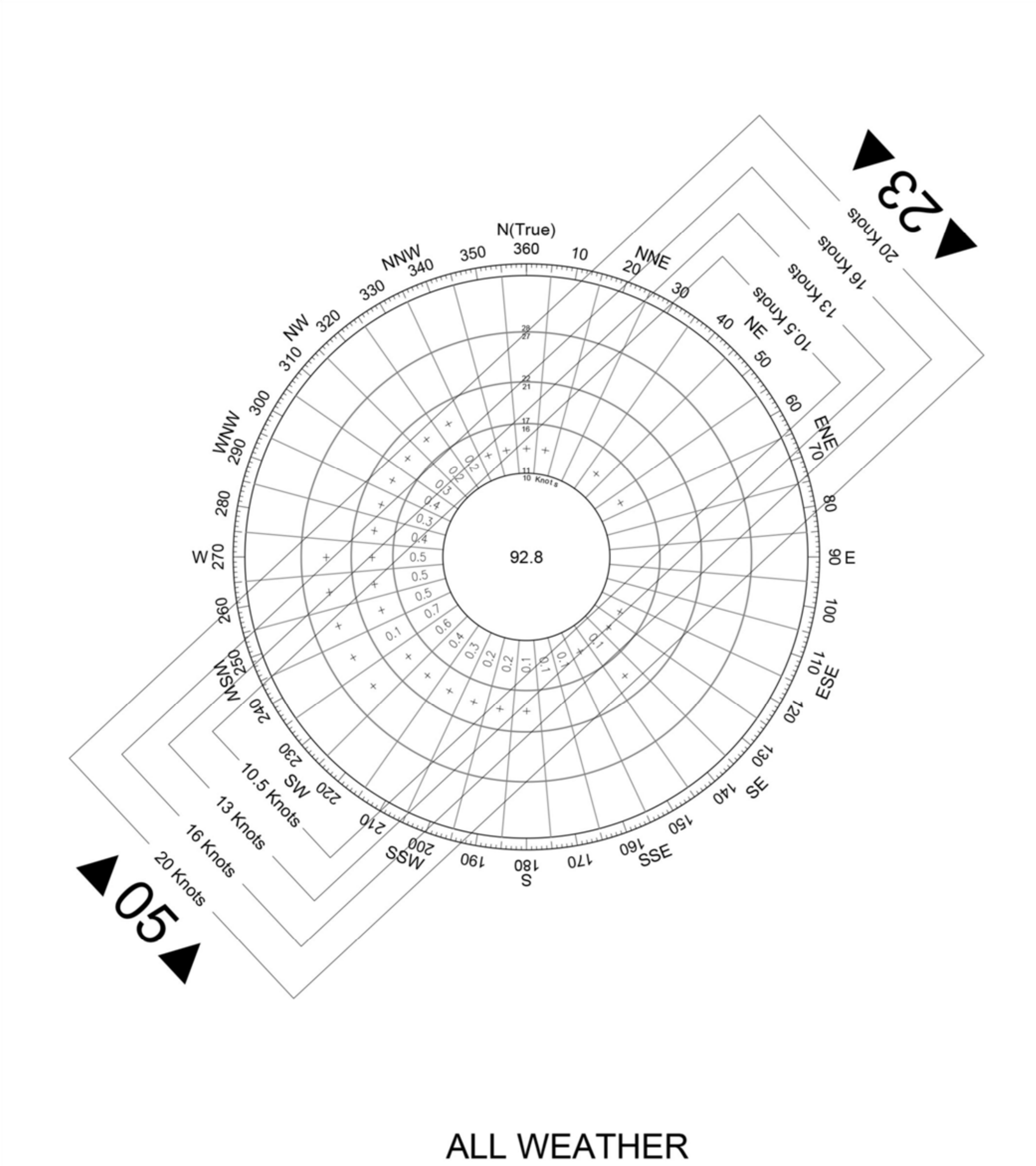
1.4.1 Temperature

Temperature data for Yeager Airport was obtained from the National Oceanic and Atmospheric Administration (NOAA) for the years 1981 to 2010. On average, July is the hottest month of the year with a mean daily maximum temperature of 85.6 degrees Fahrenheit.

1.4.2 Wind Direction and Speed

Wind, cloud ceiling, and visibility were obtained from the National Climactic Data Center (NCDC). The data are collected from the National Weather Service (NWS) station at CRW. Twelve years (1/1/2005 to 12/31/2016) of hourly weather data were used in this analysis. The direction and speed of prevailing winds are significant factors in the selection of runway orientation because aircraft land and depart into the wind. The analysis of the historical wind data reveals a propensity for the winds to occur from the south and southwest (see **Exhibit 1-3, *CRW Wind Rose***). This wind direction is consistent with the orientation of Runway 05-23 at CRW.

EXHIBIT 1-3 CRW WIND ROSE



Note: Calm winds are defined as zero to three knots.

Sources: National Climatic Data Center (NCDC) station WBAN 13866, data recorded at Yeager Airport (CRW) for the period 01/01/2005-12/31/2016; Landrum & Brown analysis.

Table 1-1, *Runway Coverage*, shows the percentage of time each individual runway direction provides coverage for each crosswind limit, based on the analysis. In addition, the column labeled "Total Runway Coverage" shows the total percent coverage provided by the two runway directions at CRW. Total runway coverage is defined as when at least one runway is available but not necessarily both. Both runway directions combined provide greater than 99% coverage, which exceeds FAA's requirements for wind coverage.

TABLE 1-1 RUNWAY COVERAGE

CROSSWIND LIMIT	RUNWAY 05	RUNWAY 23	TOTAL RUNWAY COVERAGE
10.5 knots	71.84%	89.27%	97.81%
13 knots	72.60%	90.72%	99.34%
16 knots	72.82%	91.14%	99.82%
20 knots	72.89%	91.27%	99.97%

Sources: National Climatic Data Center (NCDC) station WBAN 13866, data recorded at Yeager Airport (CRW) for the period 01/01/2005-12/31/2016; Landrum & Brown analysis.

1.4.3 Weather Conditions

Independent of wind direction, the cloud ceiling and visibility conditions at an airport determine the Air Traffic Control (ATC) procedures in effect. Cloud ceiling is the height above the earth's surface of the lowest layer of clouds not classified as "thin" or "partial." Visibility is the ability to see and identify prominent, unlighted objects by day and prominent lighted objects at night. Ceiling and visibility may vary with cloud conditions, fog, precipitation, and haze.

Visual Meteorological Conditions (VMC) exist when the cloud ceiling is at least 1,000 feet above ground level and the visibility is at least three miles. Weather conditions below VMC are defined as Instrument Meteorological Conditions (IMC). There are three different IMC categories – CAT I, II, and III. **Table 1-2, *IMC Categories***, describes the ceiling and visibility definitions for each category.

TABLE 1-2 IMC CATEGORIES

CATEGORY	MINIMA
CAT I	HAT or minimum descent altitude not lower than 200 feet and with either a visibility not less than ½ statute mile or an RVR not less than 1,800 feet
CAT II	HAT lower than 200 feet but not lower than 100 feet and an RVR not less than 1,200 feet
CAT III	HAT lower than 100 feet or no HAT and an RVR less than 1,200 feet

Source: FAA AC 150/5300-13A Change 1, *Airport Design*, Chapter 1, Paragraph 102, Subparagraphs S, T, and U.

Table 1-3, *Historical Weather Conditions*, shows the historical occurrence of weather conditions at CRW. According to the weather analysis, CRW is in VMC 89.32% of the time and in IMC for the remainder of the time (10.68%).

TABLE 1-3 HISTORICAL WEATHER CONDITIONS

CATEGORY	PERCENT OCCURRENCE
VMC	**89.32%**
IMC	**10.68%**
IMC CAT I	7.76%
IMC CAT II	2.26%
IMC CAT III	0.66%

Sources: National Climatic Data Center (NCDC) station WBAN 13866, data recorded at Yeager Airport (CRW) for the period 01/01/2005-12/31/2016; Landrum & Brown analysis.

1.4.4 Fog

Just north of the Runway 23 end is a large valley containing a creek, which stems from the Elk River. On clear nights, with relatively little to no wind present, fog forms in the valley, running perpendicular to the runway end as depicted in **Exhibit 1.4**, ***Runway 23 Fog***.

The fog can be one of two types, depending on thickness. Radiation fog occurs when the ground rapidly cools due to terrestrial radiation, and the surrounding temperature reaches its dew point. As the sun rises in the morning and the temperature increases, this type of fog will begin to dissipate. If the fog is less than 20 feet thick, it can also be known as ground fog.

EXHIBIT 1-4 RUNWAY 23 FOG

Source: Yeager Airport, 2017.

1.5 Airfield Facilities

Exhibit 1-5, *Existing Airport Facilities*, displays CRW's facilities, including the runway and taxiways, passenger terminal, as well as the WVANG and general aviation facilities. The airfield is the focus of this Master Plan. The airfield includes the runways, taxiways, all FAA airfield safety areas, airport lighting, and navigational aids.

1.5.1 Runways

CRW originally opened with two active runways, Runway 05-23 and 14-32 (later renamed 15-33). Runway 15-33 was closed in 2008 because it had a shorter length as compared to Runway 05-23; the cost of making the runway comply with more recent RSA standards; and to make room for additional general aviation hangar development and expansion of the WVANG apron. CRW currently operates exclusively on Runway 05-23, the sole runway on the airfield. The Runway 15-33 pavement is now used as a taxiway.

Runway 05-23 is 150 feet wide by 6,802 feet long. It is constructed of grooved asphalt and is considered to be in good condition. In 2007, a 400-foot by 175-foot EMAS[1] was installed on the Runway 05 end and declared distances[2] were applied to Runway 23 in order to provide improved RSAs at both ends of the runway. On March 12, 2015, a slope failure destroyed the Runway 05 RSA and EMAS. The EMAS was eight years old and sat atop an engineered fill of 1.5 million cubic yards. The slope failure caused a significant amount of damage to the EMAS, as well as the surrounding area.

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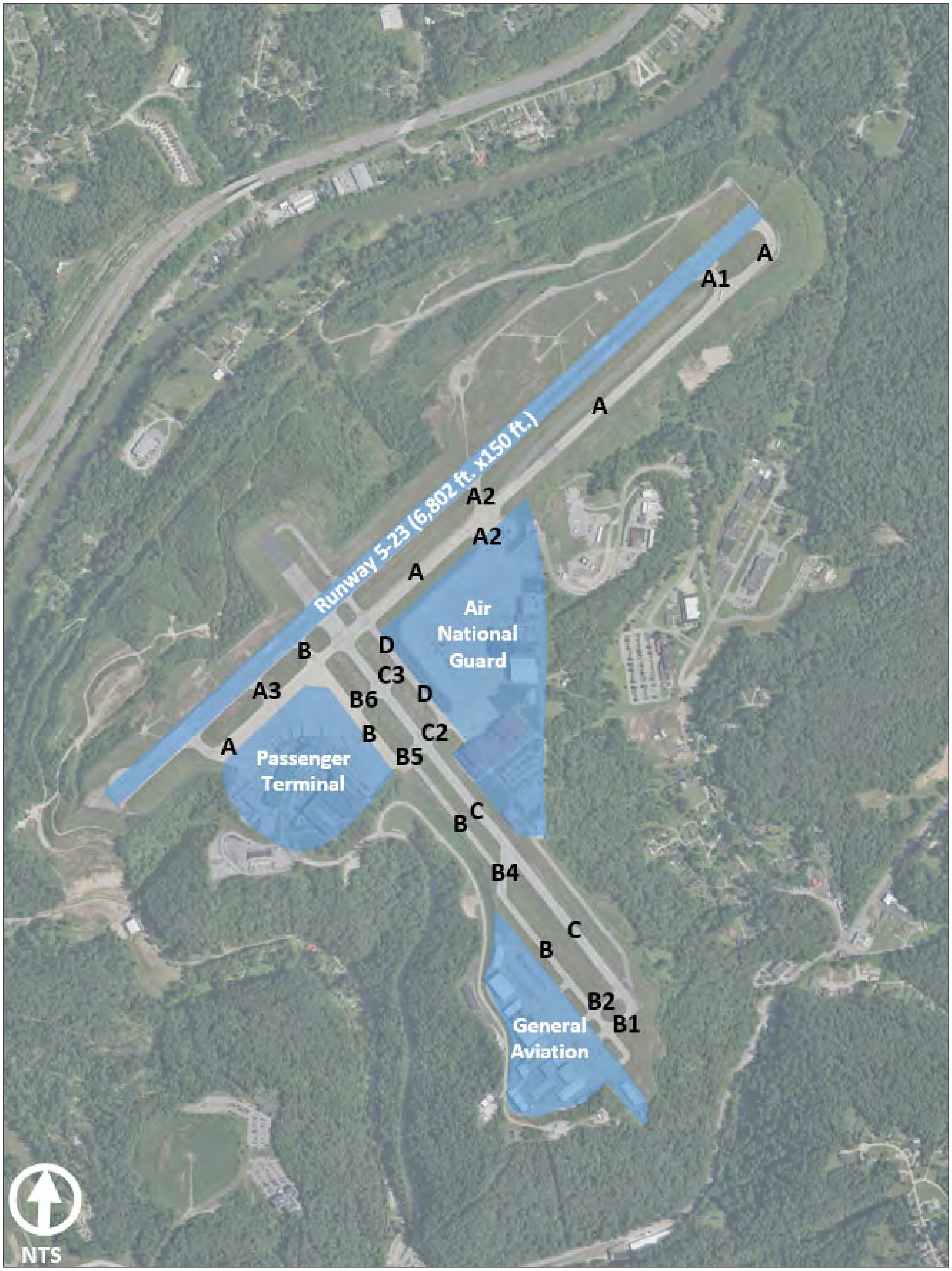
1 An EMAS uses crushable material, which is placed at the end of a runway to stop an aircraft overrun. The aircraft tires sink into the EMAS material, which forces the aircraft to decelerate. EMAS is provided for runways where it is not possible to have a 1,000-foot overrun area. According to FAA Advisory Circular 150/5300-13A, *Airport Design*, a standard EMAS provides an equivalent level of safety as a full-dimension RSA.

2 Per FAA Advisory Circular 150/5300-13A, *Airport Design*, declared distances are "the distances the airport operator declares available for a turbine powered aircraft's takeoff run, takeoff distance, accelerate-stop distance, and landing distance requirements."

EXHIBIT 1-5 EXISTING AIRPORT FACILITIES



Note: Reflects current conditions as of November 2017. Does not reflect the Runway 05 RSA project that is currently in design.

Sources: Quantum Spatial, 2017; Landrum & Brown analysis.

The loss of the EMAS resulted in the shortening of the usable lengths of Runway 05-23 by as much as 500 feet in both directions. **Table 1-4, *Existing Declared Distances***, displays the post-slope failure declared distances that were in place in 2017.

TABLE 1-4 EXISTING DECLARED DISTANCES

DECLARED DISTANCES	LENGTH (in feet)	
	RUNWAY 05	RUNWAY 23
TORA/TODA	6,802	6,802
LDA	5,725	5,802
ASDA	6,302	6,302

Notes: 1. TORA = Takeoff Run Available; TODA = Takeoff Distance Available; LDA = Landing Distance Available; ASDA = Accelerate-Stop Distance Available.
2. Does not reflect the Runway 05 RSA project that is currently in design.
Sources: FAA Airport Master Record Form 5010 for CRW; Landrum & Brown analysis.

The CWVRAA published the *Interim Runway Safety Area Study* in 2018 (2018 Interim RSA Study) to address the loss of the EMAS and the reduction in operational runway lengths. That study concluded that safety could be improved and the declared distances could be increased with the installation of a new EMAS on the Runway 05 end. **Table 1-5, *Proposed Declared Distances***, presents the declared distances that are expected to be in effect upon construction of the Runway 05 EMAS. Construction is expected to be complete by the end of 2018.

TABLE 1-5 PROPOSED DECLARED DISTANCES

DECLARED DISTANCES	LENGTH (in feet)	
	RUNWAY 05	RUNWAY 23
TORA/TODA	6,715	6,715
LDA	6,015	6,215
ASDA	6,215	6,715

Notes: TORA = Takeoff Run Available; TODA = Takeoff Distance Available; LDA = Landing Distance Available; ASDA = Accelerate-Stop Distance Available.
Sources: 2018 Interim Runway Safety Area Study; Landrum & Brown analysis.

1.5.2 Taxiways

Taxiways are paved areas that facilitate the movement of aircraft from one part of the airfield to another. One of the most important uses for a taxiway is to provide access between aircraft parking aprons and the runways. There are three types of taxiways: parallel, entrance/exit, and access. Taxiways that are parallel to runways generally provide a route for aircraft to reach the runway ends. Entrance/exit taxiways, which usually connect runways to parallel taxiways, provide paths for aircraft to enter the runway for departure or leave the runway after landing. Access taxiways provide a means for aircraft to move among the various airfield components such as parking aprons.

CRW's taxiways are illustrated in Exhibit 1-4 in Section 1.5*, Airfield Facilities*. Taxiway A serves as the parallel taxiway for Runway 05-23. Taxiway A extends from the Runway 23 end to approximately 700 feet from the Runway 05 end. Taxiways A3, B, C, D, A2, and A1 provide access between Taxiway A and the runway. Taxiways B and C are parallel taxiways that connect the general aviation apron to the rest of the airfield. Taxiways B, C, and D serve as parallel taxiways between the passenger terminal and the WVANG apron. There are also numerous other taxiways that provide access between parallel taxiways and parking aprons.

1.5.3 FAA Airfield Safety Areas

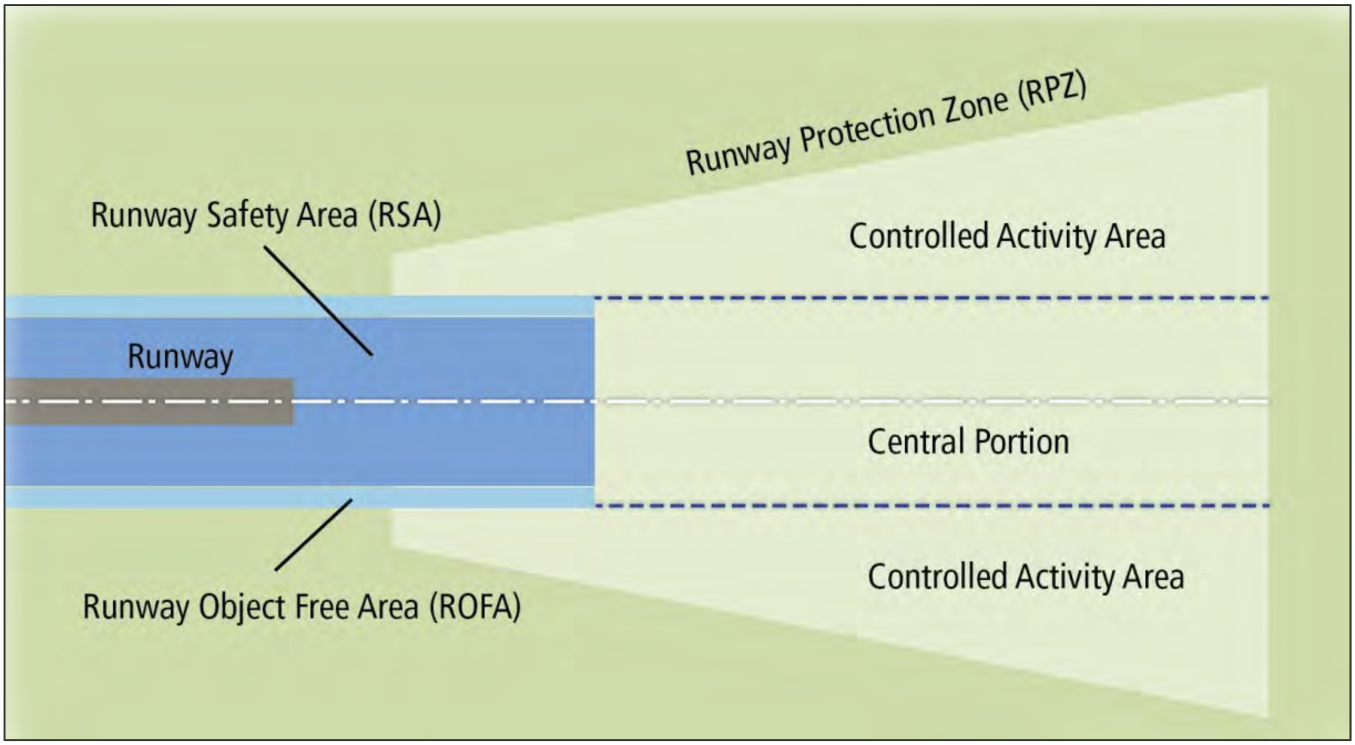
There are three key design standard requirements, referred to in this document as airfield safety areas, which have a direct relationship to the runway and taxiway system: (1) RSA, (2) Runway and Taxiway Object Free Area (OFA), and (3) Runway Protection Zone (RPZ). The size of airfield safety areas varies depending on the size of the aircraft using the facilities.

The airfield safety areas are illustrated on **Exhibit 1-6, *Airfield Safety Areas***. This information is based on design guidelines provided in FAA Advisory Circular 150/5300-13A Change 1, *Airport Design* and FAA Memorandum, *Interim Guidance on Land Uses Within a Runway Protection Zone*.

The RSA is the most stringent design requirement. It is 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. The RSA is centered on the runway centerline and it extends both laterally from the centerline of the runway and beyond both ends of the runway for a distance specified in FAA Advisory Circular 150/5300-13A Change 1, *Airport Design*. The RSA must be clear, graded, and devoid of hazardous ruts, depressions, or other surface variations. It must be drained to prevent water accumulation and must be capable, under dry conditions, of supporting snow removal equipment, aircraft rescue and firefighting equipment, and the occasional passage of aircraft, without causing structural damage to the aircraft. The RSA should be devoid of objects other than those that must be located in the RSA due to their aviation-related function; however, these should be constructed on frangible (breakaway) structures with the frangible point no higher than three inches off the ground.

The OFA is an area on the ground (centered on a runway or taxiway) provided to enhance the safety of aircraft operations by having the area free of objects, except for objects that need to be located in the OFA for air navigation or aircraft ground maneuvering purposes. The OFA is a two-dimensional surface that requires the clearing of above-ground objects that extend above the runway safety edge elevation. It is acceptable to taxi and hold aircraft in the OFA.

EXHIBIT 1-6 AIRFIELD SAFETY AREAS



Source: FAA Advisory Circular 150/5300-13A Change 1, *Airport Design*.

The RPZ is a two-dimensional trapezoid area off the runway end that is centered on the extended runway centerline. The RPZ consists of two parts: (1) the central portion, which extends from the beginning to the end of the RPZ, centered on the runway centerline, with a width equal to the runway OFA and (2) the controlled activity area, which consists of the remaining area on either side of the RPZ. The purpose of the RPZ is to enhance the protection of people and property on the ground by keeping the RPZ area free of incompatible objects and activities. The best way to achieve this protection is for the airport owner, where practical, to own the property within the RPZs and clear the area of all incompatible aboveground objects.

The existing airfield safety areas at CRW do not meet FAA requirements in all cases. The analysis of the safety areas against the FAA standards can be found in Chapter 3, *Facility Requirements.*

1.5.4 Lighting and Navigational Aids

CRW has a variety of lighting and navigational aids that are used to guide aircraft approaches and better identify the runway environment at night and during poor visibility conditions.

1.5.4.1 Identification Lighting

CRW has a rotating beacon that is used to visually identify the location of the Airport. The beacon projects alternating green and white beams from sunset to sunrise. When activated during daytime hours, the beacon signals ground visibility of less than three miles and/or cloud ceiling of less than 1,000 feet (IMC). The CRW beacon is located on top of the Airport Traffic Control Tower (ATCT) at the Airport.

1.5.4.2 Taxiway Lighting

CRW's taxiways have medium intensity taxiway lighting. The taxiway lighting indicates the taxiway edges and/or centerline to provide guidance to pilots during periods of low visibility and at night.

1.5.4.3 Runway Lighting

Table 1-6, *Existing Runway Lighting*, displays the lighting available on Runway 05-23.

TABLE 1-6 EXISTING RUNWAY LIGHTING

AID	RUNWAY	
	05	23
Runway Edge Lighting	High Intensity	
Centerline Lighting	Yes	
Touchdown Zone Lighting	Yes	Yes
Approach Lighting System	None	ALSF-I
Runway End Identifier Lights	Yes	No
Visual Glide Slope Indicators	VASI	VASI

Notes: VASI = Visual Approach Slope Indicator; ALSF = Approach Lighting System with Sequenced Flashing Lights.
Sources: FAA Airport Master Record Form 5010 for CRW; Landrum & Brown analysis.

Runway 05-23 is equipped with high intensity runway edge lights and centerline lights. Both ends of the runway have Touchdown Zone (TDZ) lights. TDZ lights include two rows of light bars located on either side of the runway centerline, normally at 100-foot intervals, extending 3,000 feet along the runway.

Approach lighting systems are used in the vicinity of runway thresholds in conjunction with electronic navigational aids to guide approaches to the runways. These systems provide the basic means to transition from instrument flight rules to visual flight for landing. The approach lighting system supplies the pilot with visual cues concerning aircraft alignment, height, and position relative to the runway threshold. Approach lighting systems are typically situated atop a series of towers that extend along the runway centerline.

There are a number of different types of approach lighting systems. Runway 23 is equipped with an Approach Lighting System with Sequenced Flashers-Category I (ALSF-I). Runway 05 does not have approach lighting; however, this runway does have a four-bar Visual Approach Slope Indicator (VASI) and Runway End Identifier Lights (REIL). A VASI is a system of lights positioned to the side of the runway that provides visual descent information during an approach to a runway. REILs provide rapid and positive identification of the approach end of a runway. The system consists of a pair of synchronized flashing lights located laterally on each side of the runway threshold. Runway 23 has a four-bar VASI in addition to its ALSF, but does not have REILs.

CRW also has lighted wind indicators (windsocks), located west of the old Runway 15 end, east of the old Runway 33 end, southeast of the Runway 05 end, and northwest of the Runway 23 end. These windsocks provide wind direction information visually to pilots while on final approach and prior to takeoff.

1.5.4.4 Navigational Aids

CRW has several navigational aids, which are visual or electronic devices that provide point-to-point guidance information or position data to aircraft in flight.

Very High Frequency Omnidirectional Range with Tactical Air Navigation (VORTAC)

A Very High Frequency Omnidirectional Range with Tactical Air Navigation (VORTAC) is a co-located VOR and TACAN within the same facility. A VOR transmits VHF radio signals in a finite number of compass headings. A TACAN is the military version of the VOR-DME system and is designed to overcome some of the disadvantages of the civilian counterpart. It is an economical and applied practice to locate the facilities together rather than duplicate the navigational aids. The VORTAC serving CRW is located approximately 40 miles southwest of the Airport off Smith Creek Road.

Distance Measuring Equipment (DME)

Because VORs provide bearing information only, distance-measuring equipment (DME) measures the distance from an aircraft to the ground-based station (typically near the runway). CRW's DME is co-located with the Runway 05 glide slope shelter.

Runway Visual Range (RVR) Equipment

Runway Visual Range (RVR) refers to the length of visible runway and is used to ensure safe landings at an airport. Equipment used to calculate RVR consists of transmitters and receivers placed on 14-foot towers spaced 250 feet apart. A transmitter emits a gauged intensity of light towards the receiver, which is then calculated into an RVR value. Fog, rain, or snow affect the intensity of light emitted from the transmitter to the receiver, lowering the RVR value. Minimum RVR values are established to maintain safe landing procedures at airport facilities. There are two transmissometers located on the west sides of each runway end.

Airport Surveillance Radar (ASR)

Airport Surveillance Radar (ASR) is used at airports to monitor aircraft movement on the ground and in the air. The radar scans 360 degrees of azimuth and assists air traffic controllers in directing traffic. CRW's ASR facility is located adjacent to the general aviation apron.

Runway Navigational Aids

Runway 23 is equipped with a ground-based Instrument Landing System (ILS). An ILS provides vertical guidance through a glide slope and horizontal guidance through a localizer. It works in conjunction with a runway's approach lighting system and DME or marker beacons. Runway 23's CAT I ILS results in minima of 250-foot ceiling and 24 RVR.

Runway 05 has the localizer and glide slope components of an ILS but its glide slope is not currently usable due to the relocation of the Runway 05 threshold after the 2015 slope failure. The Runway 05 localizer provides minima of 673-foot ceiling and 55 RVR. The glide slope is expected to be restored in the spring of 2019 as part of the Runway 05 RSA project, which was in the design process at the time of this inventory.

2 Aviation Demand Forecast

This chapter of the Airfield Master Plan Update presents forecasts of aviation activity for Yeager Airport (CRW). Forecast activity levels are projected in five-year increments over a 20-year planning horizon, with 2016 serving as the base year for the analysis. Activity levels for 2017 were estimated based on actual data from the first four months of the year, and planning levels were developed for 2022, 2027, 2032, and 2037. Among the components that have been projected are annual passenger enplanements, annual aircraft operations, and aircraft fleet mix.

The aviation activity projections are a critical component in the master planning process and serve as a basis for:

- Determining the role of the Airport, with respect to the type of aircraft to be accommodated in the future;
- Evaluating the capacity of existing Airport facilities and their ability to accommodate projected aviation demand;
- Estimating the development requirements of the future terminal, airside and landside facilities.

This chapter also presents an overview of historical aviation activity trends and presents the methodology and assumptions for developing the forecasts.

2.1 Past Trends in Aviation

This section summarizes historical aviation activity at CRW. It shows how the Airport's traffic has evolved and will serve as the starting point for the development of the forecast. A review of recent trends also identifies those factors, which have or in the future might, influence future traffic volumes.

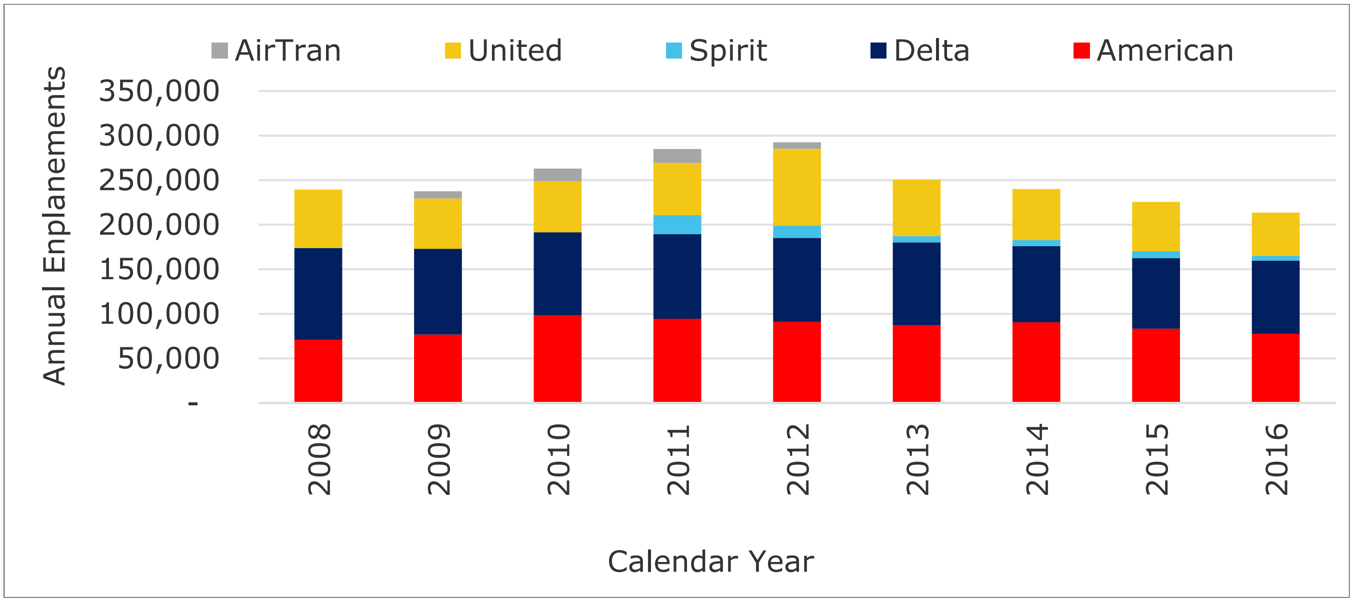
2.1.1 Airport Role

As discussed in Chapter 1, *Inventory*, CRW is designated as a Nonhub Primary Airport by the Federal Aviation Administration (FAA) because enplanements at CRW account for more than 10,000 but less than 0.05% of the annual passenger boardings in the United States. The Airport caters to a diverse aviation customer base including commercial passenger airlines such as Delta, American, United and Spirit, as well as ad hoc cargo operators, private pilots, and the military.

2.1.2 Enplaned Passenger Trends

In 2008, there were 239,500 passenger enplanements at CRW. Enplanements peaked in 2012 at 292,411 and have since decreased on average 7.6% annually to 213,514 enplanements in 2016. A primary reason for the decline in enplanements is airline mergers, which have contributed to market consolidation and evolving air service models. It should be noted that during the peak activity in 2011 and 2012, CRW had Low Cost Carrier (LCC) service by both AirTran and Spirit. **Exhibit 2-1, *Historical Enplanements***, displays how enplanements have evolved by carrier since 2008.

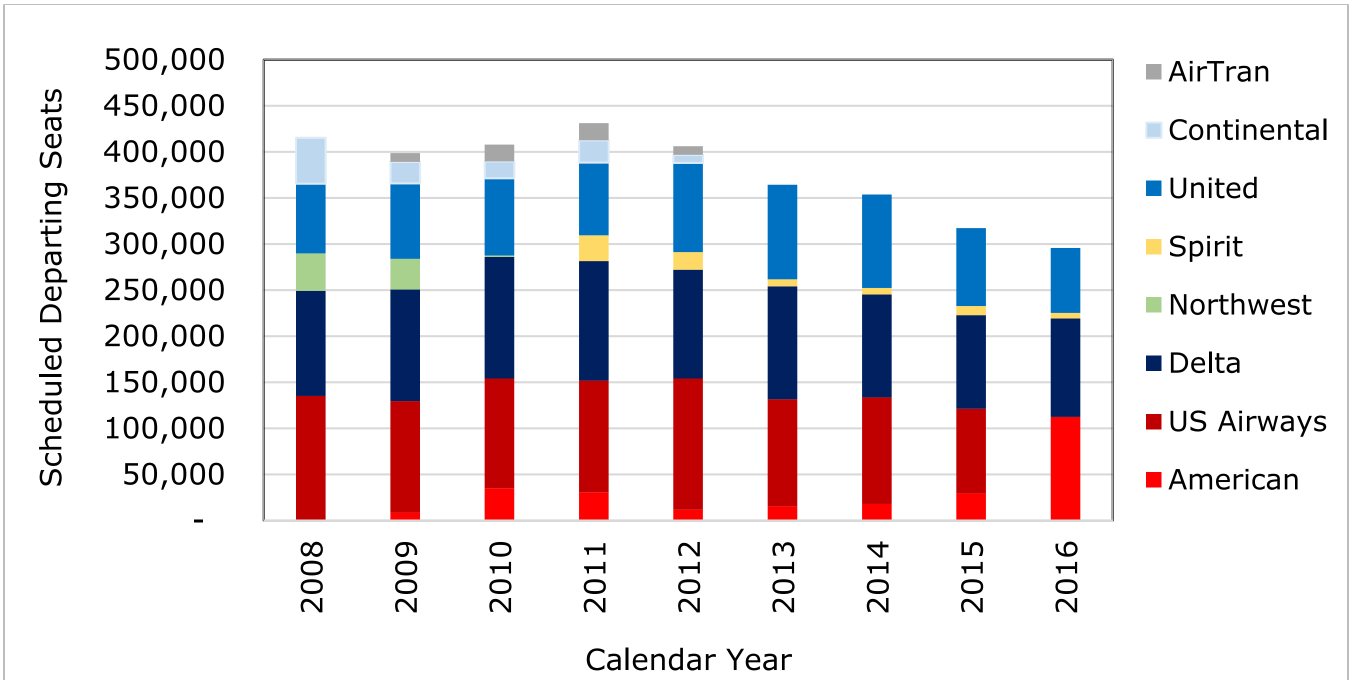
EXHIBIT 2-1 HISTORICAL ENPLANEMENTS



Notes: Airlines include mergers Does not include charter activity (approximately 8 arrivals on average a year).
Sources: Airport Data, Landrum & Brown analysis.

Non-stop markets at CRW have consolidated as a result of airline mergers over the last few years. For example, American previously had service to New York and Chicago; however, due to the merger with US Airways, they re-evaluated their air service model and focused connections at Philadelphia, Washington D.C. and Charlotte. **Exhibit 2-2, *Historical Scheduled Passenger Seats***, displays how scheduled passenger seats have been affected due to airline mergers over the past few years.

EXHIBIT 2-2 HISTORICAL SCHEDULED PASSENGER SEATS

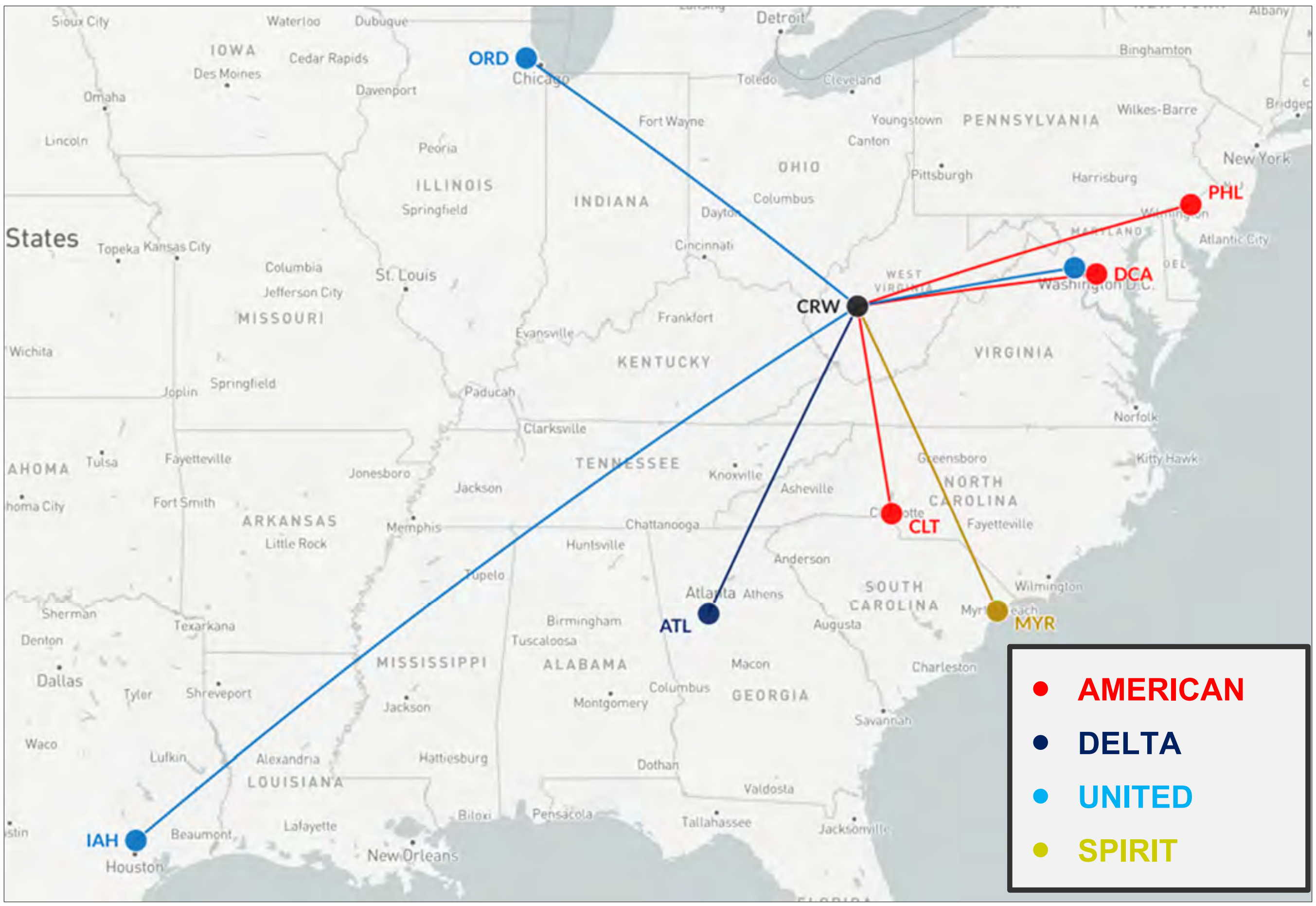


Notes: Does not include charter activity (approximately eight arrivals on average per year).
Sources: Official Airline Guide; Landrum & Brown analysis.

2.1.3 Air Service

Air service at CRW is currently provided by American, Delta, and United, with seasonal service by Spirit. The legacy carriers' air service at CRW is focused around feeder service to its hubs: in 2016, American had service to Charlotte, Washington, D.C., and Philadelphia; Delta had service to Atlanta; and United had service to Washington, D.C., Houston, and Chicago O'Hare. Spirit provided seasonal service to Myrtle Beach, which continues to Fort Lauderdale. **Exhibit 2-3, *CRW 2016 Scheduled Passenger Routes***, details 2016 scheduled passenger routes from CRW.

EXHIBIT 2-3 CRW 2016 SCHEDULED PASSENGER ROUTES



Sources: Official Airline Guide (OAG), Landrum & Brown analysis.

2.1.4 Historical Cargo Capacity

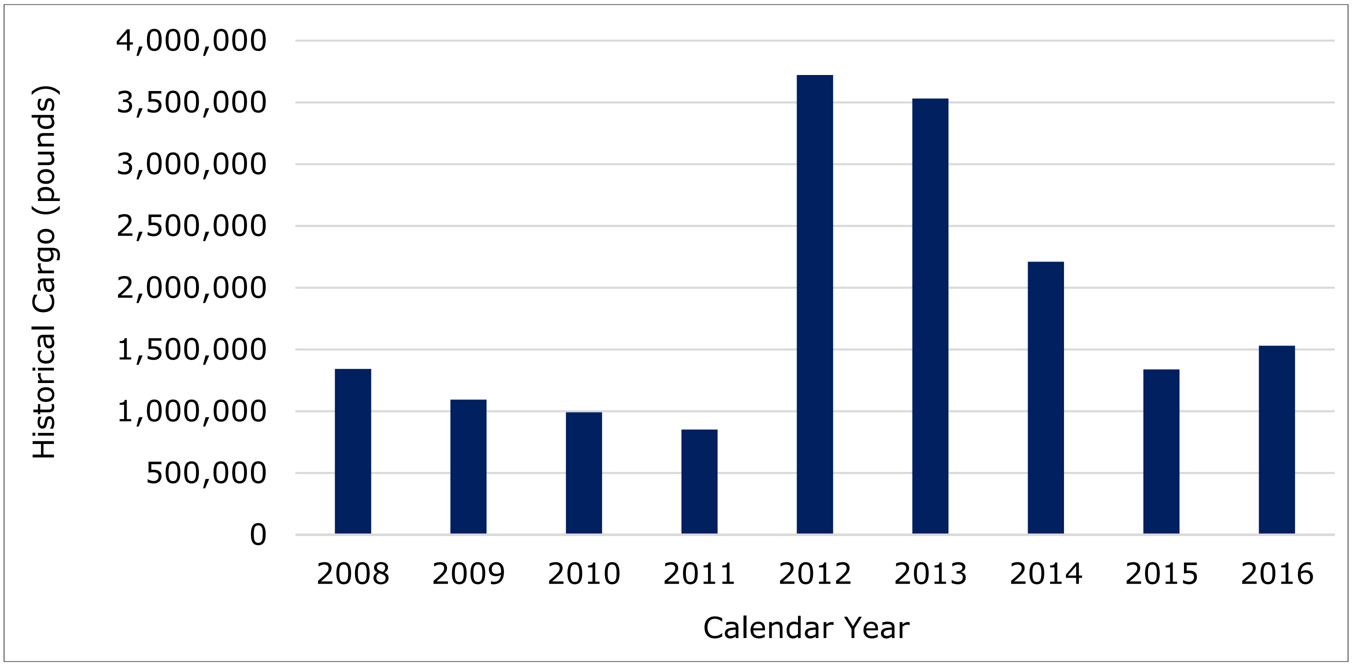
The FAA classifies air cargo as either freight or mail, which can be further categorized as either domestic or international. Air cargo can be moved in the belly of passenger aircraft or aboard all-cargo (freighter) aircraft. Most passenger airlines accommodate air cargo as a by-product to the primary activity of carrying passengers. They fill belly space in their aircraft that would otherwise be empty. The incremental costs of carrying cargo in a passenger aircraft have traditionally been negligible and include only ground handling expenses and an increase in fuel consumption.

It is important to remember that virtually all air cargo begins or ends its journey on a truck making the ground distribution system as equally critical as the airside. The design and location of airports and their cargo facilities must take this into consideration and be capable of accommodating growth in the landside component of the operation commensurate with growth on the airside.

The domestic and international cargo segments differ dramatically in terms of the types of carriers, the airport facilities required, the use of trucks, time sensitivity, and other factors. Domestic cargo is dominated by the integrators, which carry 90% of the cargo shipped within the United States. Integrators operate with a very tight shipping window to their Midwest distribution hubs, which creates a concentration of ground traffic within a region as trucks bring the packages to the airport at the last possible minute. Large volumes of domestic freight also move in the bellies of passenger aircraft. The goods are not typically as time sensitive and arrive at the cargo facilities in smaller concentrations, with much greater frequency, and without well-defined shipping windows.

Historical cargo volumes at CRW decreased on average 14.1% annually from 1,341,000 pounds in 2008 to 851,000 pounds in 2011. The cargo total volume peak was in 2012 and 2013 due to an increase in FedEx traffic. Since then, there has been a decrease in volume due to reduced traffic (FedEx consolidated traffic at Huntington, WV). Total cargo pounds in 2016 was 1,529,000 pounds. **Exhibit 2-4, *Historical Air Cargo Volume***, details historical annual cargo volumes at CRW.

EXHIBIT 2-4 HISTORICAL AIR CARGO VOLUME



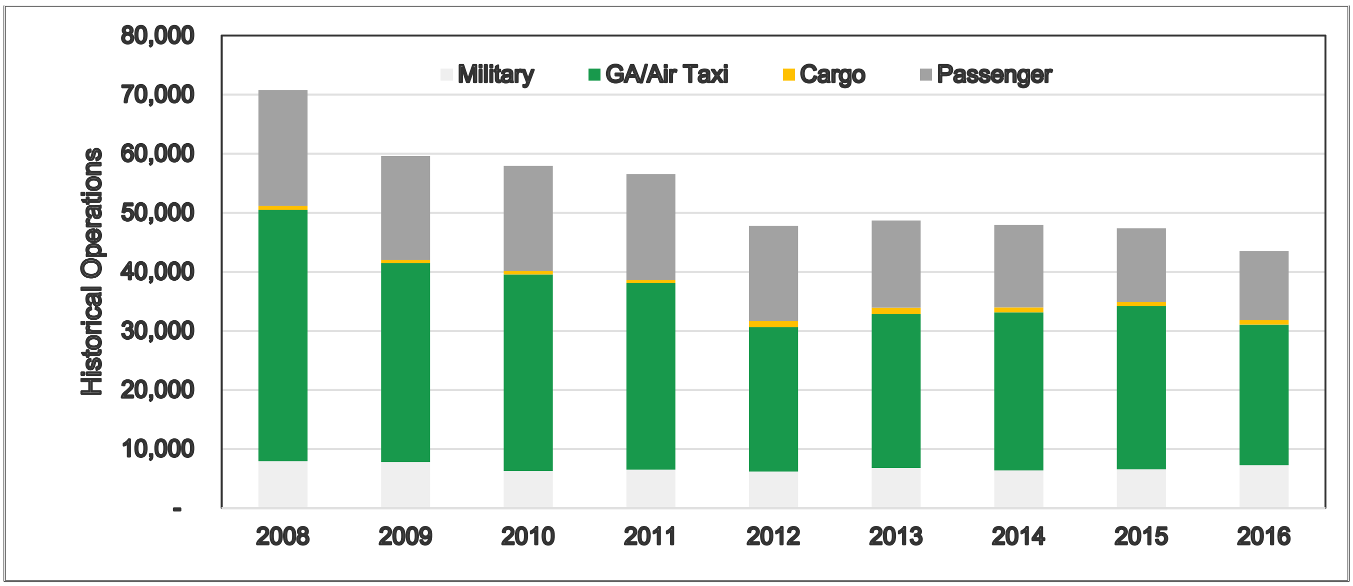
Note: Includes belly cargo pounds.
Sources: Airport Data, Landrum & Brown analysis.

2.1.5 Historical Aircraft Operations

For purposes of developing the operations forecast, historical aircraft operations at CRW were classified into four key segments: (1) commercial passenger; (2) all-cargo/freighter; (3) air taxi/general aviation; and (4) military. Total operations have decreased on average 5.9% annually from 70,700 operations in 2008 to 43,500 in 2016. This decrease was primarily driven by the passenger segment (6.3% decrease annually) and the general aviation/air taxi segment (7.0% decrease annually). Passenger operations decreased primarily due to evolving air service models. As mergers occurred at the Airport, routes were consolidated, and air service strategies were updated. In recent years, general aviation operations at CRW, and broadly within the United States, have been negatively affected by the rise in fuel prices and the associated increased costs to operate general aviation aircraft. Local general aviation traffic has recently been affected due to the loss of an on-Airport flight school.

Exhibit 2-5, *Historical Operations*, details historical annual aircraft operations at CRW.

EXHIBIT 2-5 HISTORICAL OPERATIONS



Sources: Airport Data, Landrum & Brown analysis.

2.2 Factors Influencing Demand

Forecasting aviation demand is not an exact science where the same approach can be applied at all airports. Each airport presents its own unique set of variables that need to be considered. In order to project aviation demand at CRW, many factors were analyzed including airline strategies, aircraft trends, and competing air service at alternate airports.

2.2.1 Airline Strategies

Many airlines have merged or been acquired in the 21st century, including American/TWA in 2001, US Airways/America West in 2005, Delta/Northwest airlines in 2008-2010, Southwest/AirTran in 2010, United/Continental airlines in 2010-2012, and most recently American/US Airways in 2013. Many airlines form alliances in order to reduce costs and improve service offerings. The alliances provide revenue-generating opportunities and cost savings through the codeshare benefits of linked networks, frequent flyer programs, facilities, and services. These mergers and alliances have caused market consolidation and fleet strategies to evolve which have affected activity at CRW in the past.

2.2.2 Aircraft Trends

Variable fuel costs, aircraft type, and aircraft age have an impact on which aircraft the airlines choose to fly. The next-generation Boeing 737s and Airbus 320/321s have among the best fuel economies in the industry. The airlines have designated certain aircraft for retirement that have poor fuel economy compared to newer models. Small regional jets like the EMB-135/140 and the CRJ-100/200, as well as the EMB-120 turboprop are going through reductions and being replaced by larger EMB-170/175 and CRJ-700/900 aircraft. The current airline fleet mix is changing quickly nationwide, bringing many new challenges to airlines that are forced to cut capacity, aircraft, and labor in an effort just to survive.

2.2.3 Low Cost Carriers (LCCs)

When LCCs enter air markets, prices tend to decline and travel (especially leisure travel) increases. In 2011, during the peak of traffic at CRW, LCCs (AirTran and Spirit) accounted for a 10.8% market share of scheduled seats at CRW. AirTran has since merged with Southwest Airlines and no longer operates at CRW; Spirit is scheduled to account for 1.8% in 2017. Competing airports such as Huntington and Columbus offer LCC service that has potential to transfer to CRW over the forecast period.

2.2.4 Socioeconomic Trends

The intrinsic links between the level of aviation activity and economic growth are well documented. Simply put, growth in population, income, and business activity typically lead to increased demand for air travel. An individual’s demand for air travel is often referred to as “underlying demand” in that it cannot be realized without the presence of air service at a price that results in a decision to fly.
For purposes of the forecasts of aviation activity for CRW an emphasis was put on the following socio-economic variables as barometers of economic prosperity: population, employment, per capita personal income (PCPI), and gross regional product (GRP). The socio-economic data used in this analysis were obtained from Woods and Poole Economics, Inc. of Washington, D.C., and the U.S. Census Bureau. Data was accessed for the Charleston-Huntington-Ashland Combined Statistical Area (CSA), City of Charleston, State of West Virginia, and the United States. Economic variables are presented in constant dollars where appropriate to eliminate distortions resulting from inflation.

2.2.4.1 Population

Population is expected to decrease slightly for Charleston (-0.2%) and remain constant for the CSA over the forecast period. In the state, population is expected to increase 0.3%, whereas the population for the United States is expected to increase 0.9% over the next 20 years. **Table 2-1, *Population Trends***, displays the historical and forecast population trends.

TABLE 2-1 POPULATION TRENDS

CALENDAR YEAR	TOTAL POPULATION (IN THOUSANDS)			
	CSA	CHARLESTON	WEST VIRGINIA	U.S.
1990	719	243	1,793	249,623
1995	727	243	1,824	266,278
2000	714	236	1,807	282,162
2005	705	229	1,820	295,517
2010	708	227	1,854	309,347
2015	694	221	1,844	321,421
2016	694	220	1,849	324,161
2017	694	220	1,856	327,168
2022	696	219	1,888	342,677
2027	697	218	1,921	358,822
2032	696	216	1,950	375,078
2037	692	213	1,972	390,515
AAGR				
1990-2016	-0.1%	-0.4%	0.1%	1.0%
2017-2037	0.0%	-0.2%	0.3%	0.9%

Notes: AAGR = Average Annual Growth Rate; CSA = Charleston-Huntington-Ashland Combined Statistical Area.
Source: Woods & Poole 2017.

2.2.4.2 Employment

Growth in employment is an important indicator of the overall health of the local economy. Population changes and employment changes tend to be closely correlated as people migrate in and out of areas largely depending on their ability to find work in the local economy. Employment for Charleston and the CSA is expected to increase 0.8% annually through 2037, slightly slower than the state (0.9%) and the United States (1.3%). **Table 2-2, *Employment Trends***, displays the historical and forecast employment trends.

TABLE 2-2 EMPLOYMENT TRENDS

CALENDAR YEAR	TOTAL EMPLOYMENT (IN THOUSANDS)			
	CSA	CHARLESTON	WEST VIRGINIA	U.S.
1990	321	130	778	138,514
1995	347	141	839	148,126
2000	363	149	875	165,446
2005	361	145	892	172,557
2010	360	144	900	173,035
2015	355	140	907	190,195
2016	358	141	918	193,023
2017	361	142	927	195,849
2022	377	148	974	209,800
2027	392	154	1,018	223,883
2032	406	160	1,060	237,611
2037	418	165	1,099	250,785
AAGR				
1990-2016	0.4%	0.3%	0.6%	1.3%
2017-2037	0.8%	0.8%	0.9%	1.3%

Notes: AAGR = Average Annual Growth Rate; CSA = Charleston-Huntington-Ashland Combined Statistical Area.
Source: Woods & Poole 2017.

2.2.4.3 Per Capita Personal Income (PCPI)

Income statistics are broad indicators of the relative earning power and wealth of the region and inferences can be made related to a resident's ability to purchase air travel. PCPI corresponds to the average income per inhabitant (total personal income divided by total population).

Between 1990 and 2016, PCPI for the CSA area increased at an average annual rate of 1.7%, in line with the state of West Virginia and the United States. The historical rate of real PCPI growth for the CSA area is expected to continue in the future, with Woods & Poole Economics projecting long-term growth of 1.5% per annum through 2037, slightly higher than the forecast for the city, state, and the United States (1.4% expected annual growth). **Table 2-3, *Personal Income Per Capita Trends***, displays the historical and forecast PCPI trends.

TABLE 2-3 PERSONAL INCOME PER CAPITA TRENDS

CALENDAR YEAR	TOTAL PERSONAL INCOME PER CAPITA (IN 2009 DOLLARS)			
	CSA	CHARLESTON	WEST VIRGINIA	U.S.
1990	22,765	25,861	21,875	29,082
1995	24,940	28,433	23,839	30,901
2000	28,075	32,507	26,928	36,833
2005	29,715	34,199	28,823	38,916
2010	32,890	36,975	31,560	39,622
2015	34,257	38,380	33,560	43,924
2016	34,908	39,027	34,022	44,637
2017	35,480	39,629	34,567	45,308
2022	38,550	42,796	37,437	48,803
2027	41,705	46,018	40,342	52,347
2032	44,464	48,901	42,858	55,536
2037	47,036	51,652	45,191	58,604
AAGR				
1990-2016	1.7%	1.6%	1.7%	1.7%
2017-2037	1.5%	1.4%	1.4%	1.4%

Notes: AAGR = Average Annual Growth Rate; CSA = Charleston-Huntington-Ashland Combined Statistical Area.
Source: Woods & Poole 2017.

2.2.4.4 *Gross Regional Product (GRP)*

GRP is a measure of the value of goods and services produced in a state, county or other metropolitan area. GRP for West Virginia grew at a rate of 2.0% per year from 1990 to 2016, slightly faster than the CSA (1.7%) and city (1.8%). Over the same period, the United States economy grew on average 2.6% per year. Over the forecast period, GRP for the CSA, city, and state are expected to grow at about 1.0% per year. **Table 2-4, *Gross Regional Product Trends***, displays the historical and forecast GRP trends.

TABLE 2-4 GROSS REGIONAL PRODUCT TRENDS

CALENDAR YEAR	GROSS REGIONAL PRODUCT (IN MILLIONS OF 2009 DOLLARS)			
	CSA	CHARLESTON	WEST VIRGINIA	U.S.
1990	18,383	7,771	41,264	8,643,982
1995	21,014	9,090	47,469	9,857,091
2000	22,436	10,144	51,368	12,293,614
2005	24,606	10,952	57,937	14,106,895
2010	28,046	12,580	66,161	14,618,132
2015	27,898	12,137	68,499	16,501,908
2016	28,247	12,257	69,497	16,923,958
2017	28,557	12,378	70,388	17,298,638
2022	30,081	12,969	74,689	19,221,367
2027	31,602	13,546	78,986	21,267,484
2032	33,059	14,080	83,209	23,408,118
2037	34,422	14,550	87,296	25,637,132
AAGR				
1990-2016	1.7%	1.8%	2.0%	2.6%
2017-2037	1.0%	0.9%	1.1%	2.1%

Notes: AAGR = Average Annual Growth Rate; CSA = Charleston-Huntington-Ashland Combined Statistical Area.
Source: Woods & Poole 2017.

2.2.5 Regional Growth

Several companies in Charleston and nearby areas announced expansion and investments in the area in 2017. These announcements will encourage additional demand at CRW for both business and personal travel as underlying demand (and discretionary spending) intrinsically increase due to these expansions. Many of these announcements are closely tied to the energy industry, which is expected to continue to grow over the forecast period. The recent announcements include:

- In August 2017 N3, a technology-enabled sales and marketing execution firm, announced its intentions to create roughly 300 jobs at the Charleston location to better serve its expanding customer base.[1]
- In September 2017 it was announced that Liberty One, the newest facility for US Methanol, will open in Charleston in mid-2018, which will be capable of producing 200,000 metric tons of methanol a year on the 11-acre site. Construction of the plant will result in the hiring of 300 temporary construction jobs. Once the facility is completed, approximately 50 people will be hired on a permanent basis.[2]
- In September 2017, Niche Polymers in Ravenswood, West Virginia announced 30 available job opportunities. Since starting operations in 2008, the company has been able to continue to grow in size and in production output.[3]
- In September 2017, it was announced that Toyota Motor Manufacturing West Virginia will be making a $115.3 million investment to produce the company's first American-made hybrid transaxles at its Buffalo, West Virginia facility. Production of the transaxles is scheduled to begin at the Buffalo Toyota engine and transmission plant in 2020.[4]
- In October 2017, the voters of West Virginia approved the issuance of $1.6 billion in road construction bonds. The state projects this construction could require as many as 48,000 jobs.[5]
- In October 2017, Hino motors announced a $100 million/250 employee expansion in West Virginia. Officials with Japanese truck manufacturer Hino Motors announced plans to expand their West Virginia manufacturing plant into the abandoned Coldwater Creek warehouse facility in Mineral Wells. Hino officials are hoping to double their market share over the next six years as well as double employment by 2020.[6]

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1 https://www.theet.com/statejournal/tech-firm-n-plans-to-bring-jobs-to-southcharleston/article_927decb3-b8a9-53f1-a08e-b0c60e2e60f9.html

2 MetroNews Staff, September 7, 2017

3 MetroNews Staff, September 28, 2017

4 http://www.herald-dispatch.com/_recent_news/toyota-announces-expansion-of-wvoperations/article_b58e8bcc-a2cd-11e7-9431-979ff7fd2ba4.html

5 https://www.theet.com/news/state-s-economic-outlook-beginning-to-bounce-back-deskins-i/article_30f55f8cf2a6-5c5c-86f2-7a4d3631f097.html

6 https://www.theet.com/statejournal/hino-motors-expanding-in-west-virginia/article_5a21a194-1aea-5b58-8f6e-03669977f02b.html

- In November 2017, it was announced that China Energy Investment Corporation Limited has signed an agreement with the West Virginia Department of Commerce on an $83.7 billion plan to invest in shale gas development and chemical manufacturing projects in West Virginia. This agreement is over a twenty-year period which helps ensure long-term viability for people traveling to and from Texas due to their strong ties with the energy industry. Since this announcement, American Airlines and China Southern have announced a new codeshare agreement effective January 2018, giving American Airlines passengers access to more than 100 destinations in China.[7]
- In November 2017, it was announced that a newly formed company, PPD of WV One, is planning to build a $73 million synthetic fuel plant in Greenbrier County, with construction expected to commence in early 2018. It will be Proton Power's first time being involved with a project in West Virginia, and the company intends for the plant "to become the first of many" in West Virginia. The new facility will be capable of producing 7.2 million gallons of diesel and 7,200 tons of biochar per year.[8]

In addition to the announcements, other positive economic news is occurring. In September of 2017, WSAZ New Channel 3 Investigation reported that 1,007 coal mining jobs were added in West Virginia in 2017.[9] The West Virginia Economic Outlook was released by West Virginia University in October 2017. It stated that of the 26,000 jobs lost since 2012, West Virginia has regained about 4,500. This suggests that the state of West Virginia's economy has bottomed out and is on pace to regain all of the 26,000 jobs lost by 2021.[10]

Another key facility in the area is the Summit Reserve, one of four facilities managed by the National Council of the Boy Scouts of America (BSA). It is currently the home of the National Scout Jamboree. In July 2017, the National Scout Jamboree was held at this facility, hosting thousands of boy scouts from around the world. Many boy scouts utilized CRW in route to this event. This facility is expected to inject $25.3 million into the local economy annually.[11]

7 http://www.wsaz.com/content/news/China-Energy-signs-837-billion-West-Virginia-investment-agreement-456288953.html
8 https://www.wvgazettemail.com/business/new-company-plans-to-build-synthetic-fuel-plant-in-greenbrier/article_ddb33ed2-a8b9-5275-8909-3669e974e43b.html
9 WSAZ News September 11, 2017
10 https://www.theet.com/news/state-s-economic-outlook-beginning-to-bounce-back-deskins-i/article_30f55f8cf2a6-5c5c-86f2-7a4d3631f097.html
11 https://en.m.wikipedia.org/wiki/The_Summit_Bechtel_Family_National_Scout_Reserve

2.3 Passenger Demand Forecast

This section presents the passenger demand forecast for CRW. Any comprehensive effort to project future airline passengers begins with a forecast of originating enplaned passengers. The level of originating passengers reflects the attractiveness of the region as a place to live, a place to visit, and as a place to work and conduct business. A reasonable forecast of originating passengers is critical in order to estimate future demands for terminal facilities such as ticketing, baggage claim, automobile parking, and access roadways.

All enplaned passengers at CRW are domestic originating passengers because direct international service is not available at the Airport. Airlines provide point-to-point service at the Airport; therefore, only a handful of connections are made at CRW during each year. As a result, domestic O&D enplanements are used as a reasonable estimate for total enplanements for CRW.

A base and high passenger demand forecast was developed to display the range of activity the Airport could accommodate over the forecast period. It is important to note that the forecasts are considered “unconstrained” and do not take in consideration airfield or other facility constraints.

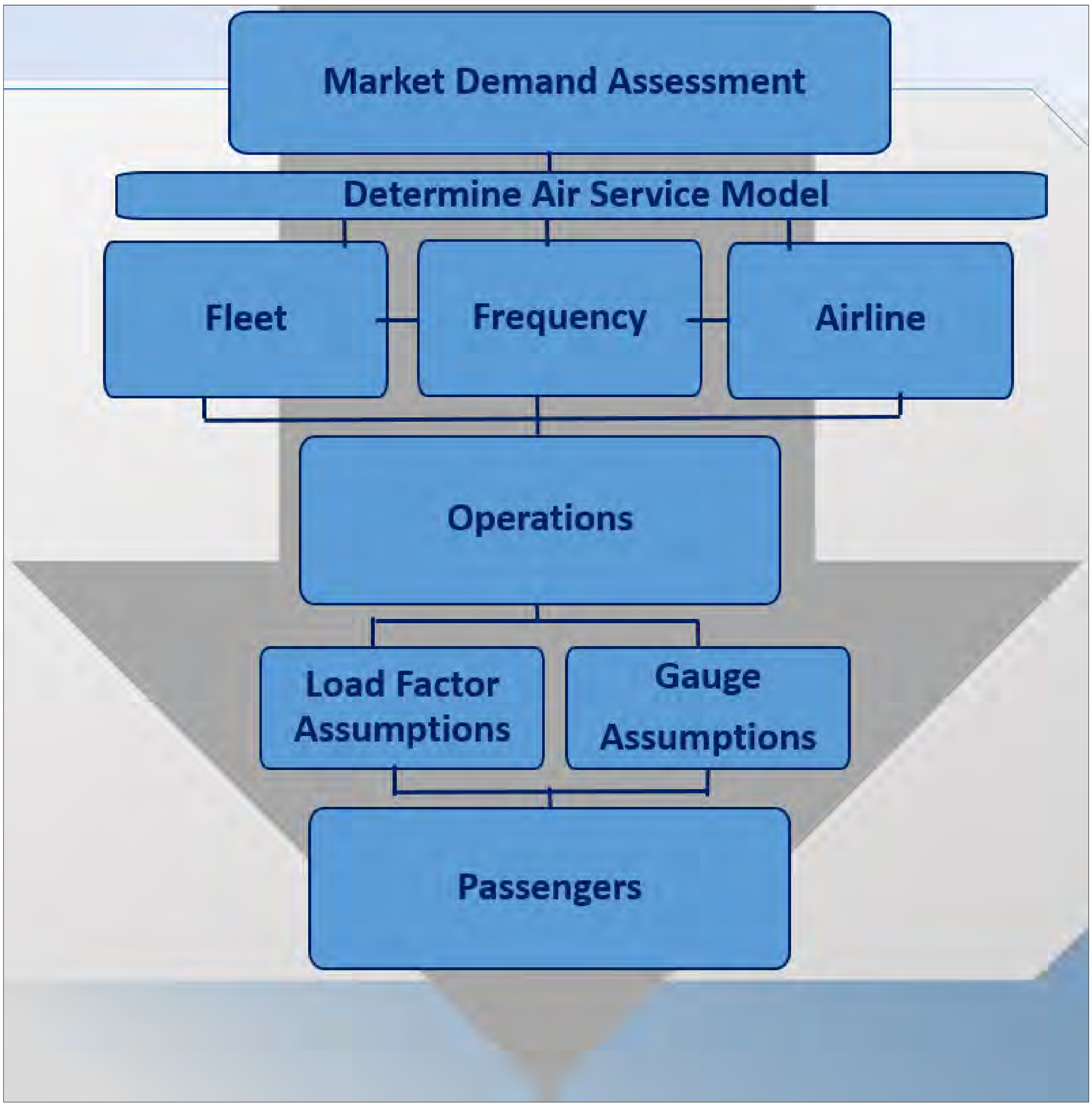
2.3.1 Regression Analysis Methodology

Ten years of historical originating enplaned passenger data was used as a first step to forecast demand at CRW through a regression analysis. Woods & Poole data was used to test the relationship between historical passengers and the socioeconomic data of the Charleston region. Forecast models were developed using the classical technique of multi-linear regression, with the dependent variable transformed according to a linear function. The methodology for preparing the passenger forecasts recognizes that key parameters such as population, employment, total personal income, and GRP will change over time. This approach assumes that the fundamental mathematical relationships between the independent variables and domestic O&D passenger traffic will persist and will support the development of realistic forecasts. However, the results of this analysis determined there is no viable correlation between historical passenger and socio-economic data.

2.3.2 Passenger Forecast Methodology

Since there was no viable regression between historical passengers and socio-economic data, a market demand driven approach was used to determine future operations. Assumptions were then developed for airline strategies, fleet mix, load factors, and gauge to derive commercial enplanements (see **Exhibit 2-6, *O&D Market Demand Assessment***).

EXHIBIT 2-6 O&D MARKET DEMAND ASSESSMENT



Source: Landrum & Brown analysis.

2.3.2.1 O&D Market Demand Assessment

U.S. Department of Transportation Origin and Destination (O&D) 2016 data was used to determine which markets were drivers for activity at CRW. As seen in **Table 2-5, *O&D Market Demand Assessment***, the top 20 destinations were analyzed to determine the feasibility for direct service. This data explains the potential for air service based on current travel patterns. Destination feasibility was determined by looking at the potential for weekly service (total 2016 passengers divided by 52). The grey destinations in the table are direct markets that currently exist at the Airport. The yellow highlighted markets were selected as potential new markets based on high demand from current activity. As a result of the data, it was assumed that new markets would be hub airports or destination markets with high O&D demand.

TABLE 2-5 O&D MARKET DEMAND ASSESSMENT

RANK	FINAL DESTINATION	HUB	2016 PASSENGERS	% OF REPORTED	EXISTING	WEEKLY SERVICE PASSENGERS
1	Atlanta(ATL)	√	17,775	9.6%	DL	342
2	Houston (IAH)	√	8,745	4.7%	UA	168
3	Washington D.C. (DCA)	√	6,725	3.6%	AA	129
4	Orlando (MCO)	√	5,973	3.2%	-	115
5	Dallas (DFW	√	5,401	2.9%	-	104
6	Chicago (ORD)	√	4,913	2.6%	UA	94
7	Los Angeles (LAX)	√	4,725	2.5%	-	91
8	Denver (DEN)	√	4,659	2.5%	-	90
9	Philadelphia (PHL)	√	4,434	2.4%	AA	85
10	Las Vegas (LAS)	√	4,394	2.4%	-	85
11	Fort Lauderdale (FLL)	√	4,365	2.3%	-	84
12	Washington D.C. (IAD)	√	4,304	2.3%	UA	83
13	Myrtle Beach (MYR)		4,239	2.3%	NK	82
14	Charlotte (CLT)	√	3,930	2.1%	AA	76
15	Phoenix (PHX)	√	3,588	1.9%	-	69
16	Tampa (TPA)	√	3,531	1.9%	-	68
17	Boston (BOS)	√	3,435	1.8%	-	66
18	San Antonio (SAT)		3,170	1.7%	-	61
19	San Francisco (SFO)	√	2,982	1.6%	-	57
20	New York (LGA)	√	2,937	1.6%	-	56
	Top 20 Markets			56.0%		
	Other			44.0%		

Notes: Yellow highlights new direct markets. Grey highlights existing direct markets.
Sources: U.S. DOT, Air Passenger Origin-Destination Survey; Landrum & Brown analysis.

2.3.2.2 Market Assumptions

Base Forecast

The base forecast includes current and previously operated select markets at the Airport. It was assumed that all existing markets will continue at CRW over the forecast period. Based on the results of the O&D market demand assessment, previously-operated select markets that are assumed to start service by 2023 include Orlando (Spirit), Dallas (American), and Detroit (Delta). The reasons these markets were added were due to their demand and previous success in these markets.

Orlando was previously operated by AirTran (no longer in operation). Although this airline is no longer in existence, as it was purchased by Southwest in 2011, Orlando continues to be the most popular destination that passengers are traveling to that does not have direct service from CRW. It is likely that Spirit will start this market seasonally by 2023 and offer weekly service throughout the forecast period starting in 2024.

Dallas was cancelled by American due to the reduced runway lengths caused by the slope failure in March 2015. The state of West Virginia is interested in reinstating the Dallas service through a minimum revenue guarantee. This is due to the economic growth in the energy sector, with many ties to Texas. It is expected that service to Dallas will return, operating four times a week by 2023, and increase to daily by the end of the forecast period.

Detroit was previously operated daily by Delta. It is expected that Delta will resume service to Detroit by 2023 to allow for increased network reliability (hub variability) and increased connections to the western U.S.

High Forecast

The high forecast assumes new destination markets are added to the Airport over the forecast period. New direct markets assumed to start service by 2028 include Denver (United), Fort Lauderdale (Spirit), Las Vegas (Spirit) and Phoenix (American).

Like the base forecast, it is assumed that all existing markets will continue at CRW over the forecast period. Orlando (Spirit), Dallas (American), and Detroit (Delta) were also added to the forecast at the same time period as in the base forecast.

2.3.2.3 Fleet Assumptions

It is important to note that while population is forecast to remain the same over the forecast period, financial indicators are increasing, which bodes well for future traffic increases. It is reasonable to say that the Airport has “bottomed out” in traffic at this point, due in part to the reduction in runway length after the slope failure. Scheduled seats have increased in the market in 2017 as the airlines replace the DH3s (48-50 seats) and DH8s (35-37 seats). There were 2.7% more seats in the market in 2017 versus 2016; and a 17% increase in seats is scheduled for the first 4 months of 2018 vs 2017. Fares have generally been increasing since 2010, which has likely dampened demand. It is likely that the airlines at CRW will reduce fares in the future in order to fill their increased capacity.

The legacy carriers (American, Delta, and United) at CRW have typically operated turboprop and small (less than 70 seats) jet equipment. Faced with higher fuel costs and aircraft age, legacy carriers and their regional partners are moving to larger regional aircraft at airports across the United States. Indeed, the run up in fuel prices that has occurred since 2004 has resulted in a significant decline in flights by aircraft with less than 50-seats as the economics are simply not viable in many markets. As part of this trend, all DH3 and DH8 are being replaced by the 50-seat ERJs and it is expected these aircraft will be completely taken out of the fleet by 2018.

Currently, 50-seat aircraft are no longer being manufactured. It is expected that these aircraft will be phased out of fleets nationwide in the next five to ten years. However, CRW is an ideal market size for the 50-seat regional jets. While many larger airports will see upgrades to 70-seat RJs within five years, it is expected that smaller markets like CRW will continue to be served from the airlines' hubs on 50-seaters until the last of these aircraft are phased out of the fleet. Diminishing numbers of 50-seat regional jets over the next five to ten years appear to be more reasonable. The forecast therefore assumes a ten-year phase out of the 50-seat regional jets. It was assumed all 50-seat aircraft will be replaced by 2028.

All fleet assumptions described in the sections that follow apply to both the base and high forecasts unless otherwise noted.

American Airlines

American has been primarily using small regional jet aircraft (50 seats or less) from CRW to their current markets: Charlotte (CLT), Washington D.C. (DCA), and Philadelphia (PHL). American sometimes upgauges to the CRJ-700 aircraft, depending on availability. It was assumed that American will continue operating primarily 50-seat aircraft until 2027, upgauging to larger CRJ-700 (70 seats) on the CLT, DCA, and PHL routes, in line with national trends.

American is expected to upgauge to the larger CRJ-900 (76 seats) on the DFW route. American Airlines representatives indicated in an 11/20/17 letter that the DFW service was canceled in 2015 because the available runway length at CRW was not enough to support DFW service on "appropriately sized aircraft" (see **Appendix A** for a copy of the letter). While American indicated in the letter that they do not have plans to add CRW-DFW service in the "near term" (within three years) they have had discussions with CRW staff in which they have indicated it is very likely within the next 10 years. American indicated in the letter that the most appropriate service for introducing DFW service would be the E145 but they would want the flexibility to fly the CRJ-900 on the DFW route. The forecast therefore assumes DFW activity will start on the E145 in 2023, with an upgauge to the CRJ-900 by 2027.

For the high forecast it was assumed that American will start service seasonally to Phoenix (PHX) on CRJ-700 aircraft starting in 2028, increasing to once a week by 2037.

Delta Air Lines

Delta currently uses a combination of commuter and small narrow-body aircraft. In 2017 Delta operated one mainline flight per day into CRW from ATL. Based on scheduled data in the Official Airline Guide (OAG), Delta's mainline schedule for 2018 has over 500 operations scheduled on B717 aircraft with only 169 operations on A319s and B73Ws. According to Delta's website[12] Delta's B717s are 16.1 years old, on average. Delta tends to keep their aircraft for a long time; for example, their MD-88s are over 27 years old. In addition, Delta was the last U.S. airline to retire the DC-9-30, a similarly sized and configured aircraft. Delta and other airlines expressed their appreciation for the B717 in a 12/3/17 Business Insider article, praising the aircraft for its durability and reliability. Given Delta's recent fleet changes, their appreciation for the B717, and their tendency to fly older aircraft, the forecast reflects keeping the B717s in the fleet at 2018 levels through 2027, with reductions occurring through 2032 as the aircraft age reaches 30 years. It is expected that Delta will continue operating its B717 aircraft until 2032, at which time the B717s will be replaced with CS100s.

In terms of Delta's commuter service, Delta currently operates four to five commuter flights per day. It was assumed that the remainder of Delta's 50-seat aircraft will continue operating until 2027, after which they will upgauge to larger regional jet aircraft (70 to 80 seats), in line with national trends.

United Airlines

United has been primarily been utilizing small regional jet aircraft (50 seats or less) at CRW to their current markets: Washington D.C. (IAD), Houston (IAH), and Chicago (ORD). United sometimes upgauges to the CRJ-700 depending on availability. It was assumed that United will continue operating primarily 50-seat aircraft until 2027, upgauging to larger CRJ-700 on the IAD and ORD routes, in line with national trends.

The IAH route is operated with 50-seat ERJs today. The Airport has had several discussions with United regarding the Houston route. They have reiterated the importance and success of that route, recently celebrating the 15th anniversary of the flight. United has expressed interest in upgauging aircraft size and/or increasing frequency of this route to two times per day. Use of larger aircraft provides more flexibility to provide economy plus and first-class seats, which enhances revenues for the carriers. Therefore, it is expected that United will upgauge to a 76-seat aircraft on the IAH route, to provide maximum revenue enhancing potential. This route is operated by SkyWest six days a week today. Other United commuter partners operate the CRJ-900. Because it is not known which commuter partner will be used in the future, and what their fleet will be, this forecast assumes the more demanding CRJ-900. The forecast assumes the IAH flight will remain on ERJs until upgauging to the CRJ-900 by 2027.

For the high forecast it was assumed that United will start service four times a week to Denver (DEN) on CRJ-700 aircraft starting in 2028, increasing to daily by 2037.

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12 https://www.delta.com/content/www/en_US/about-delta/corporate-information/aircraft-fleet.html.

Spirit Airlines

Spirit currently operates seasonal service to Myrtle Beach (MYR) on A319s. It was assumed that Spirit would continue using A319 aircraft at CRW and later replace these aircraft with A320s by 2028.

For the high forecast it was assumed that Spirit would start new service to Orlando (MCO) on A319s by 2023, and upgauge to A320s by 2028. New service to Fort Lauderdale (FLL) and Las Vegas (LAS) was assumed to occur on A320 aircraft and remain with that aircraft type throughout the forecast period.

2.3.2.4 Gauge Assumptions (Seats Per Aircraft)

As a result of the fleet assumptions, total average gauge for the base passenger forecast increases from 51 in 2017 to 72 by 2037 (see **Table 2-6, *Base Forecast Gauge Assumptions***). Total average gauge for the high passenger forecast increases from 51 in 2017 to 75 by 2037 (see **Table 2-7, *High Forecast Gauge Assumptions***).

TABLE 2-6 BASE FORECAST GAUGE ASSUMPTIONS

GAUGE	2014	2015	2016	2017E	2022	2027	2032	2037
American	50	44	43	45	50	59	64	65
Delta	67	68	66	66	72	75	83	81
Spirit	153	156	145	145	145	145	178	178
United	45	44	45	44	50	65	71	71
Total	**51**	**51**	**51**	**51**	**57**	**66**	**72**	**72**

Sources: Airport Data, Official Airline Guide; Landrum & Brown analysis.

TABLE 2-7 HIGH FORECAST GAUGE ASSUMPTIONS

GAUGE	2014	2015	2016	2017E	2022	2027	2032	2037
American	50	44	43	45	50	59	65	67
Delta	67	68	66	66	72	75	83	81
Spirit	153	156	145	145	145	145	178	178
United	45	44	45	44	50	65	71	71
Total	**51**	**51**	**51**	**51**	**57**	**66**	**75**	**75**

Sources: Airport Data, Official Airline Guide; Landrum & Brown analysis.

2.3.2.5 Load Factor Assumptions

Legacy carrier load factors (percent of seats occupied) at CRW were assumed to remain constant throughout the forecast period. Spirit's load factors are assumed to remain constant at 87.6% until 2023, then decrease to 85.0%, remaining at that level over the remainder of the forecast period due to the addition of its new markets.

As result of these assumptions, overall load factors are expected to average 69.1% by the end of the forecast period (see **Table 2-8, *Load Factor Assumptions***). The same load factors were used for both the base and high passenger forecasts.

TABLE 2-8 LOAD FACTOR ASSUMPTIONS

LOAD FACTORS	2014	2015	2016	2017E	2022	2027	2032	2037
American	67.7%	68.7%	69.0%	66.6%	66.6%	66.6%	66.6%	66.6%
Delta	76.7%	77.8%	76.8%	74.4%	74.4%	74.4%	74.4%	74.4%
Spirit	90.2%	79.9%	87.6%	87.6%	87.6%	85.0%	85.0%	85.0%
United	56.5%	65.4%	69.1%	65.0%	65.0%	65.0%	65.0%	65.0%
Total	**67.8%**	**71.1%**	**72.2%**	**69.4%**	**69.3%**	**69.0%**	**69.1%**	**69.1%**

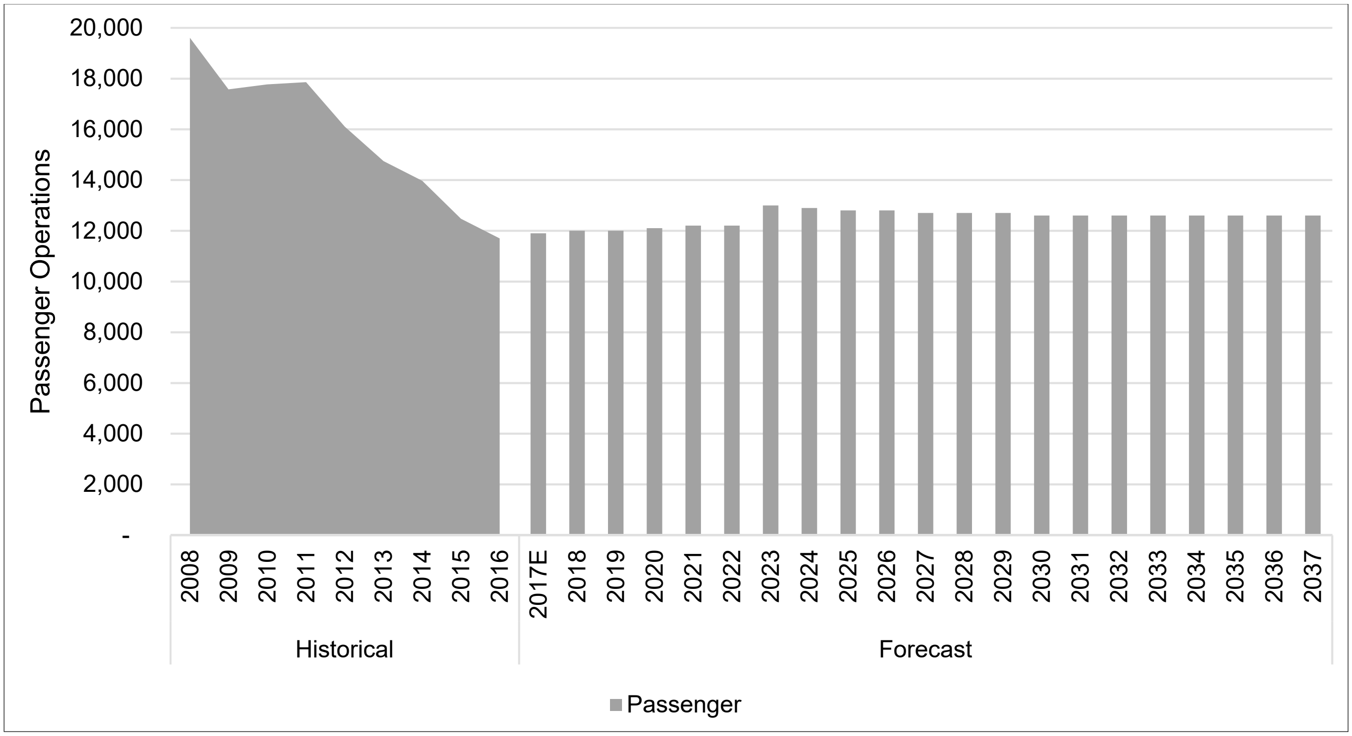
Sources: Airport Data, Official Airline Guide; Landrum & Brown analysis.

2.3.3 Passenger Operations Forecast

Current market operations are expected to increase 0.5% annually from 2016 to 2027. As larger regional jets are added on these existing markets, operations are expected to remain constant through the remainder of the forecast period. As new markets are added, operations are expected to increase based on the assumptions explained in Section 2.3.3, *Passenger Operations Forecast*.

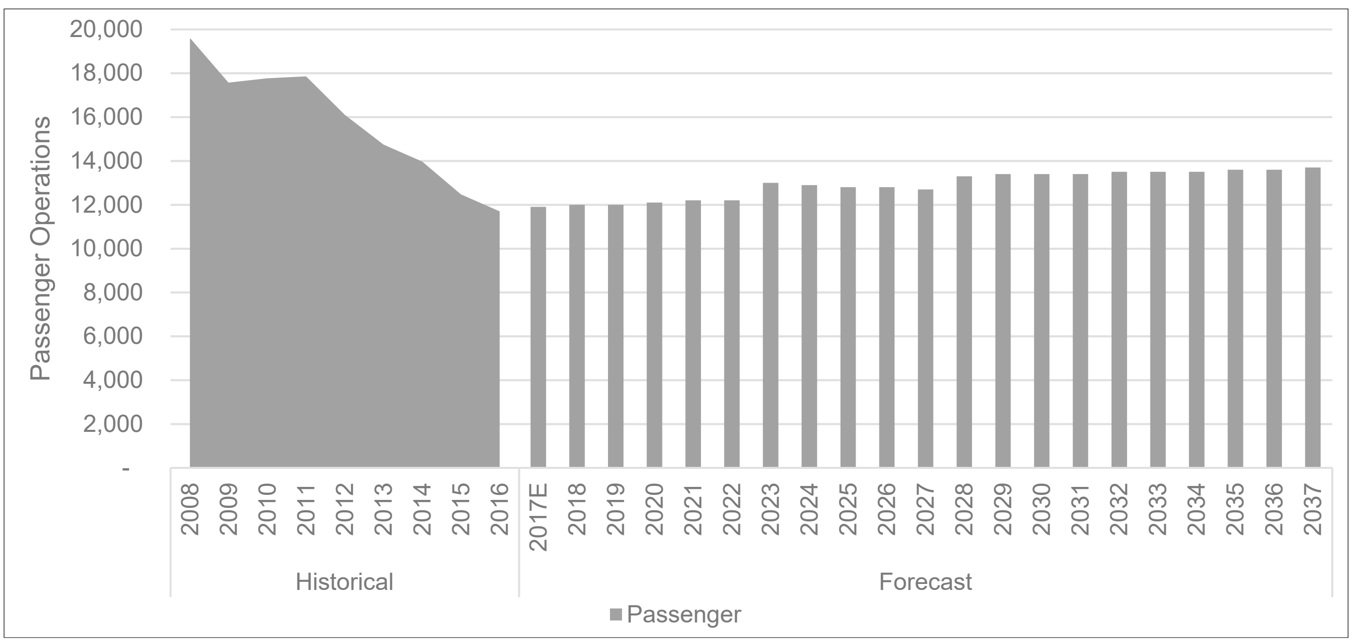
As a result of these assumptions, the base passenger operations forecast shows an average increase of 0.4% annually, from 11,700 in 2016 to 12,600 in 2037 (see **Exhibit 2-7, Base *Passenger Operations Forecast***). The high passenger operations forecast shows an average increase of 0.8% annually, from 11,700 in 2016 to 13,700 in 2037 (see **Exhibit 2-8, High *Passenger Operations Forecast***).

EXHIBIT 2-7 BASE PASSENGER OPERATIONS FORECAST



Sources: Airport Data, Official Airline Guide; Landrum & Brown analysis.

EXHIBIT 2-8 HIGH PASSENGER OPERATIONS FORECAST



Sources: Airport Data, Official Airline Guide; Landrum & Brown analysis.

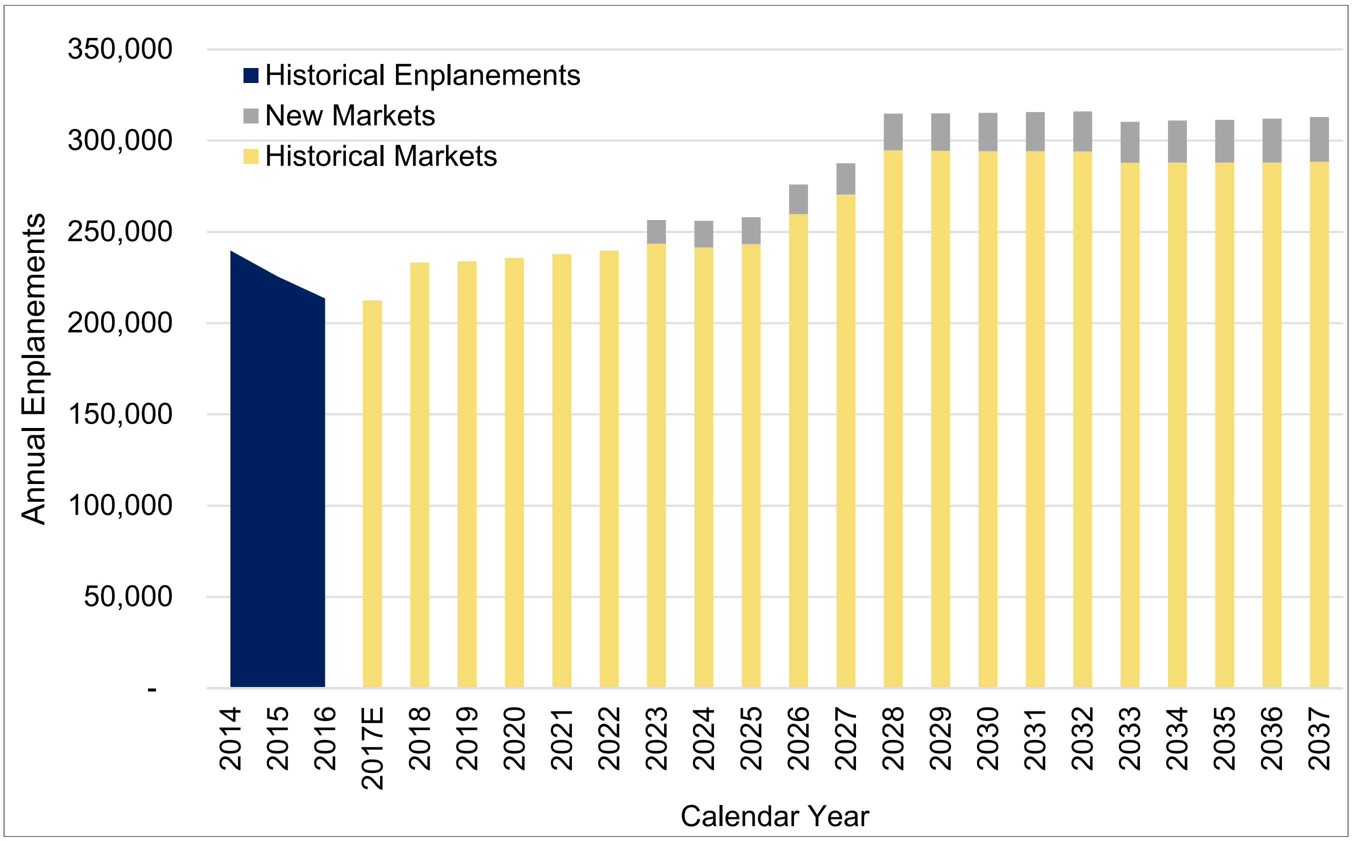
2.3.4 Passenger Enplanements Forecasts

The aggregate number of commercial passengers at an airport depends on three factors: operations, average aircraft size, and average load factor. The relationship is shown in the equation below.

Passengers = Operations * Average Load Factor * Average Aircraft Size

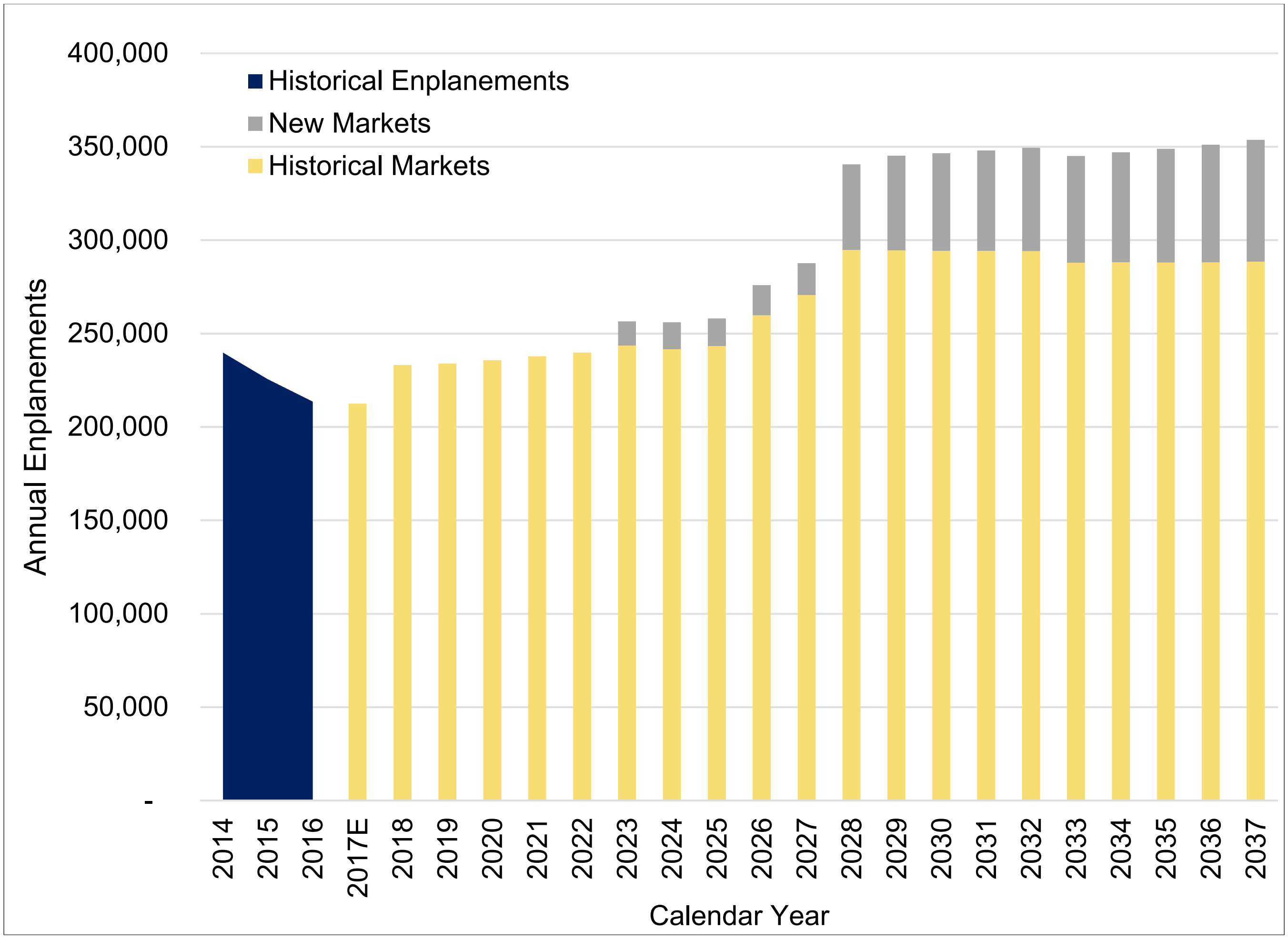
The resulting total enplanements in the base forecast are expected to increase by an average of 1.8% annually, from 213,514 in 2016 to 313,000 in 2037 (see **Exhibit 2-9, *Passenger Enplanements Base Forecast***). In the high forecast, total enplanements are expected to increase by an average of 2.4% annually, from 213,514 in 2016 to 354,000 in 2037 (see **Exhibit 2-10, *Passenger Enplanements High Forecast***).

EXHIBIT 2-9 PASSENGER ENPLANEMENTS BASE FORECAST



Sources: Airport Data; Landrum & Brown analysis.

EXHIBIT 2-10 PASSENGER ENPLANEMENTS HIGH FORECAST



Sources: Airport Data; Landrum & Brown analysis.

2.4 Other Operations Forecast

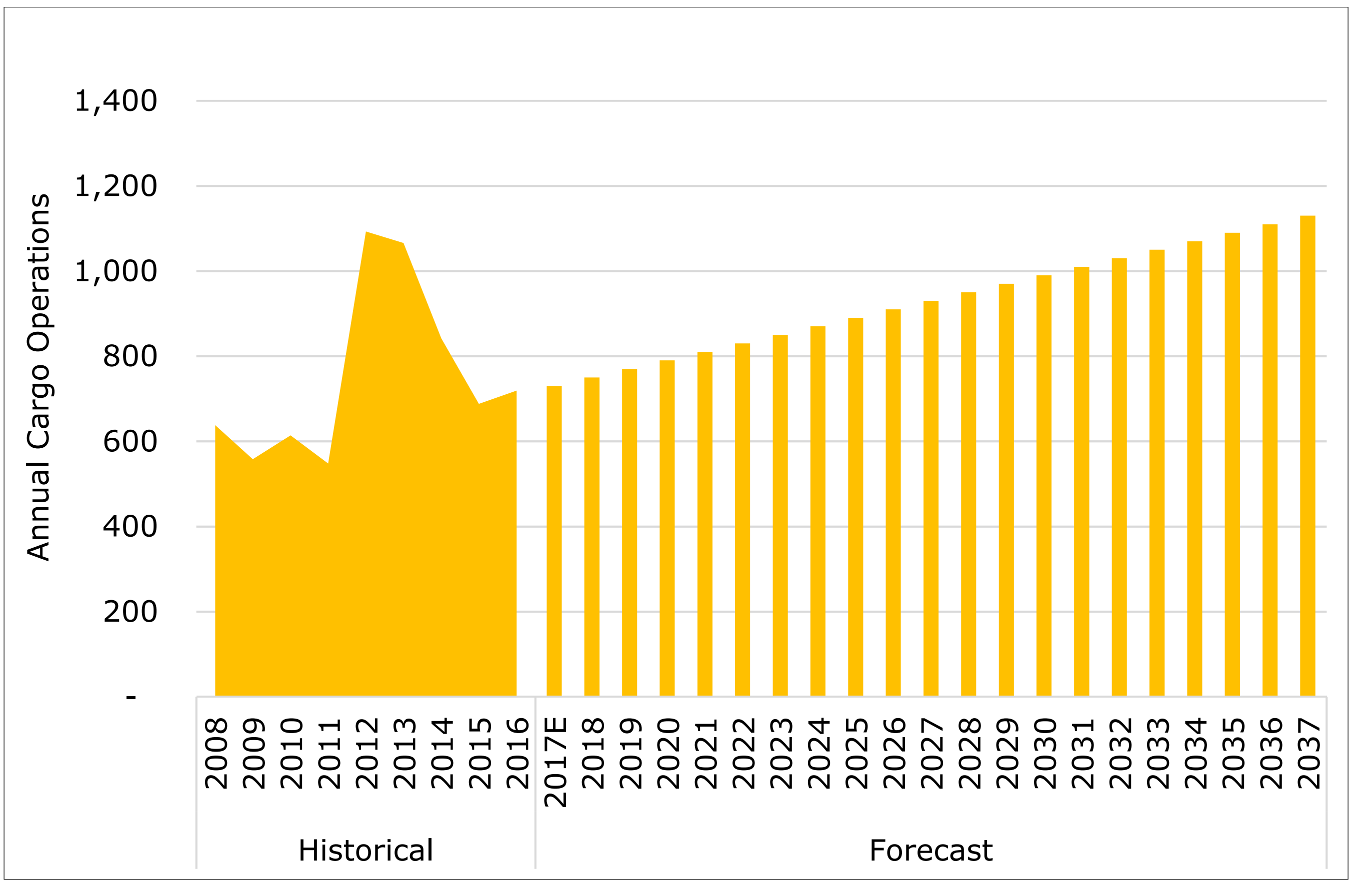
This section presents the rationale and projections of air cargo, air taxi/general aviation, and military operations at CRW. This provides a functional forecast of the key operational segments at the Airport.

2.4.1 Cargo Operations

Boeing and Airbus publish cargo forecasts on a regular basis. These forecasts were consulted to provide an understanding of historical and future cargo trends at a national and international level. In spite of the recent economic downturn, the Airbus and Boeing forecasts predict growth in the future.

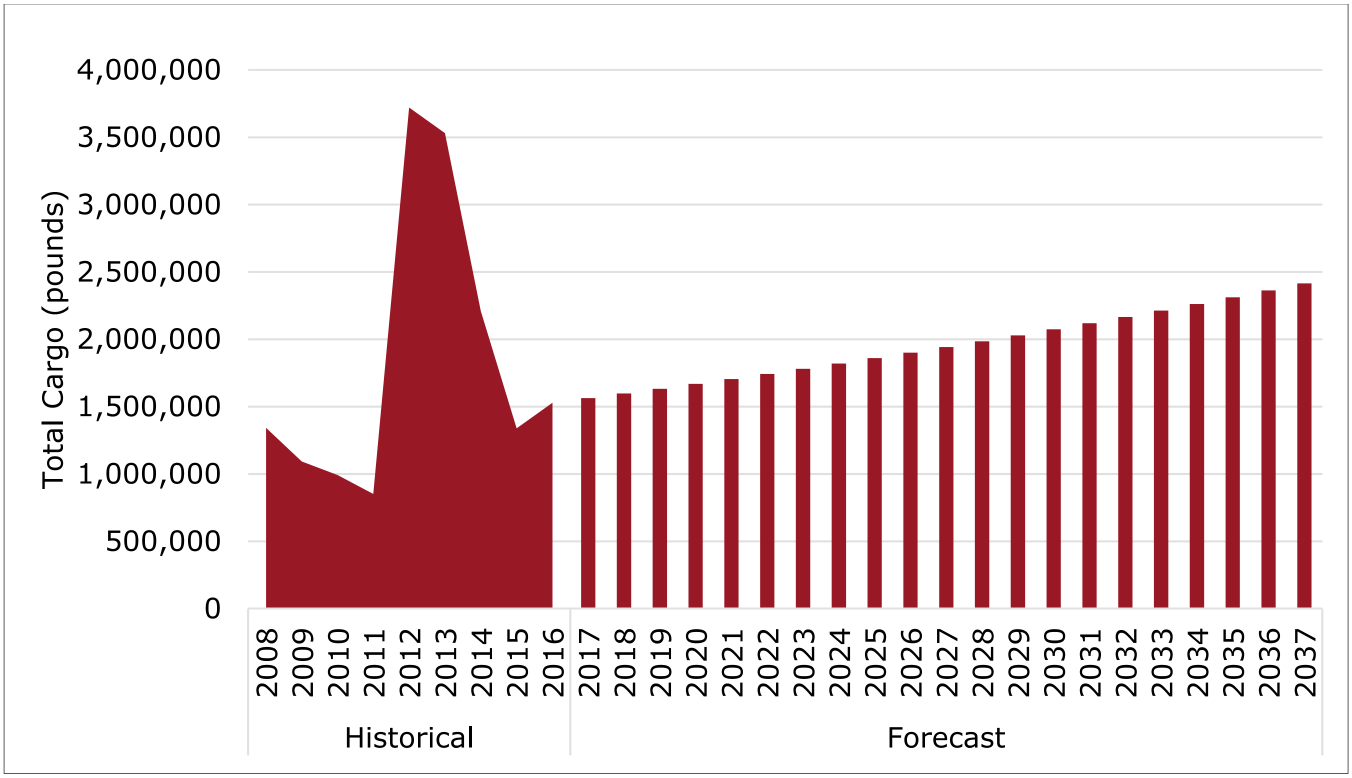
Total cargo operations are forecast to increase on average 2.2% annually based on trends for Intra-North America from the *Boeing World Air Cargo Forecast 2017-2036* and *Airbus Global Market Forecast 2017-2036*. Cargo operations are expected to increase from 716 in 2016 to 1,130 in 2037 (see **Exhibit 2-11, *Cargo Operations Forecast***). Cargo volumes are expected to stay in line with operations growth, increasing 2.2% on average annually from 1,529,000 pounds in 2016 to 2,414,700 pounds in 2037 (see **Exhibit 2-12, *Cargo Volumes Forecast***).

EXHIBIT 2-11 CARGO OPERATIONS FORECAST



Sources: Airport Data; Boeing World Air Cargo Forecast 2017-2036; Airbus Global Market Forecast 2017-2036; Landrum & Brown analysis.

EXHIBIT 2-12 CARGO VOLUMES FORECAST



Note: Includes belly cargo pounds.
Sources: Airport Data; Boeing World Air Cargo Forecast 2017-2036; Airbus Global Market Forecast 2017-2036; Landrum & Brown analysis.

2.4.2 General Aviation/ Air Taxi/ Military Operations

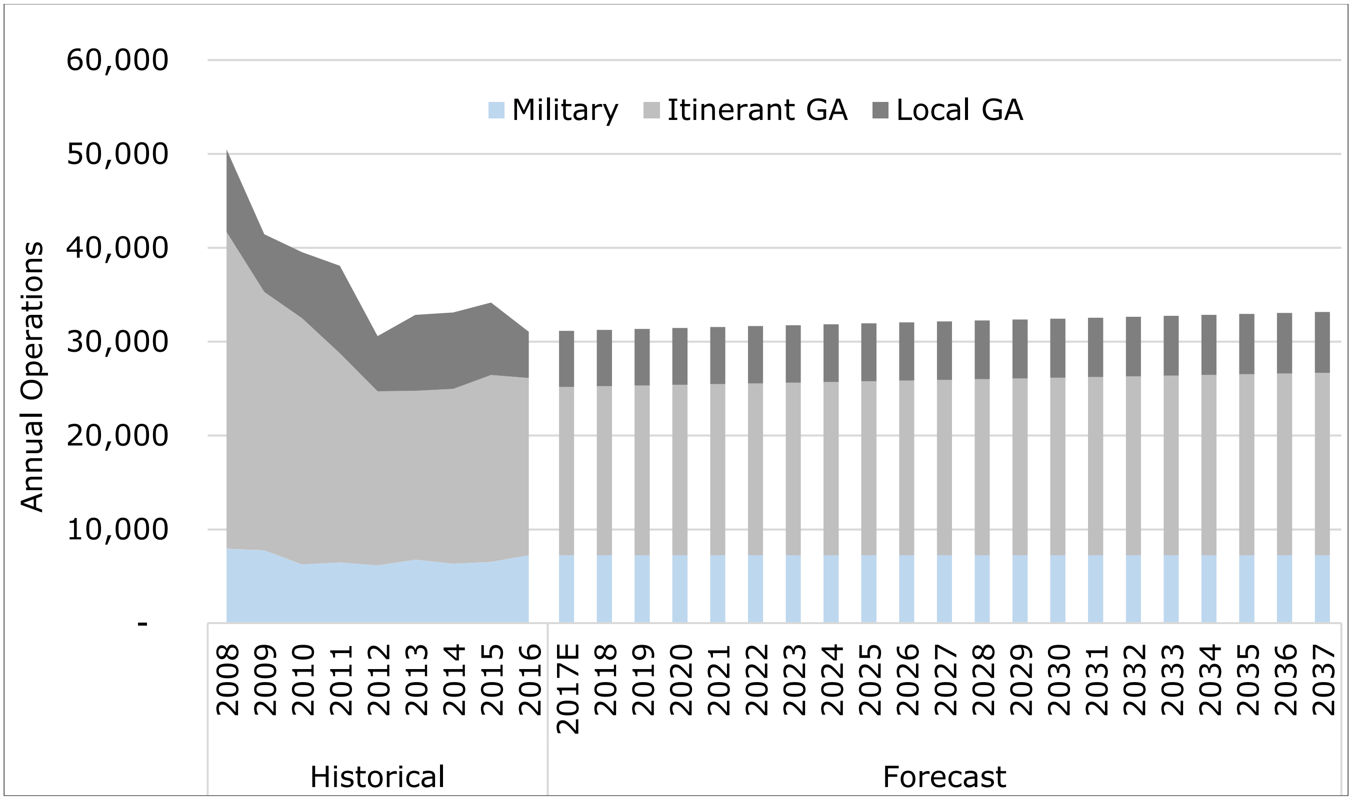
General aviation activity includes all operations which are not composed of commercial passenger, cargo, or military operations. General aviation activity includes diverse uses such as recreational flying, flight training activities, business travel, news reporting, traffic observation, police patrol, emergency medical flights, civil air patrol, and even crop dusting. The FAA publishes general aviation activity forecasts for the U.S. aviation industry annually.

General aviation operations can be subdivided into two major subcategories: “itinerant” and “local” based on FAA classifications. Local operations are defined by the FAA as “operations remaining in the local traffic pattern, simulated instrument approaches at the airport…and operations to or from the airport and a practice area within a 20-mile radius of the tower.” Itinerant operations are all operations not classified as “local.”

The FAA’s Traffic Flow Management System Counts (TFMSC) data was reviewed to determine typical destinations for itinerant general aviation operations, in particular for jets. The most demanding general aviation jets in the fleet are the Falcons, Gulfstream Vs, and Learjets. These aircraft on average travel 367 nautical miles, 293 nautical miles, and 355 nautical miles per trip, respectively. Some of these general aviation jet aircraft travel a distance of up to 2,824 nautical miles to and from CRW, including destinations such as Anchorage, Alaska and Oakland, San Jose, and Van Nuys in California.

The general aviation operations forecast for CRW is based on applying the expected growth rate of national general aviation operations forecast published in the *FAA Aerospace Forecast, Fiscal Years 2017-2037*. The FAA projects that general aviation operations at airports with FAA and Contract Control Towers will average growth of 0.3% per year through 2037. By maintaining the same market share of national general aviation operations, general aviation operations at CRW will grow at the same 0.3% per year, increasing from 23,800 operations in 2016 to 25,900 operations in 2037. Local general aviation operations are forecast to remain 25% of total general aviation operations throughout the forecast period. Military operations are expected to remain constant at 7,250 operations throughout the forecast period (see **Exhibit 2-13, *General Aviation/Air Taxi/Military Operations Forecast***).

EXHIBIT 2-13 GENERAL AVIATION/AIR TAXI/MILITARY OPERATIONS FORECAST

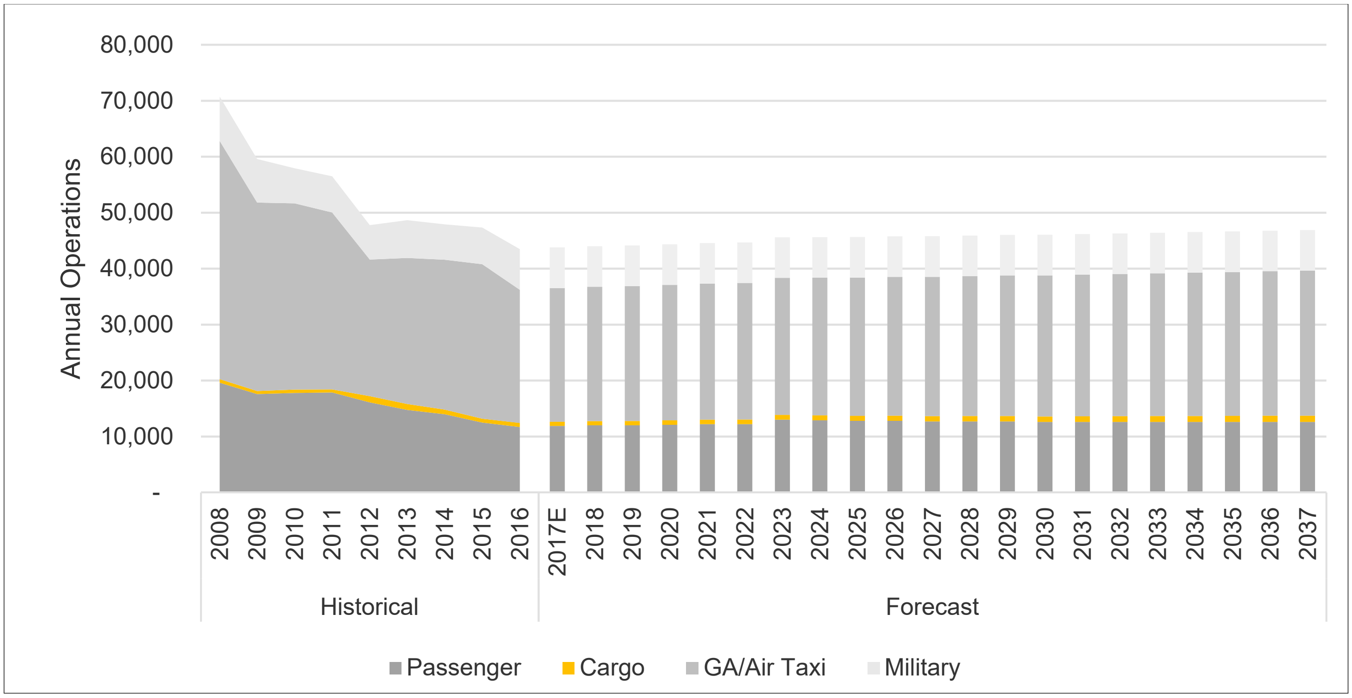


Sources: Airport Data; Landrum & Brown analysis.

2.4.3 Total Operations

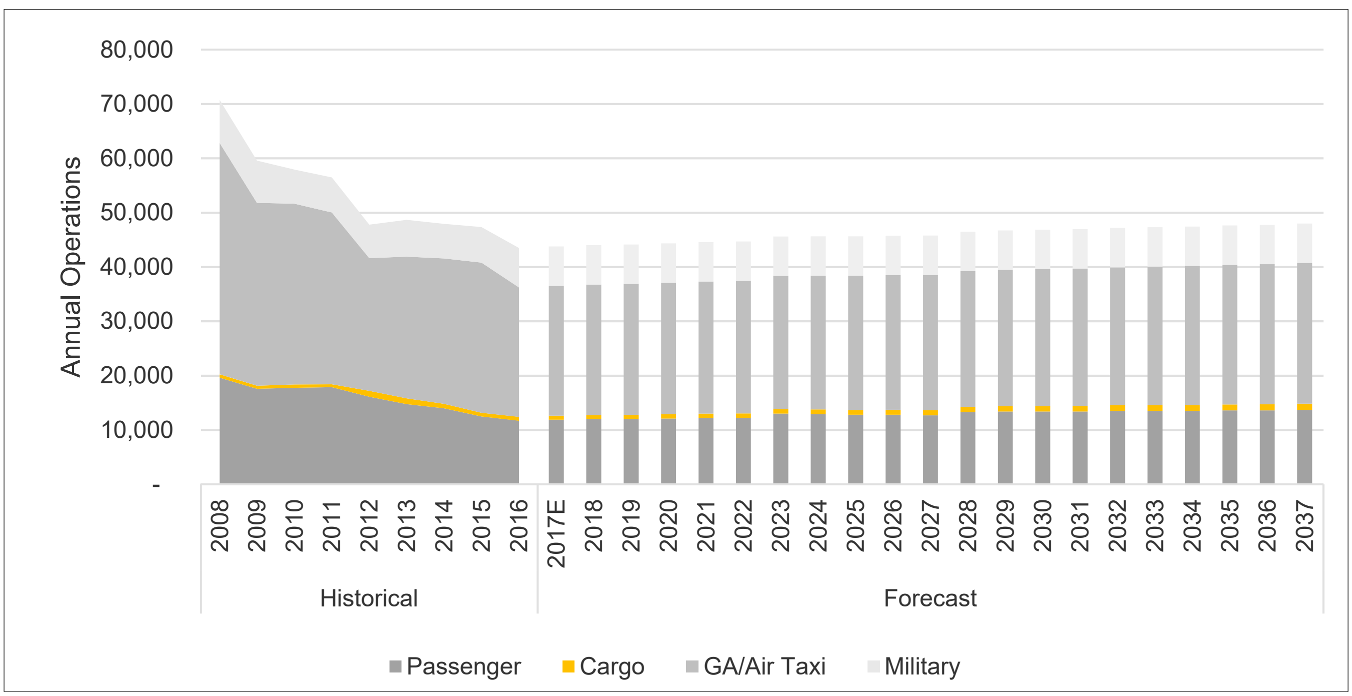
Total operations with the base passenger operations forecast are expected to increase 0.4% annually over the forecast period from 43,467 in 2016 to 46,880 in 2037 (see **Exhibit 2-14, *Total Operations Forecast with Base Passenger Operations***). Total operations with the high passenger operations are expected to increase 0.5% annually over the forecast period from 43,467 in 2016 to 47,980 in 2037 (see **Exhibit 2-15, *Total Operations Forecast with High Passenger Operations***).

EXHIBIT 2-14 TOTAL OPERATIONS FORECAST WITH BASE PASSENGER OPERATIONS



Sources: Airport Data; Landrum & Brown analysis.

EXHIBIT 2-15 TOTAL OPERATIONS FORECAST WITH HIGH PASSENGER OPERATIONS



Sources: Airport Data; Landrum & Brown analysis.

2.5 Fleet Mix Forecast

The fleet mix results are displayed in this section. **Table 2-9, *Base Forecast – Commercial Passenger Fleet Mix***, and **Table 2-10, *High Forecast – Commercial Passenger Fleet Mix***, present the results of the commercial passenger operations fleet mix for the base and high forecasts.

TABLE 2-9 BASE FORECAST - COMMERCIAL PASSENGER FLEET MIX

AIRCRAFT	SEATS	2016	2017	2022	2027	2032	2037
320	150	0%	0%	0%	0%	1%	1%
319	124	4%	3%	2%	3%	2%	2%
73W	124	1%	2%	2%	2%	2%	2%
717	110	1%	1%	4%	3%	3%	0%
CS100	100	0%	0%	0%	1%	3%	4%
CRJ-900	76	0%	0%	0%	9%	10%	11%
CRJ-700	63	0%	0%	4%	46%	79%	79%
CRJ	50	37%	52%	43%	17%	0%	0%
ERJ/ER4	50	15%	15%	44%	19%	0%	0%
DH3	50	7%	0%	0%	0%	0%	0%
DH2	37	12%	11%	0%	0%	0%	0%
DH8	35	22%	15%	0%	0%	0%	0%
Total Operations		**11,700**	**11,900**	**12,200**	**12,700**	**12,600**	**12,600**

Note: Percentages may not total to 100% due to rounding.
Sources: Official Airline Guide; Landrum & Brown analysis

TABLE 2-10 HIGH FORECAST - COMMERCIAL PASSENGER FLEET MIX

AIRCRAFT	SEATS	2016	2017	2022	2027	2032	2037
320	150	0%	0%	0%	0%	4%	4%
319	124	4%	3%	2%	3%	2%	2%
73W	124	1%	2%	2%	2%	2%	2%
717	110	1%	1%	4%	3%	3%	0%
CS100	100	0%	0%	0%	1%	2%	4%
CRJ-900	76	0%	0%	0%	9%	9%	10%
CRJ-700	63	0%	0%	4%	46%	78%	78%
CRJ	50	37%	52%	43%	17%	0%	0%
ERJ/ER4	50	15%	15%	44%	19%	0%	0%
DH3	50	7%	0%	0%	0%	0%	0%
DH2	37	12%	11%	0%	0%	0%	0%
DH8	35	22%	15%	0%	0%	0%	0%
Total Operations		**11,700**	**11,900**	**12,200**	**12,700**	**13,500**	**13,700**

Note: Percentages may not total to 100% due to rounding.
Sources: Official Airline Guide; Landrum & Brown analysis.

Table 2-11, *Cargo Fleet Mix*, presents the results for the cargo fleet mix. All DC93s, DC91s, and B722s are expected to be taken out of the fleet by 2022. It is expected a potential substitute aircraft is the B73F. It is assumed that the Shorts 330/360 will be replaced with ATR42s by 2032, and the ATR72s aircraft will remain in the fleet over the forecast period.

TABLE 2-11 CARGO FLEET MIX

AIRCRAFT TYPE	2016	2017	2022	2027	2032	2037
Shorts 330/360	79%	79%	80%	80%	0%	0%
ATR72	12%	12%	12%	12%	12%	12%
ATR42	0%	0%	0%	0%	80%	79%
Boeing 722	2%	2%	0%	0%	0%	0%
DC93/DC91	8%	8%	0%	0%	0%	0%
Boeing 73F	0%	0%	8%	8%	8%	9%
Total	**719**	**730**	**830**	**930**	**1,030**	**1,130**

Note: Percentages may not total to 100% due to rounding.
Sources: FAA Traffic Flow Management System Counts (TFMSC); Boeing World Air Cargo Forecast 2017-2036; Landrum & Brown analysis.

Table 2-12, *General Aviation Fleet Mix*, presents the results of the general aviation fleet. The general aviation fleet mix was based on the Active General Aviation and Air Taxi Aircraft table from the FAA *Aerospace Forecast 2017-2037.* These average annual growth rates were slightly adjusted based on the current fleet mix at CRW.

TABLE 2-12 GENERAL AVIATION FLEET MIX

AIRCRAFT TYPE	2016	2017	2022	2027	2032	2037
Single Engine Piston	25%	25%	23%	22%	20%	19%
Twin-Piston	17%	17%	16%	15%	14%	14%
Single Engine Turboprop	12%	12%	12%	12%	11%	9%
Twin-Turboprop	19%	19%	20%	20%	21%	21%
Jet	27%	27%	29%	31%	34%	37%
Total	**23,799**	**23,900**	**24,400**	**24,900**	**25,400**	**25,900**

Sources: Airport Data; FAA Aerospace Forecast 2017-2037; Landrum & Brown analysis.

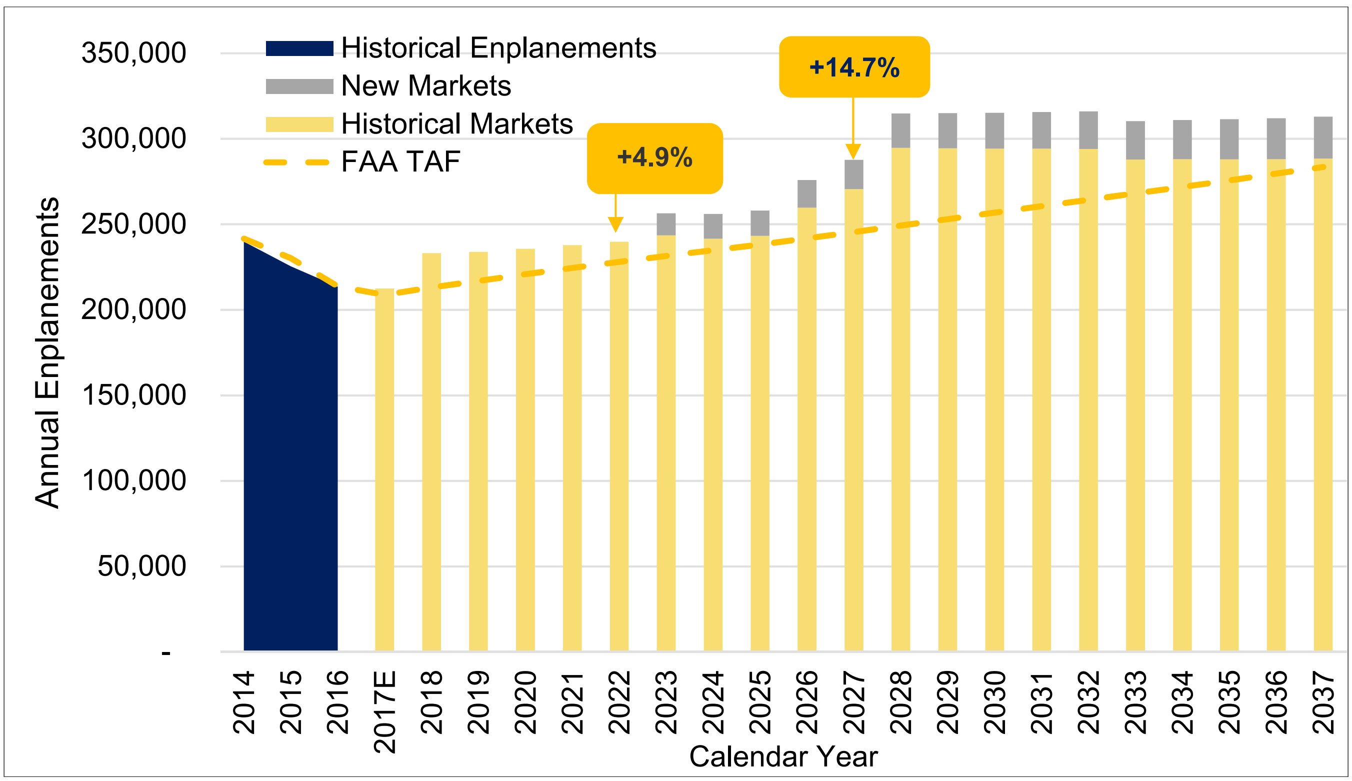
2.6 Comparison to FAA Terminal Area Forecast

The FAA publishes its own forecasts annually for each U.S. airport including CRW. The FAA requires that Master Plan enplanement and operations forecasts be compared with the most current Terminal Area Forecast (TAF) for CRW. If the Airfield Master Plan forecast deviates by more than 10% from the TAF in the 5-year time period or by more than 15% in the 10-year time period, differences must be resolved before proceeding with further planning. This section compares the enplaned passenger and operations totals for the CRW Master Plan base forecast with the 2016 TAF (released in early 2017). The Master Plan forecasts do not exceed the 10% (5-year) and 15% (10-year) ranges when compared to the 2016 TAF.

2.6.1 Enplaned Passenger Forecast Comparison

The FAA 2016 TAF predicts enplanements will increase at an average annual rate of 1.4% from 2016 through 2037 compared to 2.4% in the Master Plan base forecast (see **Exhibit 2-16, *Master Plan Base Enplanements Forecast vs. 2016 FAA TAF***). The Master Plan base forecast is within 4.9% in the first five years and 14.7% in the first ten years.

EXHIBIT 2-16 MASTER PLAN BASE ENPLANEMENTS FORECAST VS. 2016 FAA TAF

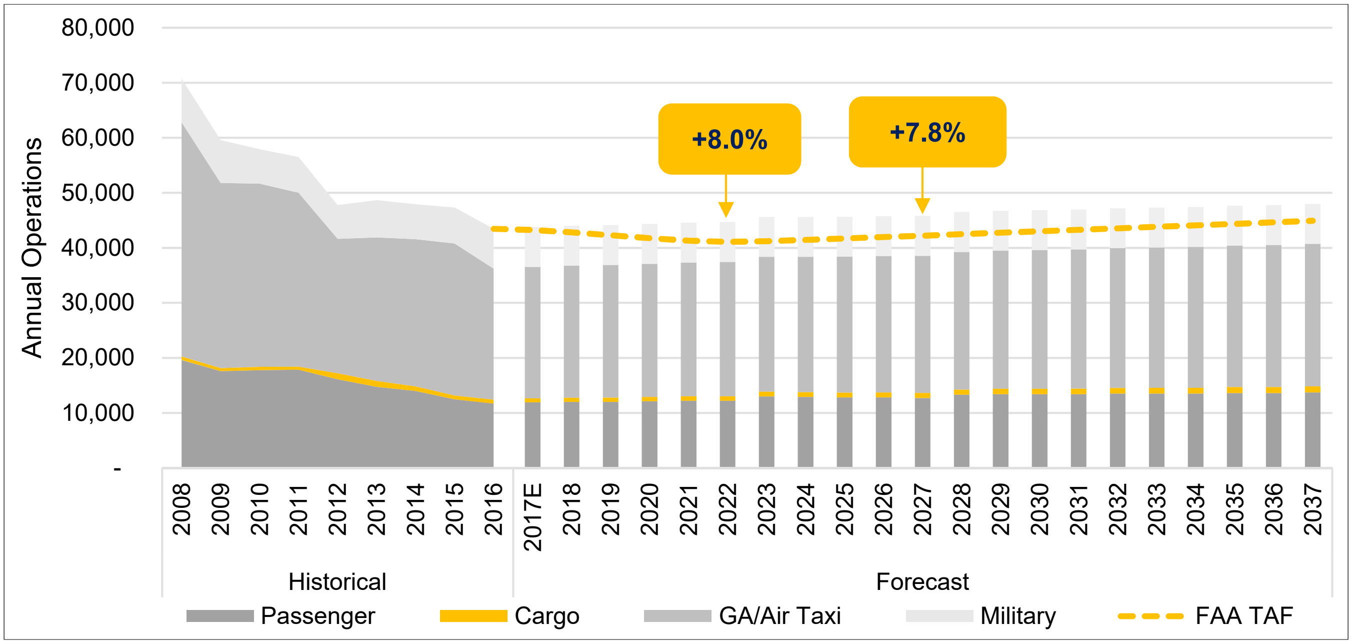


Sources: Airport Data; FAA 2016 Terminal Area Forecast; Landrum & Brown analysis.

2.6.2 Total Aircraft Operations Forecast Comparison

The total operations forecasts developed for the Master Plan base forecast were also compared to the FAA's 2016 TAF. The FAA 2016 TAF predicts operations will increase at an average annual rate of 0.2% from 2016 through 2037 compared to 0.4% in the Master Plan base forecast (see **Exhibit 2-17, *Operations Forecast vs. 2016 FAA TAF***). The Master Plan base forecast is within 8.0% in the first five years and 7.8% in the first ten years.

EXHIBIT 2-17 OPERATIONS FORECAST VS. 2016 FAA TAF



Sources: Airport Data; FAA 2016 Terminal Area Forecast; Landrum & Brown analysis.

2.7 Future Critical Aircraft

Recently released FAA Advisory Circular 150/5000-17, *Critical Aircraft and Regular Use Determination,* defines a critical aircraft as the most demanding aircraft type, or grouping of aircraft with similar characteristics, that makes regular use of the airport. Regular use is at least 500 annual operations, including both itinerant and local operations but excluding touch-and-go operations.

Different aircraft may represent the critical aircraft for separate design components of the Airport. It is important to consider different and multiple critical aircraft for the airfield design components found in **Table 2-13, *CRW Future Critical Aircraft Components***. The table defines the critical aircraft for each airfield design component at CRW based on the base fleet mix forecast.

TABLE 2-13 CRW FUTURE CRITICAL AIRCRAFT COMPONENTS

CRITICAL AIRCRAFT DESIGN COMPONENT	FUTURE CRITICAL AIRCRAFT	2037 AIRCRAFT OPERATIONS
GENERAL AIRFIELD COMPONENTS		
Aircraft Approach Category (AAC)	B737-700 and CS-100 (AAC-C)	744 Combined
Airplane Design Group (ADG)	B737-700 and CS-100 (ADG-III)	
Taxiway Design Group	B737-700 and CS-100 (TDG-3)	
EMAS	TBD[1]	N/A
RUNWAY COMPONENTS (RUNWAY 05-23)		
Runway Design Code (RDC)	B737-700 and CS-100 (RDC C-III)	744 Combined
Runway Length	CRJ-900	1,408

[1] The EMB145 is the current critical aircraft for the EMAS, however, it is not expected to be in the fleet mix by 2037. A future critical aircraft for EMAS will be determined later in the Master Plan.

Sources: Airport Data; FAA Aerospace Forecast 2017-2037; Landrum & Brown analysis.

The critical aircraft for Aircraft Approach Category (AAC), Airplane Design Group (ADG), and Taxiway Design Group (TDG) is a combination of the B737-700 and CS-100. These two aircraft are the most demanding aircraft projected to operate at CRW in 2037 that will have 500 annual operations. Together these two aircraft are projected to have 744 annual operations in 2037. The CRJ-900 has the longest runway length requirement (on the DFW and IAH routes) in the forecast fleet. It is projected to have 1,408 annual operations in 2037.

3 Requirements

This chapter presents the future airfield requirements for Yeager Airport (CRW). The airfield requirements were calculated in accordance with the standards and recommendations provided by the Federal Aviation Administration (FAA). The requirements identified in this chapter will be used to identify reasonable and prudent alternatives that will allow CRW to serve forecast demand throughout the planning period. The CRW airside facility requirements are presented in the following sections:

- Airside Capacity
- Runway Length Requirements
- Obstructions
- Lighting and Navigational Aids (NAVAIDS)
- Airfield Design Requirements
- Other Airfield Requirements

3.1 Airside Capacity

CRW has a single runway – Runway 05-23. The 2010 CRW Master Plan identified that Runway 05-23 can accommodate 205,000 annual operations. The Master Plan forecast projects that annual aircraft operations could range from 46,880 (base case forecast) operations to 47,980 (high case forecast) operations in 2037. Both forecasts are well below the capacity of the runway. As a result, airside capacity was not evaluated further in this Airfield Master Plan.

3.2 Runway Length Requirements

A runway length analysis was performed to provide recommendations on the runway lengths needed to accommodate the CRW aircraft fleet throughout the planning period. For each aircraft in the fleet, takeoff and landing length requirements were calculated.

It is important to note that individual operators (airlines) may have more stringent policies that will require additional runway length than what is depicted in this planning analysis. The differences can occur due to safety and other airline-related factors, such as insurance requirements.

3.2.1 Existing Runway Lengths

Runway 05-23 is 6,800 feet long. The full length of this runway is not available for landings and takeoffs due to the application of declared distances.[1] Declared distances are needed at CRW in order to maximize the landing and takeoff distances available for aircraft and the length of the Runway Safety Area (RSA) on both runway ends. Declared distances were applied to Runway 05-23 in 2007. These distances were reduced in 2015 after a slope failure destroyed the Runway 05 Engineered

[1] Per FAA Advisory Circular 150/5300-13A, *Airport Design*, declared distances are “the distances the airport operator declares available for a turbine powered aircraft’s takeoff run, takeoff distance, accelerate-stop distance, and landing distance requirements.”

Materials Arresting System (EMAS). The lengths available in 2017 are shown in **Table 3-1, *Existing Runway 05-23 Declared Distances***.

TABLE 3-1 EXISTING RUNWAY 05-23 DECLARED DISTANCES

DECLARED DISTANCES	RUNWAY 5 (in feet)	RUNWAY 23 (in feet)
TORA	6,802	6,802
TODA	6,802	6,802
ASDA	6,302	6,302
LDA	5,725	5,802

Note: TORA = Takeoff Runway Available, TODA = Takeoff Distance Available, ASDA = Accelerate Stop Distance Available, LDA = Landing Distance Available
Sources: FAA Aeronautical Information Services - National Flight Data Center (NFDC), 2017.

The Airport recently conducted the 2017 *Interim Runway Safety Area Study* (2017 RSA Study) with the goal of quickly improving safety and restoring air service capabilities. The study recommended the installation of a new EMAS and a retaining wall to increase the declared distances available for aircraft. The project is currently in the design stages and is expected to be completed by the spring of 2019. The lengths that will be available upon completion of the project are shown **in Table 3-2, *Planned Runway 05-23 Declared Distances***.

TABLE 3-2 PLANNED RUNWAY 05-23 DECLARED DISTANCES

DECLARED DISTANCES	RUNWAY 5 (in feet)	RUNWAY 23 (in feet)
TORA	6,715	6,715
TODA	6,715	6,715
ASDA	6,215	6,715
LDA	6,015	6,215

Notes: TORA = Takeoff Runway Available, TODA = Takeoff Distance Available, ASDA = Accelerate Stop Distance Available, LDA = Landing Distance Available
Sources: 2017 RSA Study.

3.2.2 Runway Length Analysis Methodology

The charts found in the aircraft manufacturer's airport planning manuals were utilized, where possible, in conjunction with both the base case and high case forecast fleet mixes to calculate the future runway length requirements specific to conditions at CRW. The existing runway length requirements were obtained from the 2017 RSA Study. The existing requirements in that study were calculated based on the same methodology as the future requirements in this study.

The runway length an aircraft requires is based on a number of factors including:

- Density Altitude
- Aircraft Fleet and Weight
- Runway Characteristics

3.2.2.1 Density Altitude

Density altitude is a natural phenomenon that decreases aircraft and engine performance. It is a function of an airport's elevation and temperature. The higher the elevation and/or temperature, the higher the density altitude and its effects will be. Because higher density altitude decreases an aircraft's operational performance, longer runway distances are required for takeoffs and landings.

Temperature

The aircraft manufacturers' manuals contain charts to calculate takeoff runway length requirements based on temperature. The calculations are based on a "standard day" (defined as 59 degrees Fahrenheit) or a "hot day." The hot day charts in the aircraft manufacturers' manuals are based on different definitions of hot day, ranging from 84 to 87 degrees Fahrenheit.

The determination of which temperature chart to use depends upon the average or typical weather conditions for a particular region or airport. The mean daily maximum temperature at CRW is 85.6 degrees Fahrenheit[2] for the hottest month in the summer, making the hot day charts most appropriate. Therefore, the takeoff runway length requirements were calculated using the aircraft manufacturer's manuals for hot day conditions.

The aircraft manufacturers' performance manuals for landing requirements only contain charts for standard day. Therefore, landing lengths were assessed at standard day temperatures.

Elevation

CRW's elevation is 947.2 feet Above Mean Sea Level (AMSL).[3]

2 United States Department of Commerce, National Oceanic & Atmospheric Administration, National Climatic Data Center (NCDC), Summary of Monthly Normal 1981-2010, Charleston Yeager Airport, WV, US. Generated data March 30, 2017.

3 Yeager Airport Layout Plan (ALP), Airport Data Sheet, 2017.

3.2.2.2 Aircraft Fleet and Weight

The representative fleet mixes for the CRW runway length analysis were obtained from the aviation demand forecast discussed in the previous chapter. The forecast contains two sets of aircraft and destinations for passenger aircraft: (1) base case scenario and (2) high case scenario. Differences between the scenarios include different aircraft types, markets, and annual operations counts. There is only one fleet mix for cargo and general aviation aircraft.

The weight of an aircraft is a key factor in determining runway length requirements. Future landing runway length requirements were calculated at Maximum Landing Weight (MLW) because the charts in the aircraft manufacturers' manuals are only available at MLW. Conversely, the takeoff runway length charts allow takeoff requirements to be calculated based on reduced weights. An aircraft's takeoff weight is the sum of three parts:

Takeoff Weight = Operating Empty Weight (OEW) + Payload + Fuel Load

An aircraft carrying a full load of fuel and/or payload will have a longer runway length than if the fuel and/or payload were reduced. Most aircraft departing from CRW are not taking off at Maximum Takeoff Weight (MTOW) because most are not flying to long-haul destinations and do not require a full load of fuel to reach their destination. Therefore, the future takeoff runway length requirements for the CRW passenger and cargo fleet were calculated based on the amount of fuel needed to reach the forecast destinations at maximum payload.

The fuel load was calculated by destination and is typically determined using the payload/range charts found in each aircraft manufacturer's airport planning manual. However, some payload/range charts do not contain enough information to calculate a takeoff weight based on a specific destination. For these select few, a different methodology was used to determine the takeoff weight. Alternative methodologies were needed for the Airbus A319 and A320 and the Bombardier CS100 and CRJ-900. Further details on the alternative methodologies used for these four aircraft can be found in **Appendix B, *Runway Length Analysis – Methodology Exceptions***.

General aviation runway length requirements were calculated using a MTOW methodology with no payload restrictions. A destination analysis was not completed for general aviation aircraft analysis because the payload/range charts for many of these aircraft do not contain sufficient information to calculate a takeoff weight based on a specific destination.

3.2.2.3 Runway Characteristics

Runway characteristics are a factor in runway length analyses as described in the subsections that follow.

Runway Gradient

The takeoff and landing charts in the aircraft manuals are based on a runway slope of zero. An aircraft taking off on an uphill gradient requires more runway length than it does on a flat or downhill slope. The average runway gradient for Runway 05-23 is 0.7% because the Runway 23 threshold is 52 feet higher than Runway 05 threshold. The FAA formula for correcting runway length requirements is to add 10 feet of runway length for every foot of elevation increase. Accordingly, runway lengths for Runway 23 departures are 520 feet greater than those required for a runway with no slope. Therefore, this calculation was added into the takeoff length requirements.

Runway Contamination

Landing runway length requirements can be calculated for wet (contaminated) or dry runways. This study used wet runway conditions as required by FAA Advisory Circular (AC) 150/5325-4B, *Runway Length Requirements for Airport Design*. Wet conditions require longer runways for landing than dry conditions, due to the additional distance needed to decelerate on wet pavement. For those aircraft where the aircraft performance manuals do not specifically show a wet landing length curve, the dry landing length was increased by 15% as specified in the FAA's runway length AC.

3.2.3 Existing Runway Length Requirements

The 2017 RSA Study determined that the existing runway length requirements for CRW are as follows based on the 2016 and 2017 fleet:

- 6,000 feet of Landing Distance Available (LDA) in both runway directions
- 6,300 feet of Accelerate Stop Distance Available (ASDA) in the Runway 05 direction
- 6,820 feet of ASDA in the Runway 23 direction[4]

The landing requirement of 6,000 feet was determined based on the existing fleet and potential airline service. The takeoff requirement of 6,300 feet (Runway 05) and 6,820 feet (Runway 23) is based on the existing EMB145 service to Houston.

4 An additional 520 feet was added to the Runway 23 requirement for the uphill effective runway gradient.

The 2017 RSA Study preferred alternative meets the recommended LDA requirements for CRW but does not meet the ASDA need in either direction. The declared distances for the preferred alternative are compared to the recommended requirement in **Table 3-3, *Planned Runway 05-23 Declared Distances Versus Existing Requirements***. Based on this information, additional ASDA length is needed on both runway ends to allow the airlines to serve their existing markets without restrictions from CRW.

TABLE 3-3 PLANNED RUNWAY 05-23 DECLARED DISTANCES VERSUS EXISTING REQUIREMENTS

DECLARED DISTANCES	RUNWAY 05 REQUIREMENT[1] (in feet)	RUNWAY 23 REQUIREMENT[1] (in feet)	NEW RUNWAY 05 LENGTH (in feet)	NEW RUNWAY 23 LENGTH (in feet)
LDA	6,000	6,000	6,015	6,215
ASDA	6,300	6,820	6,215	6,715

1 Requirements rounded to nearest 100 feet.
Sources: Interim Runway Safety Area Study, 2017 and Landrum & Brown analysis.

3.2.4 Future Runway Length Requirements

The future landing and takeoff requirements were calculated based on the methodology described in Section 3.2.2, *Runway Length Analysis Methodology*. Runway length requirements were calculated for the short-term (2027) and long-term (2037) planning periods. Both the base case and high case forecast were used for conducting the takeoff requirements analysis given their differing destinations and operations counts. These were not significant in the landing length analysis; therefore, only one landing length analysis was conducted.

3.2.4.1 Future Takeoff Runway Length Requirements

The future takeoff runway length requirements are depicted for both the base forecast and high forecast in **Table 3-4, *Takeoff Runway Length Requirements – Base Forecast*** and **Table 3-5, *Takeoff Runway Length Requirements – High Forecast***.

Learjets operating at CRW require the longest takeoff length (8,320 feet on a hot day), however, they are not projected to make up more than 500 annual operations at CRW in 2027 or 2037. The second longest takeoff length in the base case forecast is approximately 7,820 feet (CRJ-900) to Houston. The second longest takeoff length for the high case forecast scenario is 7,920 feet (A320) to Las Vegas. Both of these aircraft are projected to have at least 500 operations during the forecast period. The calculations for the two critical aircraft can be found in **Appendix C, *Runway Length Requirements for Critical Aircraft.***

TABLE 3-4 TAKEOFF RUNWAY LENGTHS REQUIREMENTS- BASE FORECAST

AIRCRAFT[1,2]	BASE FORECAST 2027			BASE FORECAST 2037		
	DESTINATION	OPS	RUNWAY LENGTH NEEDED (ft)	DESTINATION	OPS	RUNWAY LENGTH NEEDED (ft)
Learjets (Lear 55 used)	-	321	8,320	-	391	8,320
CRJ-900[3]	**IAH-848NM**	**1,148**	**7,820**	**IAH-848NM**	**1,408**	**7,820**
Falcon 2000 and Mystere (900 used)	-	90	7,320	-	109	7,320
Gulf 5 (550 used)	-	53	7,285	-	65	7,285
A320[4]	-	-	-	MCO- 596NM	188	6,820
Gulfstream IV (450 used)	-	37	6,735	-	45	6,735
Global	-	25	6,720	-	30	6,720
Challenger 600 (Challenger 300 used)	-	31	6,540	-	38	6,540
CS100 (90% MTOW)[5]	ATL- 316NM	148	6,320	ATL- 316NM	496	6,320
CRJ-700[6]	ATL- 316NM	5851	5,820	ATL- 316NM	10,000	5,820
B73F	MCI-618NM	78	5,420	MCI-618NM	97	5,420
B737-700W	ATL- 316NM	240	5,220	ATL- 316NM	248	5,220
Hawker 800 (Citation Latitude used)	-	200	4,950	-	244	4,950
A319[4]	MCO- 596NM	366	5,020	ATL- 316NM	248	4,920
Cessna Citation XLS	-	288	4,590	-	352	4,590
Cessna Citation V	-	352	4,340	-	429	4,340
Citation Mustang	-	10	4,330	-	12	4,330
Cessna Citation 1	-	226	4,170	-	276	4,170
B717	ATL- 316NM	392	7,320	-	-	-
CRJ-200	ATL- 316NM	2147	5,920	-	-	-
EMB145	ORD-362NM	2398	5,900	-	-	-

1. **Bold** indicates recommended takeoff length per planning period based upon critical aircraft guidelines and runway length requirements.
2. Some general aviation aircraft represent a conglomeration of aircraft that have comparable performance characteristics.
3. The CRJ-900 was run at MTOW since the range for MTOW on the aircraft is like that of the takeoff weight with maximum payload for the Houston (IAH) and Dallas (DFW) destinations.
4. The A319 and A320 airport planning manuals developed by the manufacturer do not contain enough data to determine decreased takeoff weights by destination. The A319 and A320 takeoff weights to determine runway length analysis were therefore calculated based on a fuel burn analysis.
5. The CS100 airport planning manuals developed by the manufacturer do not contain enough data to determine decreased takeoff weights by destination. The aircraft was analyzed at 90% of MTOW using the available information in the manufacturer's planning manual.
6. The CRJ700 to Atlanta (ATL) does not register on the payload-range charts. The lowest range the charts contain is 600 nautical miles so the aircraft was run at the 600-nautical mile range with the assumption that the takeoff length determined will be less than what is calculated from the charts.

Sources: *Aircraft Manufacturer's Airport Planning Manuals* and Landrum & Brown Analysis.

TABLE 3-5 TAKEOFF RUNWAY LENGTHS REQUIREMENTS- HIGH FORECAST

AIRCRAFT[1,2]	HIGH FORECAST 2027			HIGH FORECAST 2037		
	DESTINATION	OPS	RUNWAY LENGTH NEEDED (ft)	DESTINATION	OPS	RUNWAY LENGTH NEEDED (ft)
Learjets (Lear 55 used)	-	321	8,320	-	391	8,320
A320[3]	-	-	-	**LAS- 1,606NM**	**585**	**7,920**
CRJ-900[4]	**IAH-848NM**	**1,148**	**7,820**	IAH-848NM	1,408	7,820
Falcon 2000 and Mystere (900 used)	-	90	7,320	-	109	7,320
Gulf 5 (550 used)	-	53	7,285	-	65	7,285
Gulfstream IV (450 used)	-	37	6,735	-	45	6,735
Global	-	25	6,720	-	30	6,720
Challenger 600 (Challenger 300 used)	-	31	6,540	-	38	6,540
CS100 (90% MTOW)[5]	ATL- 316NM	148	6,320	ATL- 316NM	496	6,320
CRJ-700[6]	ORD-362NM	5851	5,820	DEN- 1,079NM	10,680	6,220
B73F	MCI-618NM	78	5,420	MCI-618NM	97	5,420
B737-700W	ATL- 316NM	240	5,220	ATL- 316NM	248	5,220
Hawker 800 (Citation Latitude used)	-	200	4,950	-	244	4,950
A319[3]	MCO- 596NM	366	5,020	ATL- 316NM	248	4,920
Cessna Citation XLS	-	288	4,590	-	352	4,590
Cessna Citation V	-	352	4,340	-	429	4,340
Citation Mustang	-	10	4,330	-	12	4,330
Cessna Citation 1	-	226	4,170	-	276	4,170
B717	ATL- 316NM	392	7,320	-	-	-
CRJ-200	ATL- 316NM	2147	5,920	-	-	-
EMB145	ORD-362NM	2398	5,900	-	-	-

1. **Bold** indicates recommended takeoff length per planning period based upon critical aircraft guidelines and runway length requirements.
2. Some general aviation aircraft represent a conglomeration of aircraft that have comparable performance characteristics.
3. The A319 and A320 airport planning manuals developed by the manufacturer do not contain enough data to determine decreased takeoff weights by destination. The A319 and A320 takeoff weights to determine runway length analysis were therefore calculated based on a fuel burn analysis.
4. The CRJ-900 was run at MTOW since the range for MTOW on the aircraft is like that of the takeoff weight with maximum payload for the Houston (IAH) and Dallas (DFW) destinations.
5. The CS100 airport planning manuals developed by the manufacturer do not contain enough data to determine decreased takeoff weights by destination. The aircraft was analyzed at 90% of MTOW using the available information in the manufacturer's planning manual.
6. The CRJ-700 to Atlanta (ATL) does not register on the payload-range charts. The lowest range the charts contain is 600 nautical miles so the aircraft was run at the 600-nautical mile range with the assumption that the takeoff length determined will be less than what is calculated from the charts.

Sources: *Aircraft Manufacturer's Airport Planning Manuals* and Landrum & Brown Analysis.

3.2.4.2 Future Landing Runway Length Requirements

The landing lengths needed throughout the planning period are depicted for 2027 and 2037 in **Table 3-6, *Landing Runway Length Requirements***. The landing requirements were calculated using MLW for all aircraft in the fleet. The analysis resulted in a recommended maximum landing length requirement of 6,600 feet for the CRJ-900. The calculations for this critical aircraft are in Appendix C.

TABLE 3-6 LANDING RUNWAY LENGTH REQUIREMENTS

AIRCRAFT	MLW(lbs)	DRY LANDING LENGTH NEEDED (ft)	WET LANDING LENGTH NEEDED (ft)
Gulf 5 (550 used)	75,300	6,400	7,400
CRJ-900	**75,100**	**5,700**	**6,600**
Gulfstream IV (450 used)	66,000	5,500	6,300
A320	148,591	5,200	6,000
CRJ-700	67,000	5,200	6,000
B73F	129,200	N/A	5,700
737-700W	129,200	N/A	5,700
A319	137,789	4,900	5,600
B717	102,000	N/A	5,600
CRJ-200	44,700	N/A	5,500
EMB145	44,092	N/A	5,500
CS100	115,500	4,600	5,300
Challenger 600 (Challenger 300 used)	33,750	N/A	5,100
Falcon 2000 and Mystere (900 used)	42,000	3,600	4,100
Cessna Citation XLS	18,700	3,400	3,900
Learjets (Lear 55 used)	18,000	3,300	3,800
Cessna Citation V	15,200	3,100	3,500
Global	78,600	2,700	3,100
Hawker 800 (Citation Latitude used)	27,575	2,600	3,000
Citation Mustang	8,000	2,600	2,900
Cessna Citation 1	11,350	2,500	2,900

Note: Bold indicates recommended landing length based upon critical aircraft guidelines and runway length. Landing lengths are rounded to the nearest 100 feet.
Sources: *Aircraft Manufacturer's Airport Planning Manuals* and Landrum & Brown Analysis.

3.2.4.3 Military Runway Length Requirements

CRW is a joint use civil aviation/Air National Guard airport. It is home to the West Virginia Air National Guard (WVANG) 130th Airlift Wing (130 AW). The WVANG operates mainly C-130s at CRW, which typically do not require more runway length than the other operators at the Airport. However, personnel from the WVANG have indicated that they would require 8,000 feet. This length would not be eligible for FAA funding unless it is also needed for civilian aircraft. However, it is important to note the military need due to the joint-use nature of the Airport; military funding could possibly be pursued.

3.2.5 Runway Length Requirements Summary

The future runway length requirements at CRW are shown in **Table 3-7, *Runway Length Requirements***. It is recommended that these runway lengths be considered in the Master Plan alternatives analysis.

TABLE 3-7 RUNWAY LENGTH REQUIREMENTS

OPERATION/ FORECAST SCENARIO	RUNWAY LENGTH REQUIREMENT (in feet)	
	2027	2037
Landing Requirement	6,600	6,600
Base Case Takeoff Requirement	7,820	7,820
High Case Takeoff Requirement	7,820	7,920
Military Requirement	8,000	8,000

Sources: *Aircraft Manufacturer's Airport Planning Manuals* and Landrum & Brown Analysis.

3.3 Obstructions

Federal Aviation Regulations (FAR) Part 77 defines the standards by which obstructions are identified within the navigable airspace in and around airports. This is accomplished by defining specific airspace areas (referred to as "imaginary surfaces") around an airport that cannot contain any protruding objects. An object or terrain is an obstruction to air navigation if it penetrates an imaginary surface or is of greater height than allowed under other specific conditions described in FAR Part 77. The dimensions of the FAR Part 77 surfaces vary depending on the type of runway approach, which is dependent on the type of instrumentation and lighting available on the runway.

FAA United States Standard for Terminal Instrument Procedures (TERPS) provides criteria for designing instrument flight procedures for arrivals and departures. TERPS determines the weather conditions under which arrivals and departures can occur on a particular runway, in part based upon any obstructions.

Although the FAA can determine which structures are obstructions to air navigation; the FAA is not authorized to limit structure height or determine which structures should be lighted and marked. Local authorities have control over the appropriate use of property beneath an airport's airspace. If an obstruction cannot be removed and the obstruction is deemed a hazard to air navigation, the threshold of a runway can be displaced so the object or terrain is no longer an obstruction to the approach. Another option for addressing obstructions is to raise the minima (weather conditions) under which arrivals can utilize the runway based on TERPS criteria.

The obstructions to air navigation at CRW will be evaluated during the alternatives phase of the Master Plan. Any identified obstructions will need to be mitigated through the use of trimming, removing, or lighting to the extent that is most practical, based upon coordination with the FAA.

3.4 Lighting and Navigational Aids

The instrumentation and lighting systems available on a runway determine the ability of an aircraft to land in poor weather conditions. In addition, if there are obstructions to the approach surface of a runway, the minima are increased, which limits the amount of time a runway can be used.

3.4.1 Existing Runway Approach Capability

Runway 05-23 has conventional ground-based navigational systems that assist pilots in finding the runway during Instrument Meteorological Conditions (IMC), as described in Chapter 1, *Inventory*, Section 1.5.4, *Lighting and Navigational Aids*. In addition to the ground-based systems, both runway ends have published area navigation (RNAV)[5] Global Positioning System (GPS) and RNAV Required Navigational Performance (RNP) approaches. RNAV equipment can sometimes allow aircraft to operate under more stringent ceiling and visibility minima, however, this type of equipment is not readily available on all aircraft. The existing conventional and RNAV approach minima for CRW are shown in **Table 3-8, *Existing Approach Minima***.

For the purpose of the Master Plan, this section focuses on the conventional ground-based systems. Runway 23 is equipped with a Category I (CAT I) Instrument Landing System (ILS), with minima of 250-foot ceiling and 24 Runway Visual Range (RVR). Runway 23 cannot obtain the lowest possible CAT I minima due to obstructions.

Runway 05 is limited to a localizer approach because the glide slope is not available (due to the slope failure and resulting displacement of the Runway 05 threshold); it also does not have an approach lighting system. Therefore, its minima are higher (673-foot ceiling and 55 RVR). The glide slope is expected to be restored in the spring of 2019 as part of the Runway 05 RSA project, which is currently in design. Once the glide slope is restored, the minima on Runway 05 will decrease, but will still be limited due to the lack of an approach lighting system.

5 RNAV allows aircraft to use satellite signals to fly a desired flight path without the limitations of ground-based navigation systems.

TABLE 3-8 EXISTING APPROACH MINIMA

RUNWAY END	TYPE OF APPROACH[1]	CEILING (in feet)	VISIBILITY (miles or RVR)
Conventional Approaches			
Runway 05	LOC	673	55 RVR
Runway 23	ILS – CAT I	250	24 RVR
Runway 23	LOC	709	1 ½ miles
RNAV Approaches			
Runway 05	RNAV GPS Y - LPV	250	1 mile
Runway 05	RNAV RNP Z – 0.10 DA	250	50 RVR
Runway 05	RNAV GPS Y – LNAV MDA	613	1 ¾ miles
Runway 05	RNAV GPS Y – LNAV/VNAV DA	631	2 ½ miles
Runway 05	RNAV RNP Z – 0.30 DA	649	2 ½ miles
Runway 23	RNAV GPS Y – LPV	200	24 RVR
Runway 23	RNAV RNP Z – 0.30 DA	488	60 RVR
Runway 23	RNAV GPS Y – LNAV MDA	569	1 3/8 miles
Runway 23	RNAV GPS Y – LNAV/VNAV DA	670	1 7/8 miles

1. Aircraft Approach Category C was used to determine minima.

Note:. RVR = Runway Visual Range, RNAV = Area Navigation, LOC = Localizer, ILS = Instrument Landing System, CAT = Category, GPS = Global Positioning System, LPV = Localizer Performance with Vertical Guidance, LNAV = Lateral Navigation, VNAV = Vertical Navigation, MDA = Minimum Descent Altitude, DA = Decision Altitude

Sources: FAA Terminal Procedures, 2017; Landrum & Brown analysis.

3.4.2 Runway Approach Capability Recommendations

A CAT II approach is recommended on the Runway 23 end to replace the current CAT I system. This upgrade in approach capability would allow Runway 23 to remain open in CAT II conditions, which occur 2.26% of the time. In order to achieve full CAT II approach capability, the obstructions to the Runway 23 approach would need to be resolved. In addition, FAA Technical Operations service division has indicated that the following changes/additions would be needed for CAT II approaches on Runway 23:

- Upgrade the Runway 23 Approach Lighting System with Sequenced Flashing Lights (ALSF-I) to an ALSF-II. Must have standby power and be monitored with landline or microwave to Air Traffic Control (ATC).
- Install midpoint RVR sensor with uninterrupted standby power (currently have touchdown and rollout sensors).
- Replace the current Mark 1 single transmitter with a dual Mark 20 ILS. Must be dual monitoring (remote maintenance monitoring would require an additional telecom line). Requires uninterrupted backup power and generator for localizer and glide slope.
- Relocate localizer to centerline so approach is not offset

An approach lighting system is recommended for Runway 05. The approach lighting system, along with the expected restoration of the glide slope, would allow Runway 05 to remain open in all but CAT II and III conditions. The alternatives analysis will determine the best possible approach lighting system for this upgrade.

3.4.3 Runway and Taxiway Lighting

As described in Chapter 1, *Inventory*, Section 1.5.4.3, *Runway Lighting*, Runway 05-23 has the following runway lighting:

- High Intensity Runway Edge Lighting (HIRL)
- Centerline Lights
- Visual Approach Slope Indicators (VASIs)
- Runway End Identifier Lights (REIL) – Runway 23 only

The runway lighting is generally sufficient with two exceptions. The FAA is replacing VASIs with Precision Approach Path Indicators (PAPIs) at airports across the country. Both lighting systems provide vertical guidance on approaches, but the PAPIs are newer technology and are replacing the need for VASIs. Therefore, replacement of the VASIs with PAPIs on both runway ends is recommended.

The REILs on the Runway 05 end are currently located 40 feet from the runway edge. FAA Advisory Circular 150/5340-30G, *Design and Installation Details for Airport Visual Aids,* states that REIL systems that are located on the same end of runway as VASIs should be located at least 75 feet from the runway edge. If the VASI systems remain in place, these lights would require relocation to comply with FAA guidance. If the VASIs are replaced by PAPIs, the REIL system would not need to be relocated.

Taxiway lighting information was presented in Chapter 1, *Inventory*, Section 1.5.4.2, *Taxiway Lighting*. CRW's taxiway lighting is sufficient with one exception: the runway entrance taxiways do not have in-pavement hold lighting. Hold lighting is meant to increase the visibility of a hold line and can help to reduce runway incursions. Visibility issues have caused aircraft incursions in the past on Taxiway C. As a result, in-pavement hold lights are recommended for Taxiway C.

3.5 Airfield Design Requirements

Airfields are designed in accordance with the FAA guidelines and requirements at the time of construction as described in FAA AC 150/5300-13A Change 1*, Airport Design,* and based on the size of the aircraft expected to operate at an airport. Airfield design requirements for CRW were determined by evaluating the current airfield geometry and comparing it to the most recent FAA airport design standards.

3.5.1 Critical Aircraft

FAA Advisory Circular (AC) 150/5000-17, *Critical Aircraft and Regular Use Determination,* defines a critical aircraft as the most demanding aircraft type, or grouping of aircraft with similar characteristics, that make regular use of the airport. Regular use is at least 500 annual operations, including both itinerant and local operations but excluding touch-and-go operations. Chapter 2, *Forecast*, Section 2.7, *Future Critical Aircraft*, determined that the future critical aircraft for airport design is a combination of the B737-700 and the CS-100. These two aircraft are the most demanding aircraft projected to operate at CRW in 2037 that will have 500 annual operations. Together these two aircraft are projected to have 744 annual operations in 2037.

3.5.2 FAA Coding System

FAA AC 150/5300-13A Change 1*, Airport Design,* uses a coding system to relate airport design criteria to the operational and physical characteristics of the critical aircraft at an airport. The FAA classifies critical aircraft by three parameters for the purpose of airport geometric design:

- Aircraft Approach Category (AAC): classified according to aircraft approach speeds. See **Table 3-9, *Aircraft Approach Category (AAC) Definitions***.
- Airplane Design Group (ADG): defined by its wingspan and tail height, whichever is most restrictive. **See Table 3-10, *Airplane Design Group (ADG) Definitions***.
- Taxiway Design Group (TDG): based on the dimensions of the aircraft undercarriage. The determining factors are (1) the width of its main gear[6] and (2) the distance between the cockpit and the main gear.[7] **Exhibit 3-1, *Taxiway Design Group (TDG) Chart***, shows how an aircraft's dimensions (relating to its main gear) determine its TDG. For example, a 747-400 falls in TDG 6 based on its main gear width (x axis on the chart) of 41.3 feet and a cockpit-to main gear distance (y axis on the chart) of 91.7 feet.

6 The distance from the outer edge to outer edge of the widest set of main gear tires.
7 The distance from the pilot's eye to the main gear turn center.

TABLE 3-9 AIRCRAFT APPROACH CATEGORY (AAC) DEFINITIONS

APPROACH CATEGORY[1]	AIRCRAFT APPROACH SPEED[2]
Category A	Less than 91 knots
Category B	91 knots or more but less than 121 knots
Category C	121 knots or more but less than 141 knots
Category D	141 knots or more but less than 166 knots
Category E	166 knots or more

1. Aircraft Approach Category is a grouping of aircraft based on a reference landing speed, if specified, or if that is not specified, it is three times the stall speed at the maximum certificated landing weight.
2. Aircraft Approach Speed is based upon 1.3 times the aircraft stall speed in their landing configuration at the certificated maximum flap setting and maximum landing weight at standard atmospheric conditions.

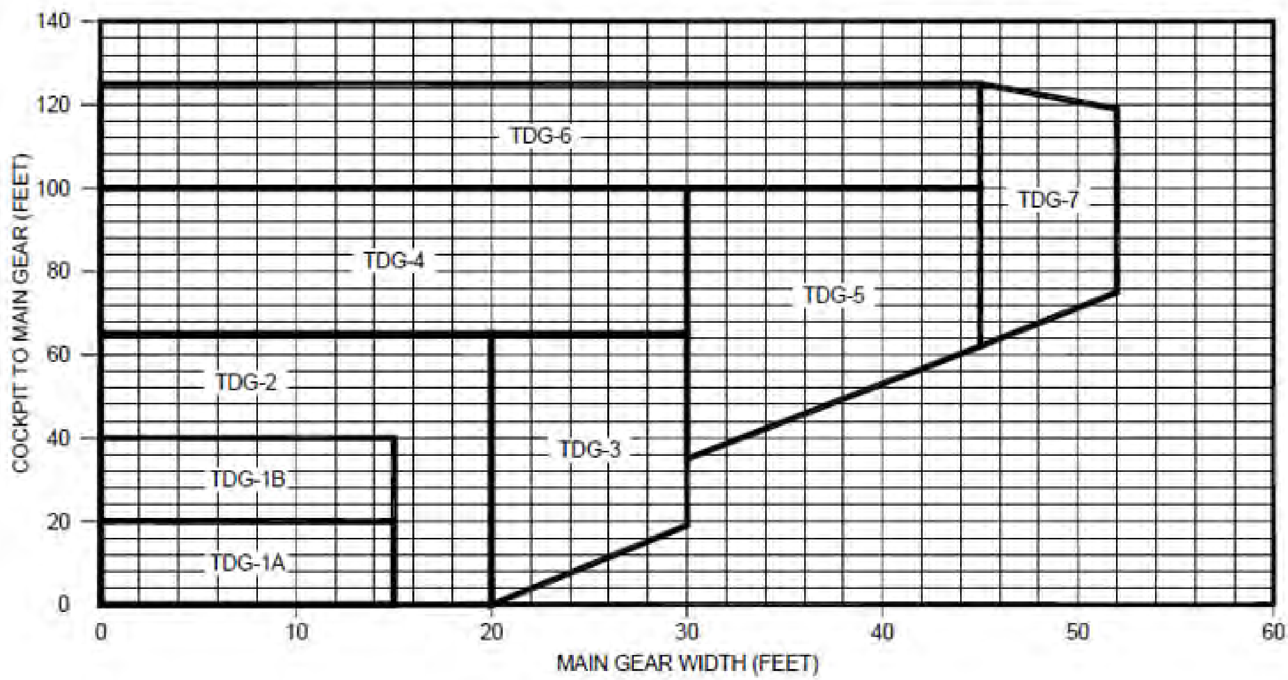
Source: FAA AC 150/5300-13A Change 1, *Airport Design*.

TABLE 3-10 AIRPLANE DESIGN GROUP

DESIGN GROUP	TAIL HEIGHT	WINGSPAN
ADG-I	Less than 20’	Less than 49’
ADG-II	20’ to less than 30’	49’ to less than 79’
ADG-III	30’ to less than 45’	79’ to less than 118’
ADG-IV	45’ to less than 60’	118’ to less than 171’
ADG-V	60’ to less than 66’	171’ to less than 214’
ADG-VI	66’ to less than 80’	214’ to less than 262’

Source: FAA AC 150/5300-13A Change 1, *Airport Design*.

EXHIBIT 3-1 TAXIWAY DESIGN GROUP (TDG) CHART



Source: FAA AC 150/5300-13A Change 1, *Airport Design*.

Based on the future critical aircraft (B737-700 and CS-100) for CRW, the AAC is C and the ADG is III. The future Airport Reference Code (ARC), which is made up of the AAC and the ADG, is C-III. CRW's future TDG is 3.

The FAA uses a Runway Design Code (RDC) to determine the design standards for an individual runway and parallel taxiway. The RDC is based on the ARC of the critical aircraft, and the approach visibility minima of each particular runway. The visibility minima definitions are in **Table 3-11, *Visibility Minima Definitions***.

TABLE 3-11 VISIBILITY MINIMA DEFINITIONS

RUNWAY VISUAL RANGE (in feet)	FLIGHT VISIBILITY CATEGORY (statute mile)
5000	Not lower than 1 mile
4000	Lower than 1 mile but not lower than ¾ mile
2400	Lower than ¾ mile but not lower than ½ mile
1600	Lower than ½ mile but not lower than ¼ mile
1200	Lower than ¼ mile

Note: RVR values are not exact equivalents.
Source: FAA AC 150/5300-13A Change 1, *Airport Design*.

Based on the critical aircraft and the recommended approach visibility minimums in Section 3.4.2, *Runway Approach Capability Recommendations*, the future RDC for Runway 23 will be C-III-2400 (based on an ARC of C-III and a CAT II approach). With the restoration of the Runway 05 glide slope and the addition of an approach lighting system, the future RDC for Runway 05 is expected to be C-III-4000. The Approach Reference Code (APRC) and the Departure Reference Code (DPRC) is the same as the RDC.

In addition to the critical aircraft determination for the civil portion of the fleet, military aircraft must also be considered. The military critical aircraft is the C-130, which has an ARC of C-IV and a TDG of 2.

3.5.3 CRW Design Criteria

The RDC C-III-2400 and C-III-4000 runway design requirements are presented in **Table 3-12, *Runway Design Criteria***. The runway dimensional requirements are the same for both RDCs except for the Runway Protection Zone (RPZ) size, which varies by the visibility component.

TABLE 3-12 RUNWAY DESIGN CRITERIA

STANDARD CATEGORY	DIMENSIONS (feet)	
	C-III-2400	C-III-4000
Runway Width	150	150
Runway Shoulder Width	25	25
Blast Pad Width	200	200
Blast Pad Length	200	200
Runway CL to Parallel Taxiway/Taxilane CL	400	400
Runway CL to Holding Position	250	250
RSA Width	500	500
ROFA Width	800	800
RSA and ROFA Length beyond Runway End	1,000	1,000
RSA and ROFA Length prior to Landing Threshold	600	600
Approach RPZ Length	2,500	1,700
Approach RPZ Inner Width	1,000	1,000
Approach RPZ Outer Width	1,750	1,510
Departure RPZ Length	1,700	1,700
Departure RPZ Inner Width	500	500
Departure RPZ Outer Width	1,010	1,010

Note: CL = Centerline, RSA = Runway Safety Area, ROFA = Runway Object Free Area, RPZ = Runway Protection Zone, OFA = Object Free Area.
Source: FAA AC 150/5300-13A Change 1, *Airport Design*.

The taxiway design criteria for ADG III and TDG 3 are shown in **Table 3-13, *Taxiway Design Criteria***. Two dimensions are shown for taxiway-to-taxiway centerline separation requirements – one for the ADG and one for the TDG. The ADG dimension applies unless 180-degree turns are required between taxiways; in which case, the TDG dimension applies.

TABLE 3-13 TAXIWAY DESIGN CRITERIA

STANDARD CATEGORY	ADG / TDG	DIMENSIONS (feet)
Taxiway CL to Parallel Taxiway/Taxilane CL	ADG III	152
Taxiway CL to Parallel Taxiway CL (with 180° turns)	TDG 3	162
Taxiway Centerline to Fixed or Movable Object	ADG III	93
Taxilane CL to Parallel Taxilane CL	ADG III	140
Taxilane Centerline to Fixed or Movable Object	ADG III	81
Taxiway Width	TDG 3	50
Taxiway Shoulder Width	TDG 3	20
Taxiway Safety Area Width	ADG III	118
Taxiway OFA Width	ADG III	186
Taxilane OFA Width	ADG III	162

Note: CL = Centerline, OFA = Object Free Area.
Source: FAA AC 150/5300-13A Change 1, *Airport Design*.

The FAA will not pay for airfield upgrades based upon military aircraft design standards; however, it is still important to note the airfield design requirements for the military operation at CRW. The C-130 operates out of the Air National Guard base at CRW. This aircraft is a C-IV aircraft and has a TDG of 2. The design differences between ADG III and IV aircraft are listed in **Table 3-14, Taxiway *ADG III versus ADG IV Requirements.*** The runway design standards (runway design, separations, and protection) for a C-III versus C-IV aircraft do not change.[8]

TABLE 3-14 TAXIWAY ADG III VERSUS ADG IV REQUIREMENTS

STANDARD CATEGORY	ADG III DIMENSIONS (feet)	ADG IV DIMENSIONS (feet)
Taxiway CL to Parallel Taxiway/Taxilane CL	152	215
Taxiway Centerline to Fixed or Movable Object	93	129.5
Taxilane CL to Parallel Taxilane CL	140	198
Taxilane Centerline to Fixed or Movable Object	81	112.5
Taxiway Safety Area Width	118	171
Taxiway OFA Width	186	259
Taxilane OFA Width	162	225

Source: FAA AC 150/5300-13A Change 1, *Airport Design*.

8 FAA AC 150/5300-13A, Change 1, *Airport Design*. February 26, 2014.

3.5.4 Compliance with Design Standards

These subsections discuss any non-standard issues related to the runway or taxiways at CRW. All non-standard issues on the airfield at CRW should be addressed in the airfield alternatives, where possible. All future pavement that is added as part of the alternatives analysis should conform to RDC C-III-2400 and TDG 3 standards, while also considering military C-IV aircraft standards as needed.

3.5.4.1 Runway Geometry

The following describes Runway 05-23's compliance with C-III runway geometry requirements in FAA AC 150/5300-13A Change 1, *Airport Design*:

- Runway width is 150 feet; meets standards
- Runway shoulders are not provided; requirement is 25 feet on either side of the runway
- The Runway 05 blast pad is 50 feet long and 200 feet wide; Runway 23 does not have a blast pad. The Runway 05 blast pad does not meet standards. The Airport currently has plans to install an EMAS on the Runway 05 end. This would eliminate the need for a blast pad on that runway end.
- Runway profile is compliant with all FAA standards

The runway geometry requirements for C-III and C-IV aircraft is the same. No further upgrades are needed for C-IV military aircraft regarding runway geometry.

3.5.4.2 Runway-to-Taxiway Centerline Separation

According to FAA AC 150/5300-13A Change 1, *Airport Design,* the required separation distance between a runway and parallel taxiway for C-III aircraft is 400 feet. The current separation distance between Runway 05-23 and Taxiway A is 284 feet near the end of Runway 05, and 328 feet from Taxiway D to the end of Runway 23. The FAA approved a Modification to Design Standards (MOS) for this deficiency in 2001. Although the Airport has a MOS for this deficiency, future alternatives should attempt to correct the issue.

Runway-to-taxiway centerline separation requirements for C-III and C-IV aircraft are the same. No further upgrades are needed for C-IV military aircraft regarding these separations.

3.5.4.3 Runway Safety Area (RSA) and Runway Object Free Area (ROFA)

According to FAA AC 150/5300-13A Change 1, *Airport Design,* the CRW Runway 05-23 RSA should be 500 feet wide, have a length that is 600 feet prior to the threshold and 1,000 feet beyond the end of the runway, and meet grading requirements. The ROFA width should be 800 feet and it should have the same lengths as the RSA. The following describes the RSA and ROFA deficiencies for Runway 05-23:

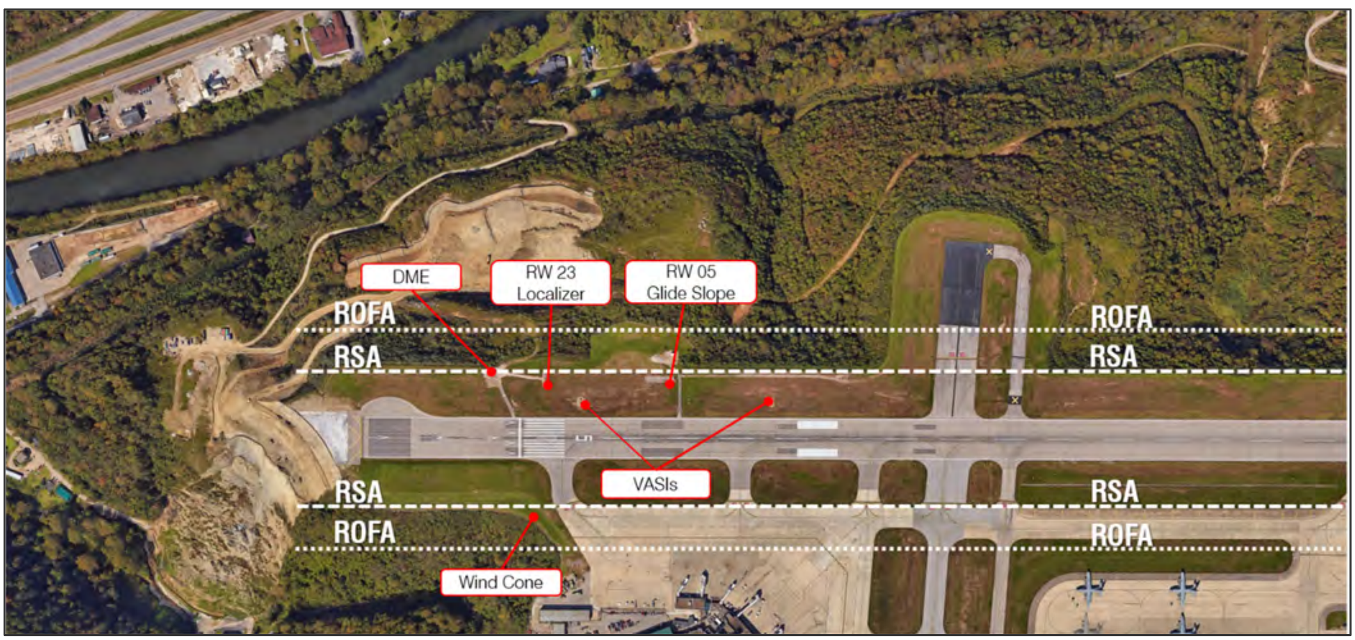
- Within the RSA/ROFA to the south of Runway 05-23 there are existing drainage structures that span nearly three quarters of the runway from Taxiway D to Taxiway A1; the transverse grades within this area are greater than 3.0%.

- The EMAS that will be constructed on Runway 05 will increase safety but will not meet the RSA/ROFA length requirement prior to the threshold (600 feet) or width requirement (500 feet for RSA and 800 feet for ROFA).
- Runway 23 end RSA/ROFA is 500 feet long so does not meet the 600-foot or 1,000-foot length requirement.

In addition, there are lighting and navigational aids in the RSA/ROFA at CRW. Navigational aids should not be in the RSA and ROFA, unless they are required to be in a specific location in order to function (referred to as "fixed-by-function"), as specified in FAA AC 150/5300-13A Change 1, *Airport Design*. Lighting and instrumentation in the Runway 05 end RSA/ROFA that are not fixed-by-function include (see **Exhibit 3-2, *Runway 05 Instrumentation and Lighting in RSA/ROFA***):

- Distance Measuring Equipment (DME)
- Runway 23 localizer
- Runway 05 glide slope
- Wind cone (ROFA only)
- VASI system

EXHIBIT 3-2 RUNWAY 05 INSTRUMENTATION AND LIGHTING IN RSA/ROFA

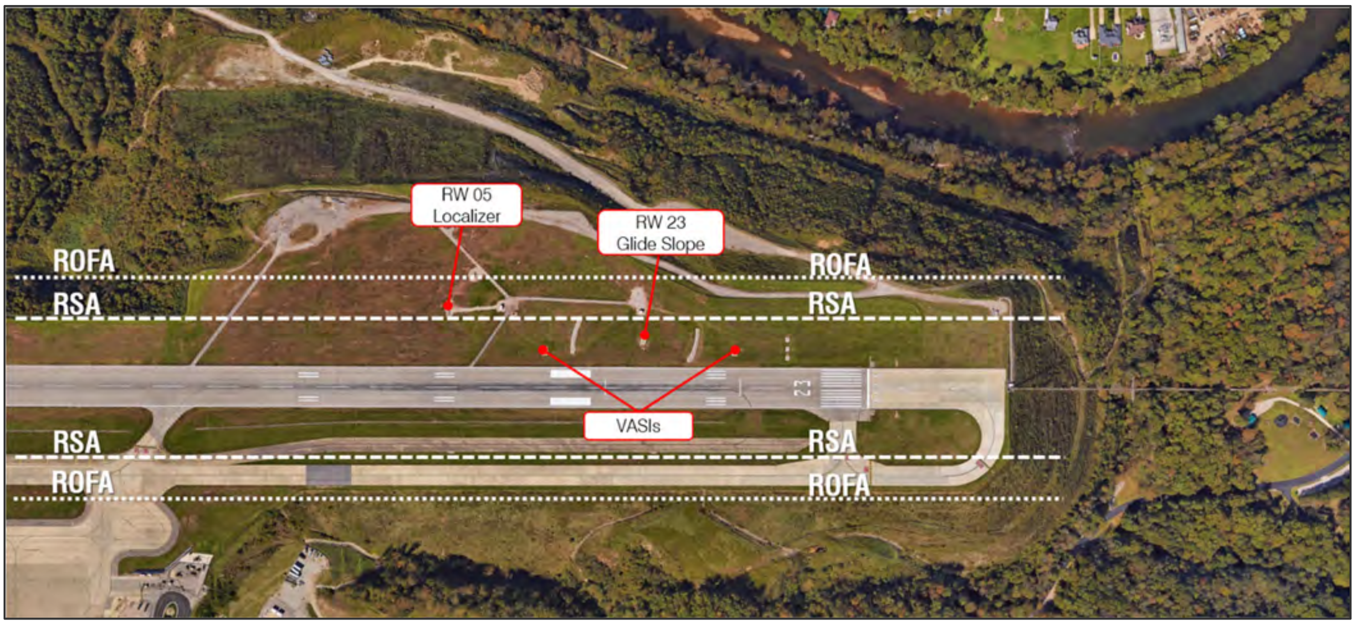


Sources: FAA AC 150/5300-13A Change 1, *Airport Design*; Landrum & Brown analysis.

Lighting and instrumentation in the Runway 23 end RSA/ROFA that are not fixed-by-function include (see **Exhibit 3-3, *Runway 23 Instrumentation and Lighting in RSA/ROFA***):

- Runway 23 end fire glide slope. This type of glide slope is technically allowed to be in the RSA. However, if any upgrades are made to the approach system, new glide slope technology would need to be installed and it could no longer be located in the RSA or ROFA.
- Runway 05 localizer (ROFA only)
- VASI system

EXHIBIT 3-3 RUNWAY 23 INSTRUMENTATION AND LIGHTING IN RSA/ROFA



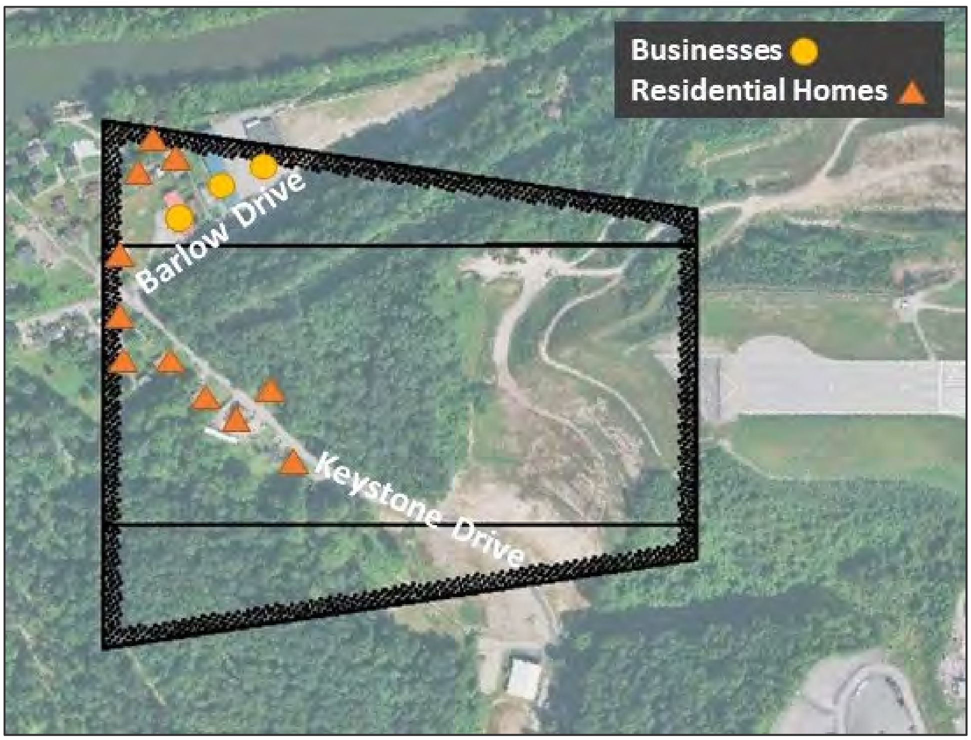
Sources: FAA AC 150/5300-13A Change 1, *Airport Design*; Landrum & Brown analysis.

3.5.4.4 Runway Protection Zone (RPZ)

The 2017 ALP shows the following incompatible land uses in the Runway 05 existing RPZ (see **Exhibit 3-4, *RPZ Incompatible Land Uses - Runway 05***):

- Portions of Keystone Drive
- Portions of Barlow Drive
- Businesses
- Residential homes

EXHIBIT 3-4 RPZ INCOMPATIBLE LAND USES – RUNWAY 05

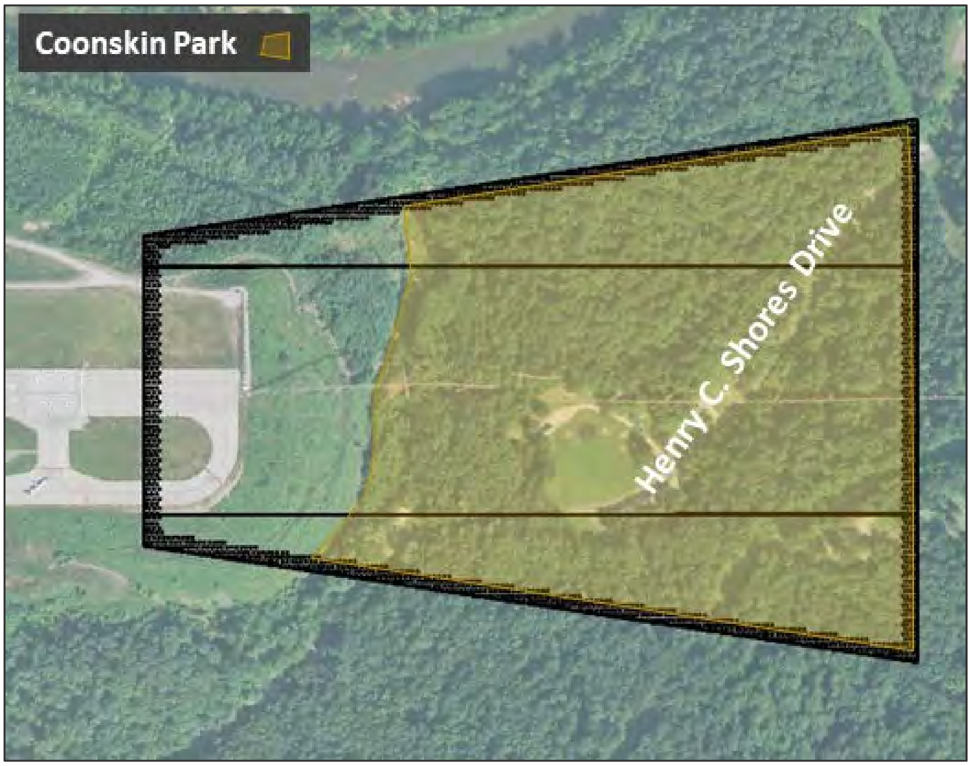


Sources: 2017 Yeager Airport ALP and Landrum & Brown analysis.

The 2017 ALP shows the following incompatible land uses in the existing Runway 23 RPZ (see **Exhibit 3-5, *RPZ Incompatible Land Uses - Runway 23***:

- Portions of Coonskin Park
- Portions of Henry C. Shores Drive

EXHIBIT 3-5 RPZ INCOMPATIBLE LAND USES – RUNWAY 23



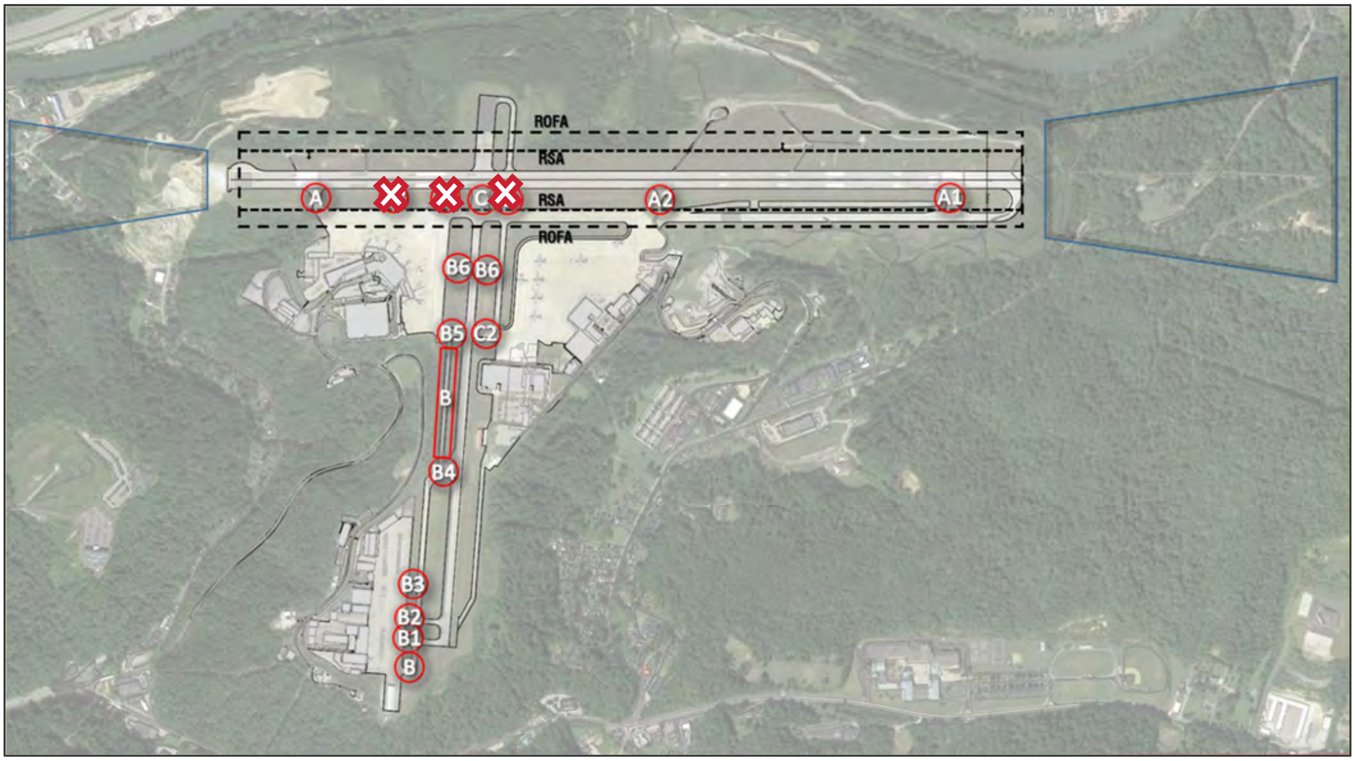
Sources: 2017 Yeager Airport ALP and Landrum & Brown analysis.

All property located in the Runway 23 RPZ is owned by the Airport. On the Runway 05 end, there are some parcels that do not belong to the Airport in the RPZ. RPZ requirements are the same for C-III and C-IV aircraft. No additional revisions are needed to the RPZs if the Airport needed to upgrade to C-IV aircraft standards.

3.5.4.5 Taxiways

Exhibit 3-6, *CRW Airfield*, identifies the CRW taxiways that do not meet FAA standards set forth in FAA AC 150/5300-13A Change 1*, Airport Design*.

EXHIBIT 3-6 CRW AIRFIELD



Note: Taxiways A3, B, and D located between Runway 05-23 and parallel Taxiway A were removed while the Master Plan analysis was underway. The removal of these taxiways is indicated via an "X" on the exhibit.
Sources: ADCI and Landrum & Brown analysis.

All of the taxiways at CRW meet the TDG 3 taxiway width requirement of 50 feet, with two exceptions. Taxiway B between Taxiway B5 and B4 is 40 feet wide. Taxiway B2 east of Taxiway B is 42 feet wide. As a result, these taxiways are limited to TDG 2 aircraft. These narrower taxiways are only used by general aviation aircraft, which are typically TDG 1 and 2. Therefore, additional width is not required for these taxiways.

None of the taxiways at CRW have paved shoulders. FAA recommends a 20-foot paved shoulder for all TDG 3 taxiways. It is recommended that the Airport install paved shoulders, where possible.

None of the existing taxiways at CRW are compliant with the FAA's standard taxiway fillet geometry requirements. The dimensions of each taxiway and the transverse grades within the taxiway safety area are deficient to FAA standards. Some taxiway safety areas to the north of Taxiway A contain transverse grades greater than 3.0% due to the presence of existing drainage structures (which run for nearly the entire length of the taxiway) and unused pavement from the previous location of Taxiway A. Per the AC, taxiway safety area transverse grades are required to be between 1.5 and 3.0%. Thus, on the north side of the taxiway, the taxiway safety area is deficient and does not meet FAA standards.

In addition, portions of the old Taxiway A pavement exist between Taxiways A2 and A1. It is recommended that this unnecessary pavement be removed to eliminate any confusion for pilots on the airfield when maneuvering along taxiways.

None of the taxiway markings that lead onto Runway 05-23 (Taxiways A, A1, A2, and C) comply with FAA standards. For a C-III taxiway, the FAA requires runway holding position markings to be a minimum of 250 feet from the centerline of the runway, with an additional one foot added for each 100 feet above sea level. This requirement means the runway holding position markings should be approximately 259 feet from the runway centerline at CRW. The holding position markings on the aforementioned taxiways vary in location from 180 feet to 230 feet from the centerline of Runway 05-23. Taxiways A3 and portions of Taxiways B and D have been removed from the airfield so the holding positions on these taxiways no longer exist or are considered a problem. All other holding positions should be further evaluated in the airfield alternatives and be corrected, where feasible.

3.5.4.6 Taxiway-to-Taxiway Centerline Separation

According to FAA AC 150/5300-13A Change 1, *Airport Design*, the required separation distance between two parallel taxiways for C-III aircraft is 152 feet. Taxiways B, C, and D are parallel taxiways that run between the Airport passenger terminal and the Air National Guard. Taxiways B and C extend to the general aviation area. The taxiway-to-taxiway separations between the three all exceed C-III separation standards. Taxiway A parallels the runway but does not parallel another taxiway. The military C-IV aircraft require additional separation over what is provided.

3.5.5 Hold Pads

There are currently no hold pads on the airfield at CRW. The lack of hold areas is currently an issue. Commercial aircraft are often asked to hold for a release prior to takeoff when flying to some east coast destinations. This situation occurs on an almost daily basis. This requires other aircraft behind the holding aircraft to back taxi on the runway in order to minimize delay for other departing aircraft. Aircraft have also been known to hold on Taxiway D, when needed. Holding on Taxiway D may not be a viable option in the future because the Air National Guard plans to acquire this taxiway as part of their lease in the future. In an effort to minimize back taxiing, decrease delays, and maximize operational airfield flow, it is recommended that the addition of a hold pads be considered for both runway ends in the future.

3.6 Other Airfield Requirements

There is a concrete gutter for drainage along the north side of Runway 23 between the 05 end and Echo Pad. Airport officials have expressed interest in extending this gutter around the perimeter of the Airport.

3.7 Summary of Airfield Requirements

The following summarizes the airfield facility requirements for CRW:

- Runway length requirements:
  - Provide 7,800 to 8,000 feet of runway length
- Lighting and navigational aids:
  - Install CAT II approach on Runway 23 end, which requires an ALSF-II
  - Install CAT I approach lighting system on the Runway 05 end
  - Replace VASIs with PAPIs
  - Relocate REILS to be at least 75 feet from the runway edge (only required with VASI systems; if VASI systems are replaced with PAPIs, this requirement no longer applies)
  - Provide in-pavement hold lights on Taxiway C
- Airfield design requirements:
  - Add runway and taxiway shoulders
  - Increase separation between Runway 05-23 and Taxiway A to 400 feet
  - Provide standard RSA and ROFA for Runway 05-23
  - Mitigate incompatible land uses in any existing and future RPZs depicted in alternatives per FAA guidance, if possible
  - Relocate lighting and NAVAIDs that are not fixed-by-function outside of the RSA/ROFA
  - Address taxiway fillet geometry and transverse grades in taxiway safety areas
  - Remove unnecessary taxiway pavement between Taxiways A2 and A1
  - Address non-standard runway holding position markings on the taxiways that lead onto Runway 05-23
  - Add multi-use hold pad at both runway ends
- Extend concrete drainage gutter around perimeter of the Airport

4 Alternatives

This chapter of the Airfield Master Plan identifies and evaluates airfield alternatives for Yeager Airport (CRW). The focus of the alternatives analysis was on providing standard Runway Safety Areas (RSAs) and additional runway length to accommodate forecast demand.

4.1 Alternatives Process

The airfield alternatives analysis involved a multi-step process as shown on **Exhibit 4-1, *Alternatives Process***. First, the current runway alignment was evaluated to determine if an alternative alignment would be feasible (Step 1). The second step involved developing initial alternatives that looked at various RSA and runway extension options (Step 2). These alternatives were then pre-screened for construction feasibility (Step 3), after which the remaining alternatives went through a more detailed "Level 1" screening based on several evaluation factors (Step 4). This screening process resulted in the identification of a short list of alternatives to be further evaluated (Step 5). In Step 6, the remaining alternatives were refined to reflect the findings of the Level 1 analysis and to add further detail such as runway exits and navigation aids. These remaining alternatives were evaluated and screened in Level 2 (Step 7), at which point a preferred alternative was selected (Step 8).

EXHIBIT 4-1 ALTERNATIVES PROCESS

1. Determine Runway Alignment
2. Develop Initial Alternatives
3. Constructability Pre-screening of Alternatives
4. Level 1 Screening
5. Identify Short List of Alternatives
6. Refine Remaining Alternatives
7. Level 2 Screening
8. Identify Preferred Alternative

4.2 Step 1: Determine Runway Alignment

CRW's sole runway is oriented in the 05-23 direction. It is situated on a hilltop about 300 feet above the valleys below, with hills that drop off sharply on all sides. A runway extension in either the 05 or 23 direction would result in extensive fill. As a result, alternative runway alignments were considered.

Any realignment of the runway would potentially require the relocation of the passenger terminal, Air National Guard, and/or general aviation facilities. The fill requirements and local impacts would be extensive. In addition, relocation of the runway to a new alignment would require that the existing runway be closed for a period of time, meaning the Airport would be closed to all operations. As a result, runway realignment was determined to be infeasible. All runway extension alternatives evaluated in this Master Plan therefore use the existing Runway 05-23 alignment.

4.3 Step 2: Develop Initial Alternatives

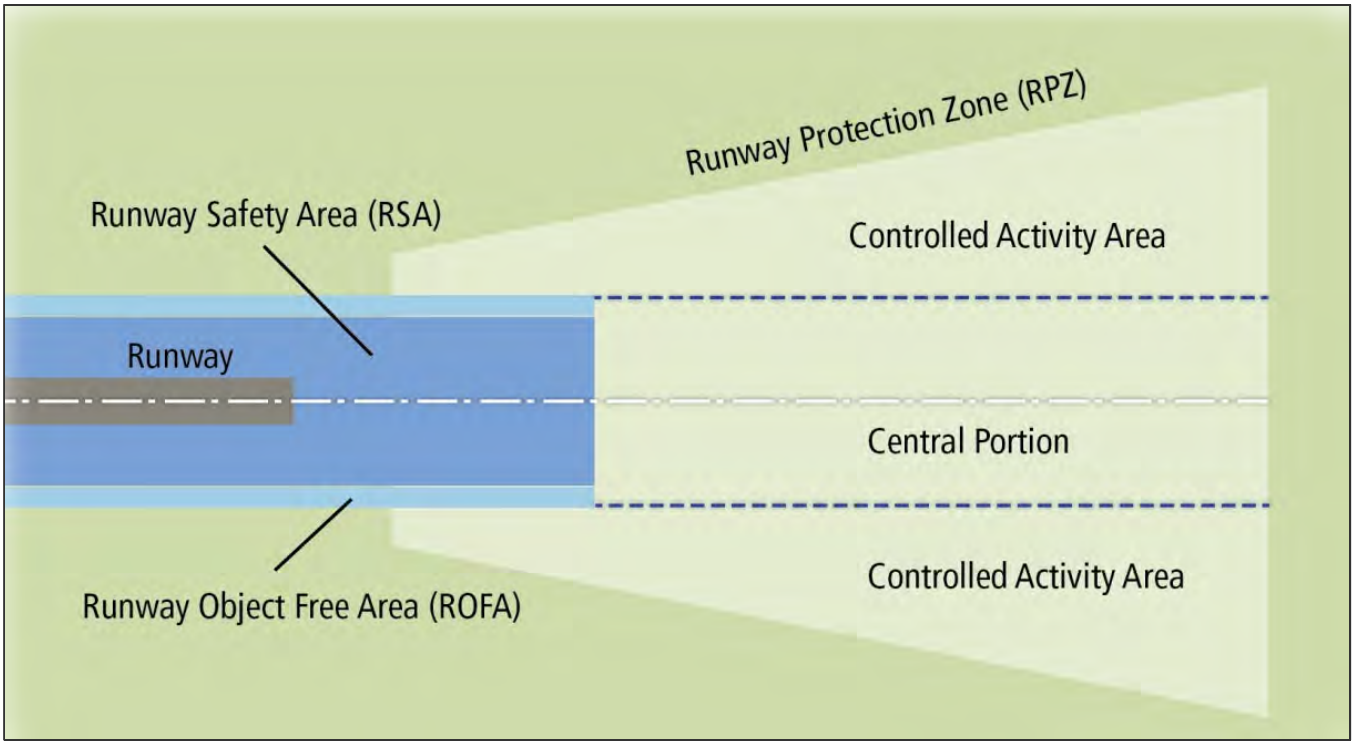
Based on the facility requirements presented in Chapter 3, the following components were included in each alternative:

- 8,000-foot long Runway 05-23. This length can accommodate 100% of the base case forecast fleet mix.
- Required airfield safety areas in compliance with Federal Aviation Administration (FAA) standards including RSAs, Object Free Areas (OFAs), and Runway Protection Zones (RPZs). See **Exhibit 4-2, *Airfield Safety Areas***, for a description of these areas.
- Category I (CAT I) approach capability on Runway 05, consisting of a glide slope, localizer and a Medium Intensity Approach Lighting System (MALS) or Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR). A MALSR is the same as a MALS but it also has a Runway Alignment Indicator Light (RAIL) portion.[1]
- CAT II approach capability on Runway 23 consisting of a glide slope, localizer and a High Intensity Approach Lighting System with Sequenced Flashers (ALSF-2).[2]
- Glide slope critical area (GSCA). Glide slope antennas provide vertical guidance to aircraft on approach and landing. A capture effect glide slope was assumed for the alternatives analysis because it is the preferred type of glide slope for CRW given the surrounding terrain. FAA Order 6750.16E, Siting Criteria for Instrument Landing Systems, states that the capture effect is the most tolerant to rising terrain and is "generally the system of choice for difficult sites."
  The GSCA for a capture effect glide slope measures 1,300 feet long by 650 wide, as shown on **Exhibit 4-3, *Glide Slope Critical Area (GSCA)***.

1 An Instrument Landing System (ILS) approach with a MALS can achieve a Height Above Threshold (HATh) of 200 feet and 5/8 mile visibility (3,000 feet runway visual range). An ILS approach with a MALSR can achieve a HATh of 200 feet and 1/2 mile visibility (2,400 feet runway visual range). The light bars for a MALS extend out 1,400 feet from the threshold. The light bars for a MALSR extend out 2,400 feet from the threshold. Source: FAA Advisory Circular (AC) 120-29A, *Criteria for Approval of Category I and Category II Weather Minima for Approach,* and FAA Order JO 6850.2B, *Visual Guidance Lighting Systems*.

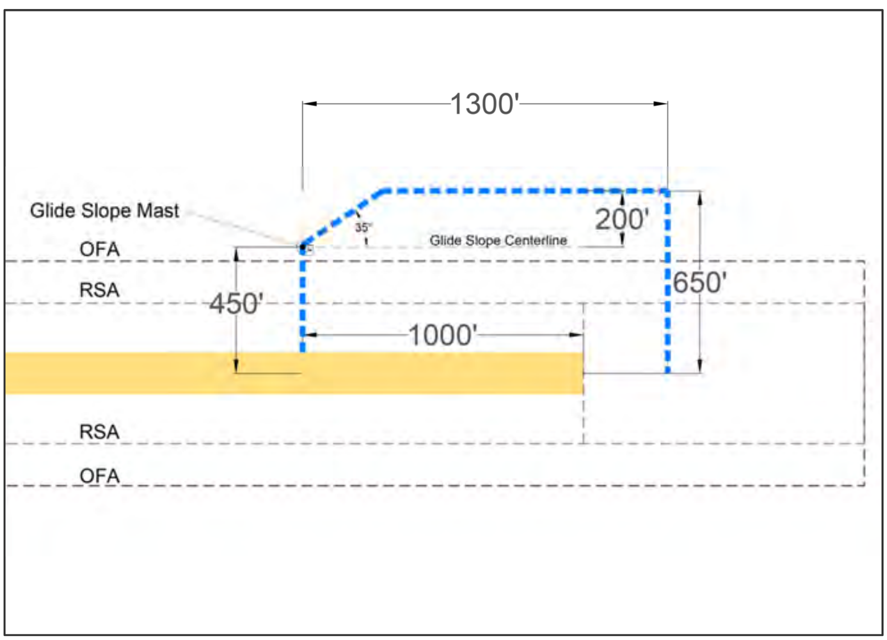
2 CAT II is defined as having a HATh lower than 200 feet but not lower than 100 feet and a runway visual range not less than 1,200 feet. The light bars for an ALSF-2 extend out 2,400 feet from the threshold. Source: FAA AC 150/5300-13A, Change 1, *Airport Design,* and FAA Order JO 6850.2B, *Visual Guidance Lighting Systems*.

EXHIBIT 4-2 AIRFIELD SAFETY AREAS



Source: FAA Advisory Circular 150/5300-13A Change 1, Airport Design.

EXHIBIT 4-3 GLIDE SLOPE CRITICAL AREA (GSCA)



Source: Landrum & Brown analysis.

Eight alternatives were developed for the 8,000-foot long Runway 05-23. The alternatives range from extending the runway/RSA by over 3,300 feet to the west, to a 3,600-foot long extension to the east. Each alternative consists of four sub alternatives labeled A through D as follows:

- **A:** No Engineered Materials Arresting System (EMAS)[3]
- **B:** EMAS on Runway 05 end
- **C:** EMAS on Runway 23 end
- **D:** EMAS on Runway 05 and 23 ends

The alternatives are shown on **Exhibit 4-4** through **Exhibit 4-19**. Each alternative has a unique "starting point" identified with a red circle. The starting point for each alternative is shown in **Table 4-1, *Starting Points for Alternatives***. The table also shows the distance the runway/RSA would be extended in each direction from the existing runway ends in each alternative.

All alternatives except the 3, 4, and 8 series of alternatives show a MALS and a MALSR to demonstrate the different land use requirements for the two systems. The series 3 alternatives do not contain a MALSR because the MALSR would place the Runway 05 end in a similar location to the 6 series alternatives. The 4 and 8 series of alternatives do not include a MALSR because it would result in the loss of gates (more than four gates), which was deemed infeasible.

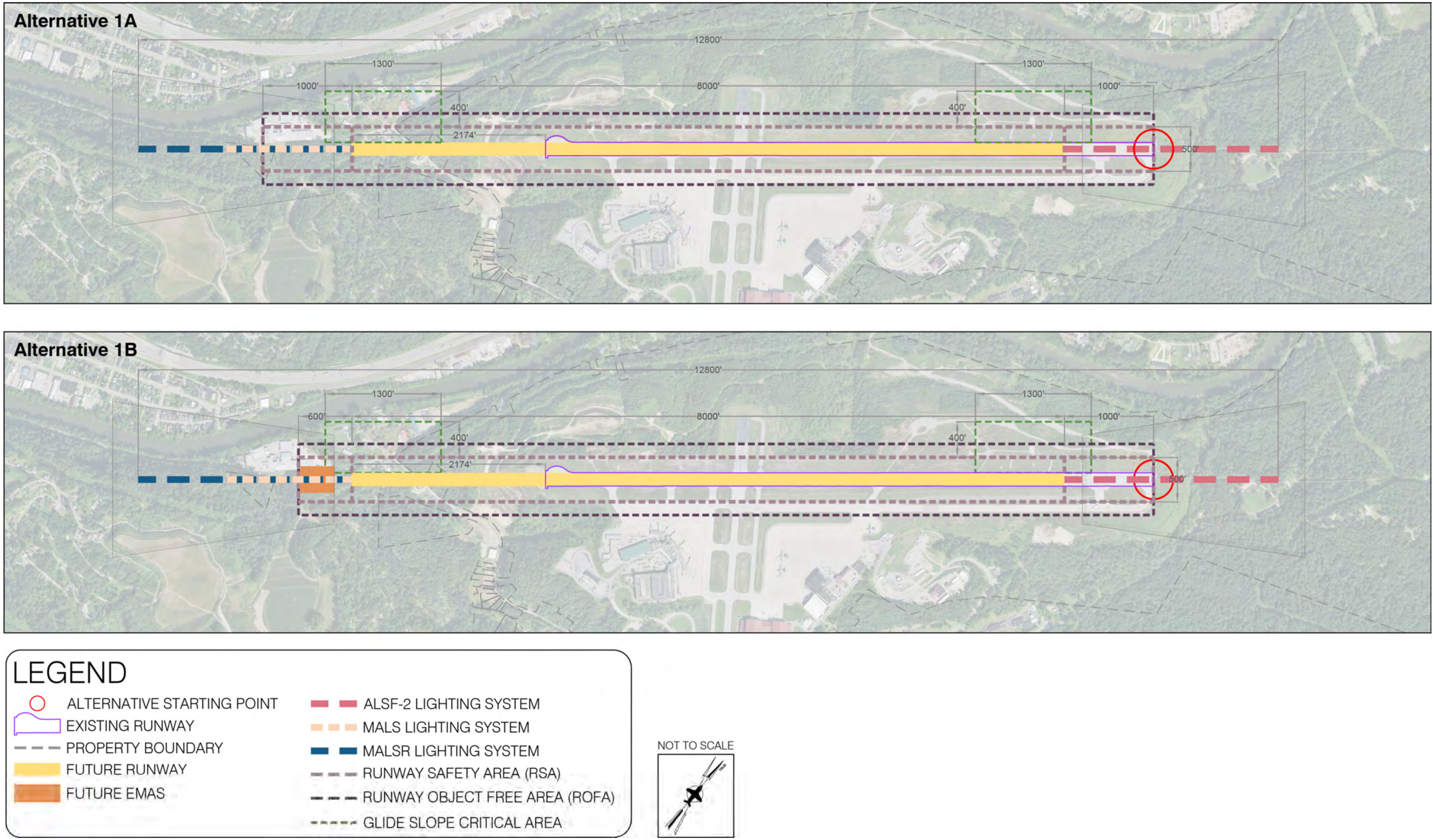
TABLE 4-1 STARTING POINTS FOR ALTERNATIVES

ALTERNATIVE SERIES	STARTING POINT DESCRIPTION	RUNWAY/RSA WESTERN EXTENSION (IN LINEAR FEET)	RUNWAY/RSA EASTERN EXTENSION (IN LINEAR FEET)
1	Start Runway 23 RSA at Runway 23 current runway end and extend west	3,174	None
2	Start Runway 05 RSA at the western property limit	665	2,173
3	Start Runway 05 MALS at western property limit	315	2,522
4	Start Runway 05 MALS at current Runway 05 end	None	3,578
5	Start Runway 05 RSA from south end of new Runway 05 wall	Southwest and northwest corner of RSA	3,025
6	Start Runway 05 RSA from current Runway 05 end	Southwest corner of RSA	3,175
7	Start Runway 05 RSA from current Runway 05 full-width RSA	None	3,300
8	Start Runway 05 MALS from center of new Runway 05 wall	Southwest corner of RSA	3,236

Source: Landrum & Brown analysis.

[3] An EMAS uses crushable material, which is placed at the end of a runway to stop an aircraft overrun. The aircraft tires sink into the EMAS material, which forces the aircraft to decelerate without additional action by the flight crew. EMAS is provided for runways where it is not possible to have a 1,000-foot overrun area. According to FAA Advisory Circular 150/5300-13A, *Airport Design*, a standard EMAS provides an equivalent level of safety as a full-dimension RSA.

EXHIBIT 4-4 RUNWAY ALTERNATIVES 1A & 1B



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

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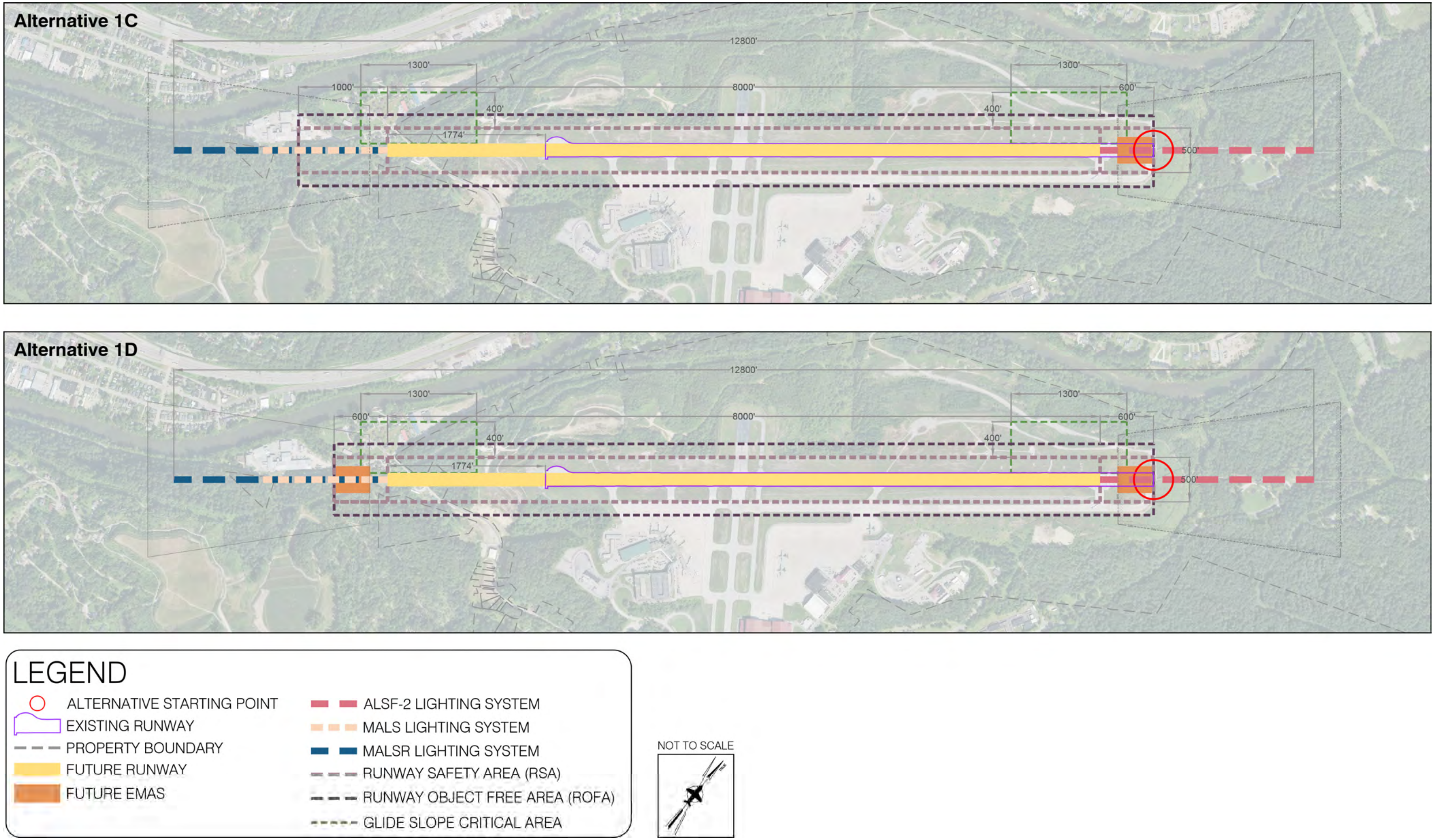
EXHIBIT 4-5 RUNWAY ALTERNATIVES 1C & 1D



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

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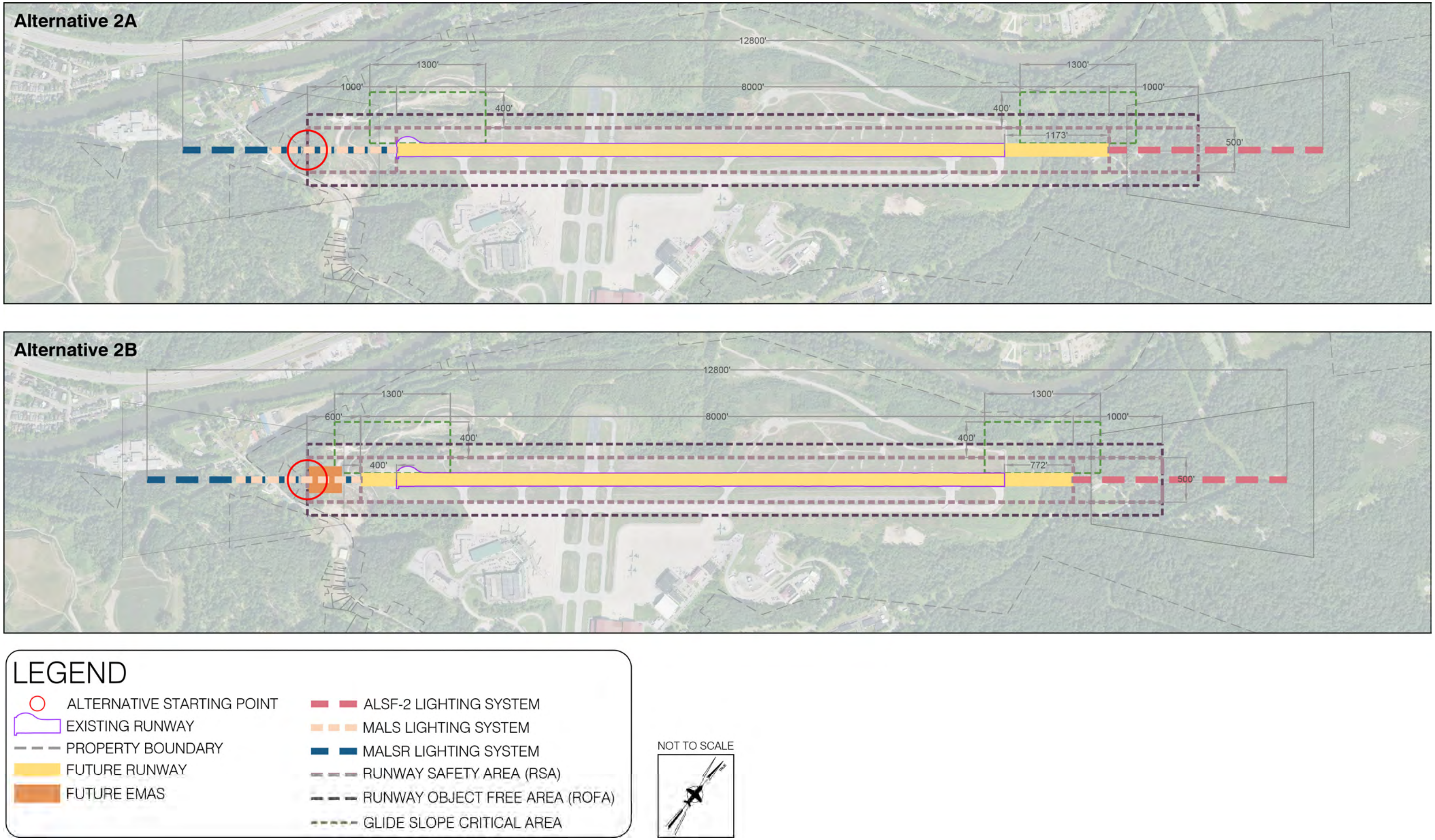
EXHIBIT 4-6 RUNWAY ALTERNATIVES 2A & 2B



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

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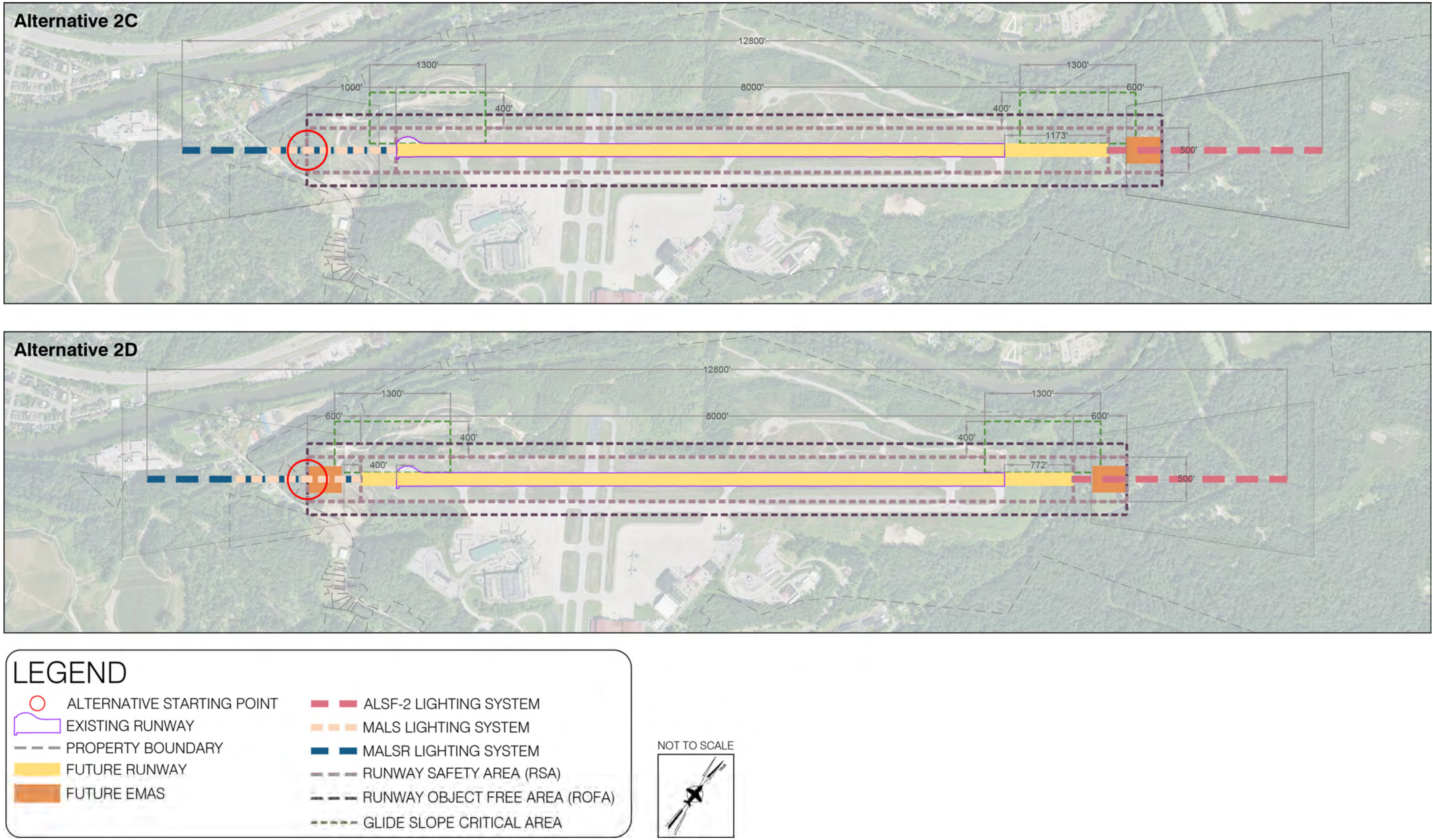
YEAGER AIRPORT

EXHIBIT 4-7 RUNWAY ALTERNATIVES 2C & 2D



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

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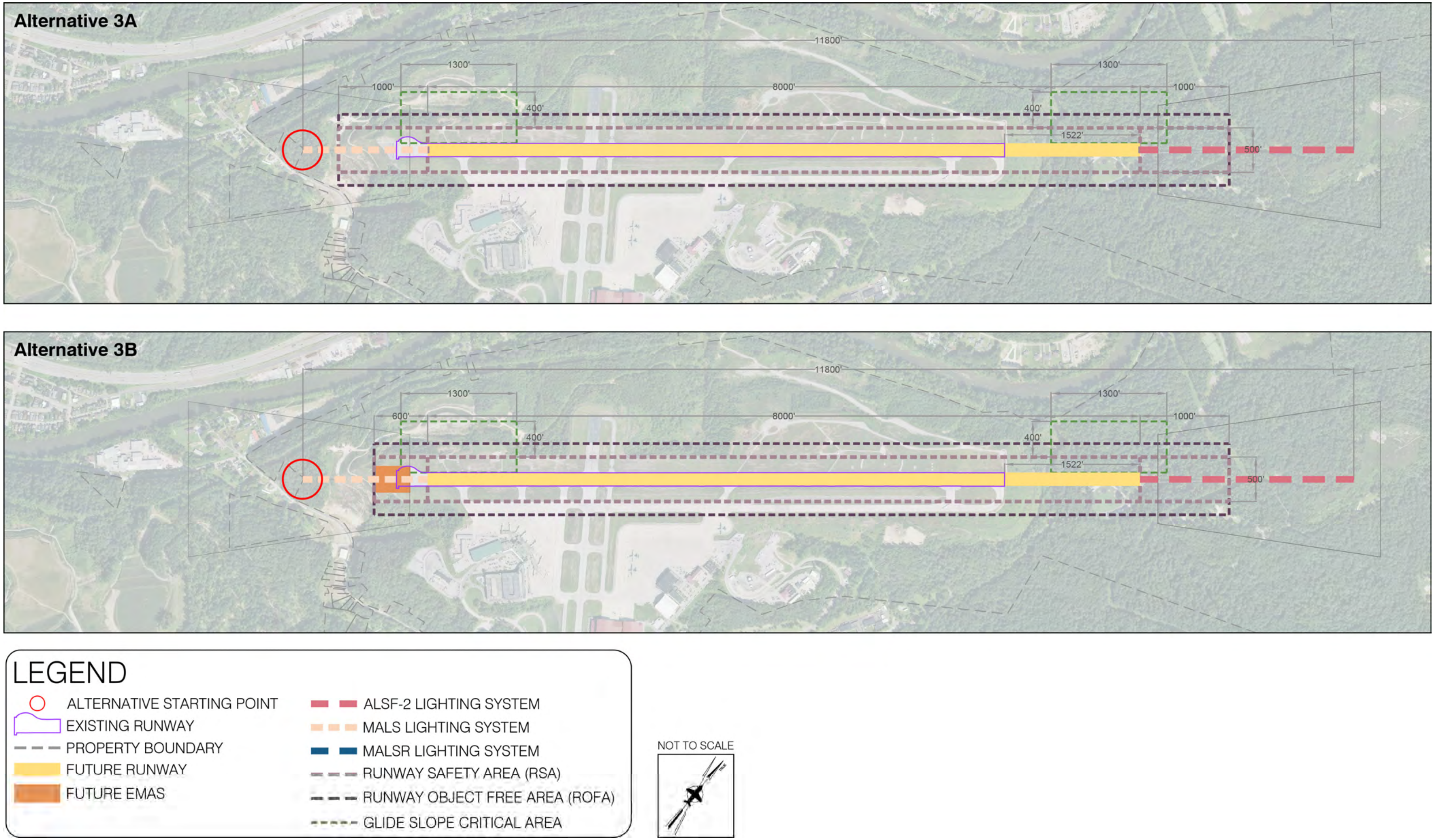
EXHIBIT 4-8 RUNWAY ALTERNATIVES 3A & 3B



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

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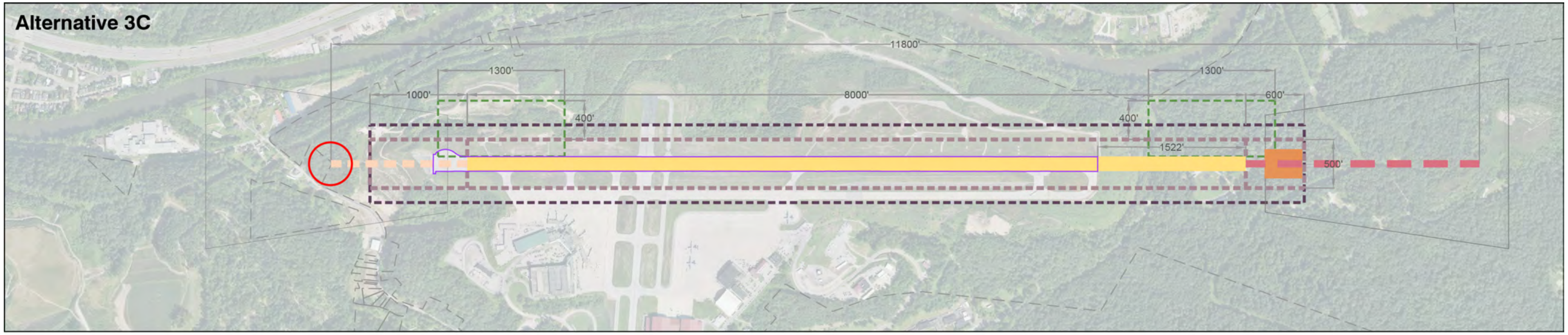
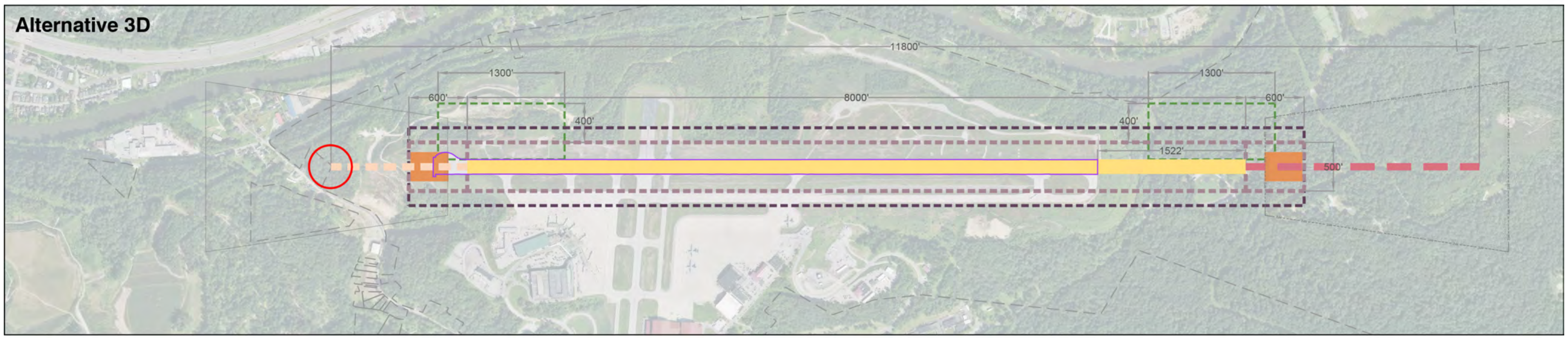
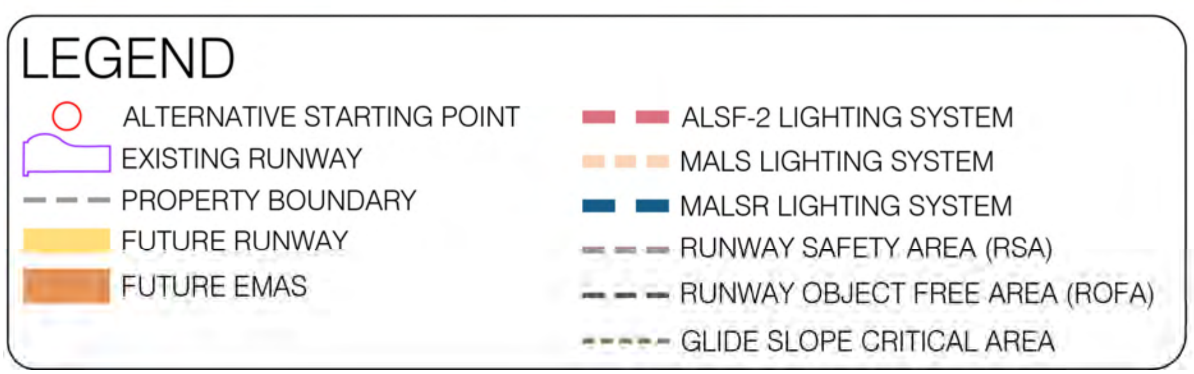
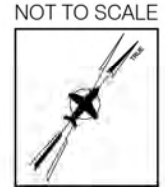
EXHIBIT 4-9 RUNWAY ALTERNATIVES 3C & 3D







NOT TO SCALE



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

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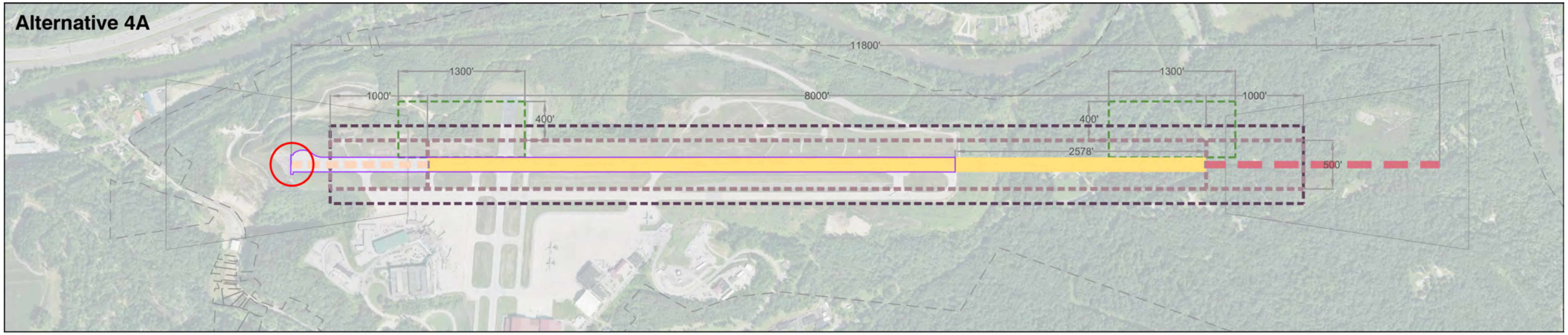
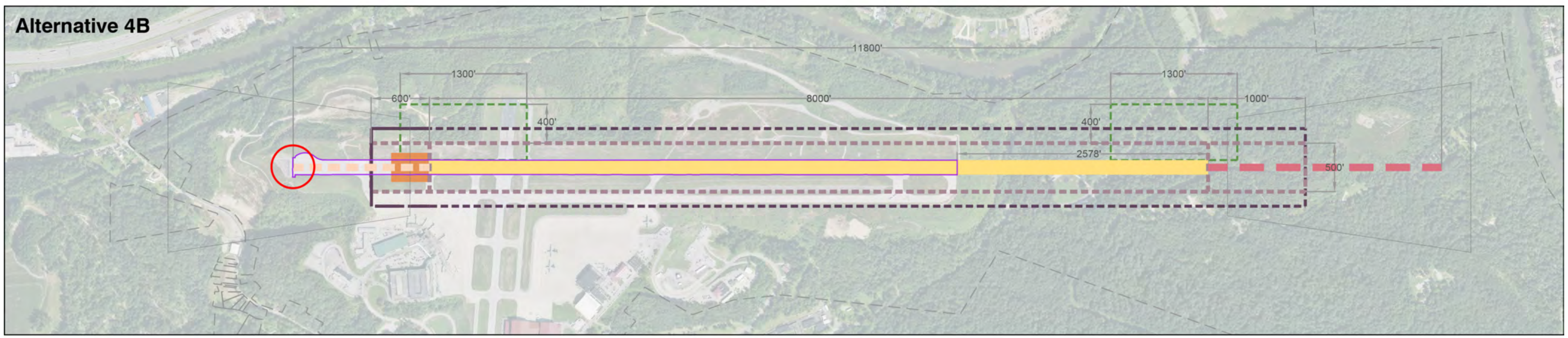
EXHIBIT 4-10 RUNWAY ALTERNATIVES 4A & 4B





LEGEND

- ALTERNATIVE STARTING POINT
- EXISTING RUNWAY
- PROPERTY BOUNDARY
- FUTURE RUNWAY
- FUTURE EMAS
- ALSF-2 LIGHTING SYSTEM
- MALS LIGHTING SYSTEM
- MALSR LIGHTING SYSTEM
- RUNWAY SAFETY AREA (RSA)
- RUNWAY OBJECT FREE AREA (ROFA)
- GLIDE SLOPE CRITICAL AREA

NOT TO SCALE

Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

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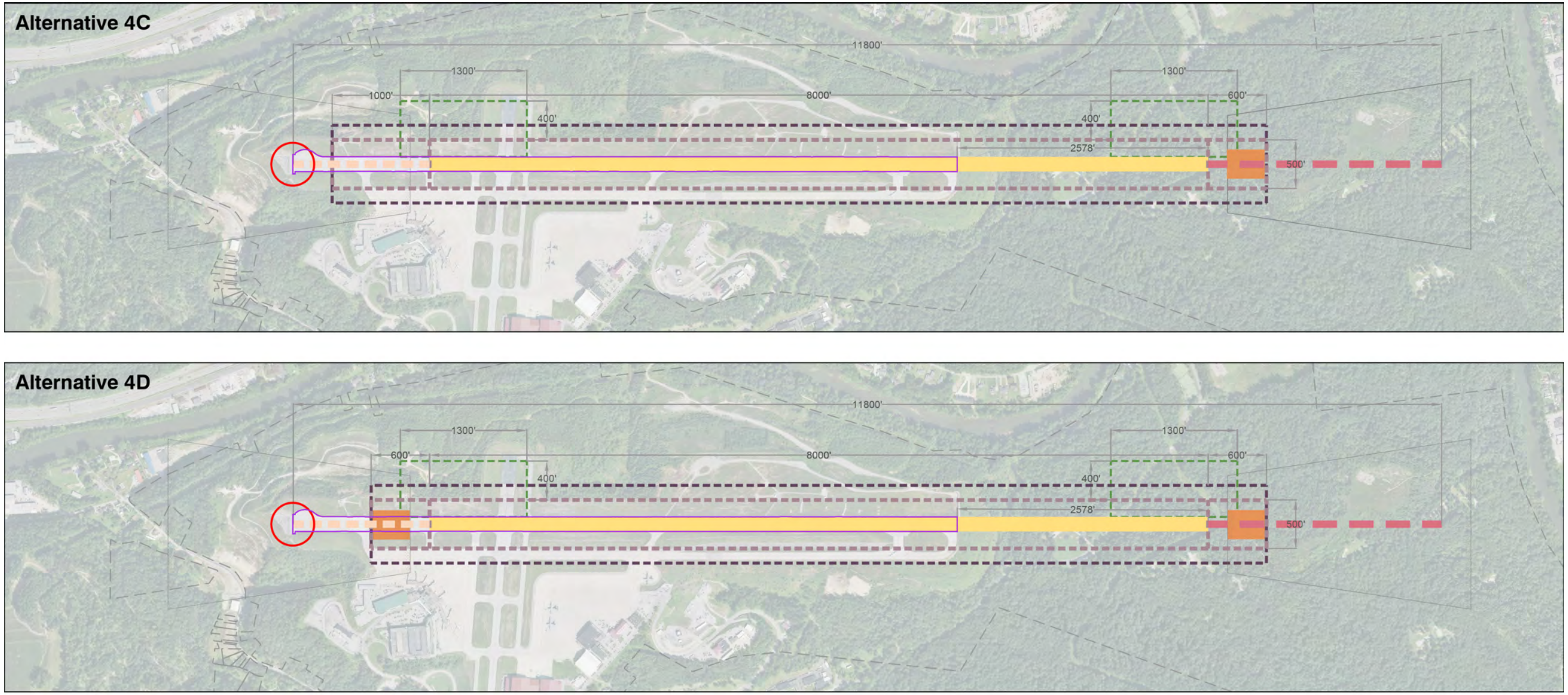
EXHIBIT 4-11 RUNWAY ALTERNATIVES 4C & 4D



LEGEND

- ALTERNATIVE STARTING POINT
- EXISTING RUNWAY
- PROPERTY BOUNDARY
- FUTURE RUNWAY
- FUTURE EMAS
- ALSF-2 LIGHTING SYSTEM
- MALS LIGHTING SYSTEM
- MALSR LIGHTING SYSTEM
- RUNWAY SAFETY AREA (RSA)
- RUNWAY OBJECT FREE AREA (ROFA)
- GLIDE SLOPE CRITICAL AREA

NOT TO SCALE

Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

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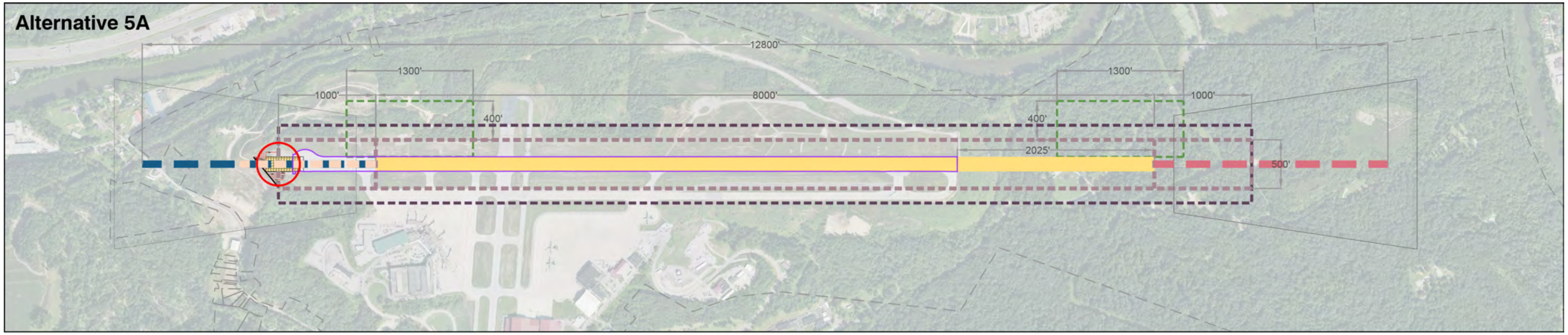
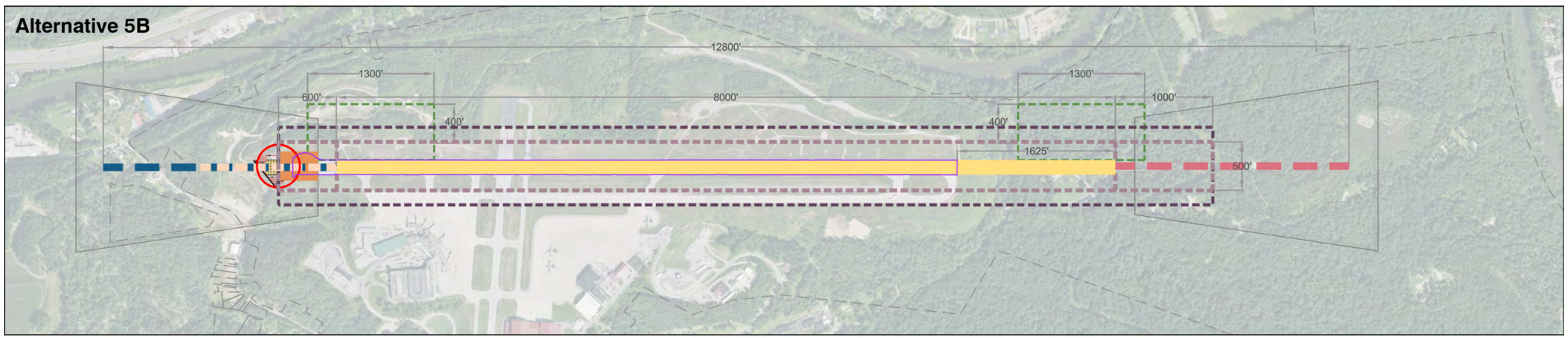
EXHIBIT 4-12 RUNWAY ALTERNATIVES 5A & 5B

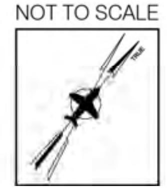




LEGEND

- ALTERNATIVE STARTING POINT
- EXISTING RUNWAY
- PROPERTY BOUNDARY
- FUTURE RUNWAY
- FUTURE EMAS
- ALSF-2 LIGHTING SYSTEM
- MALS LIGHTING SYSTEM
- MALSR LIGHTING SYSTEM
- RUNWAY SAFETY AREA (RSA)
- RUNWAY OBJECT FREE AREA (ROFA)
- GLIDE SLOPE CRITICAL AREA

NOT TO SCALE



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

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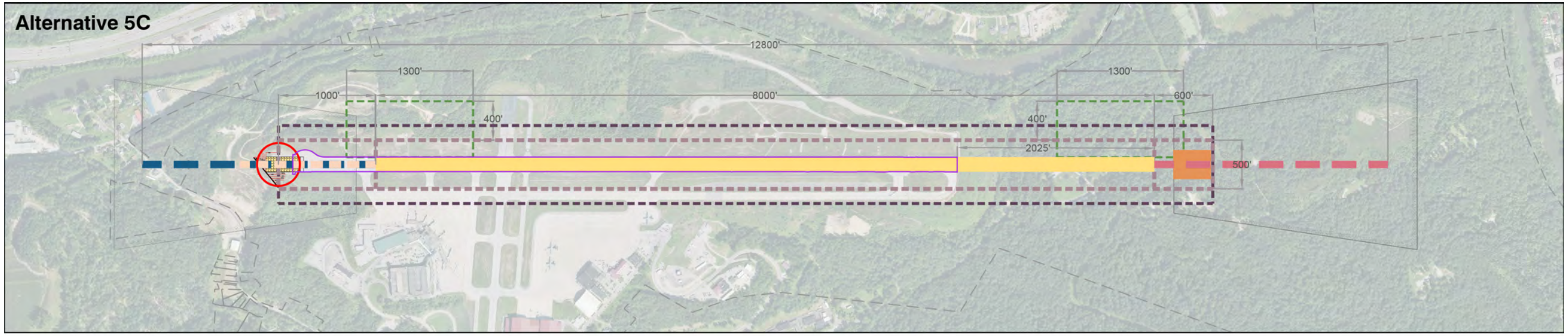
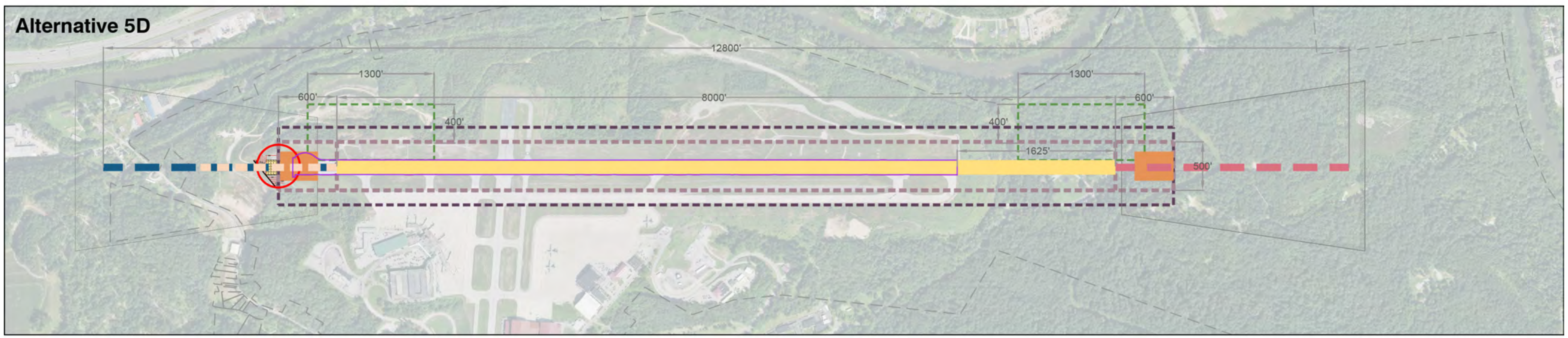
EXHIBIT 4-13 RUNWAY ALTERNATIVES 5C & 5D

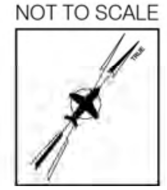




LEGEND

- ALTERNATIVE STARTING POINT
- EXISTING RUNWAY
- PROPERTY BOUNDARY
- FUTURE RUNWAY
- FUTURE EMAS
- ALSF-2 LIGHTING SYSTEM
- MALS LIGHTING SYSTEM
- MALSR LIGHTING SYSTEM
- RUNWAY SAFETY AREA (RSA)
- RUNWAY OBJECT FREE AREA (ROFA)
- GLIDE SLOPE CRITICAL AREA

NOT TO SCALE



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

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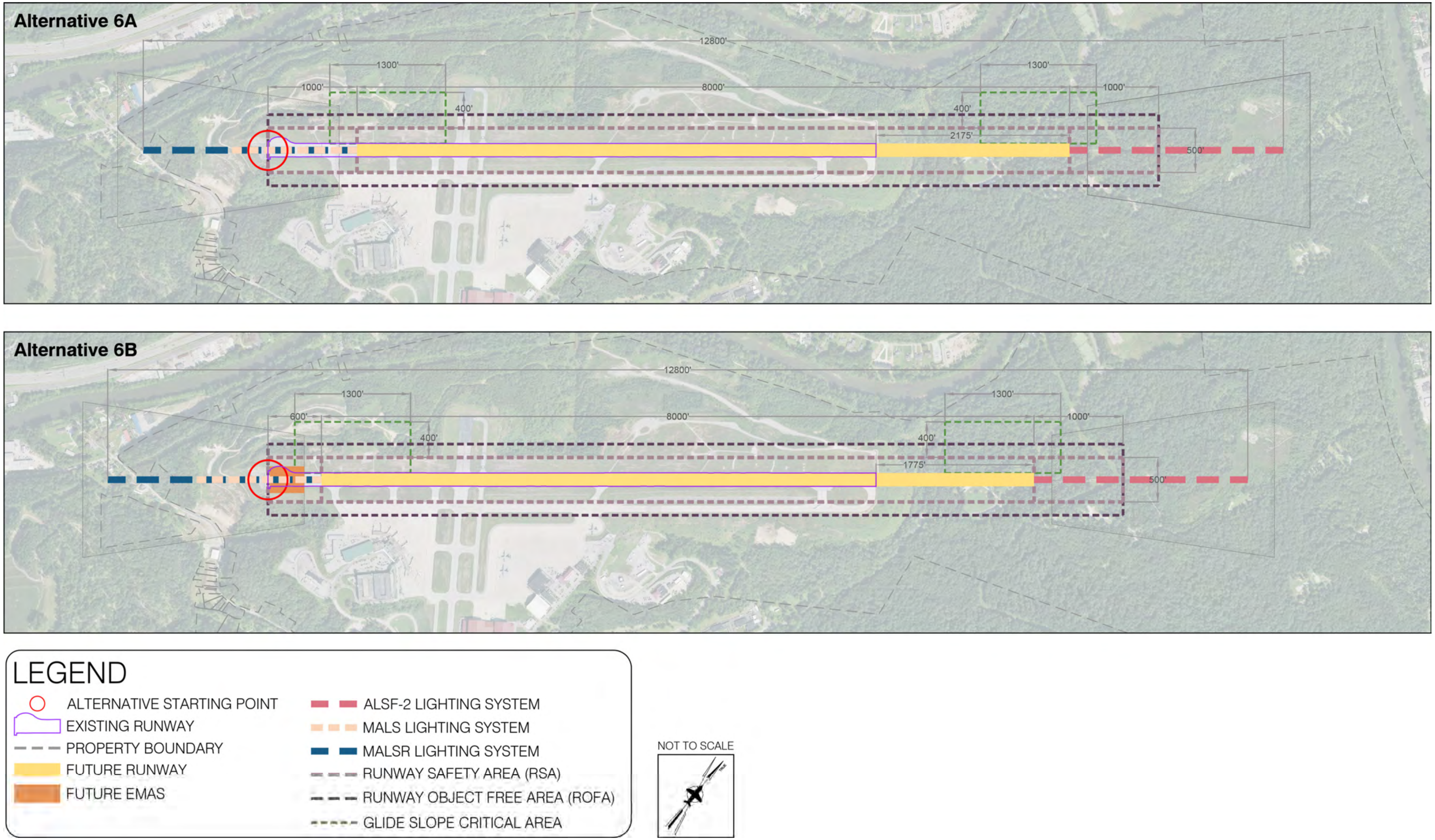
EXHIBIT 4-14 RUNWAY ALTERNATIVES 6A & 6B



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

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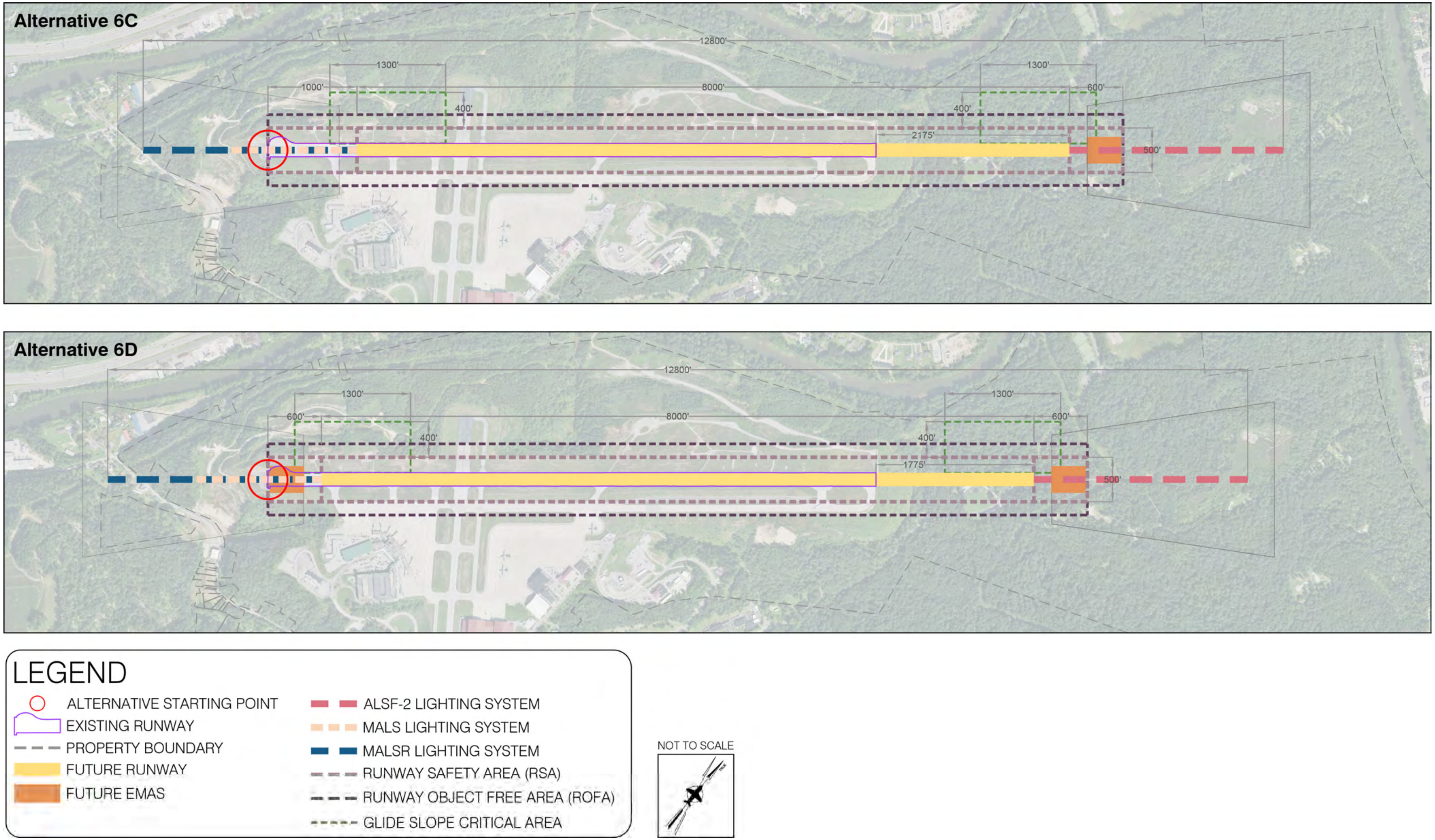
EXHIBIT 4-15 RUNWAY ALTERNATIVES 6C & 6D



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

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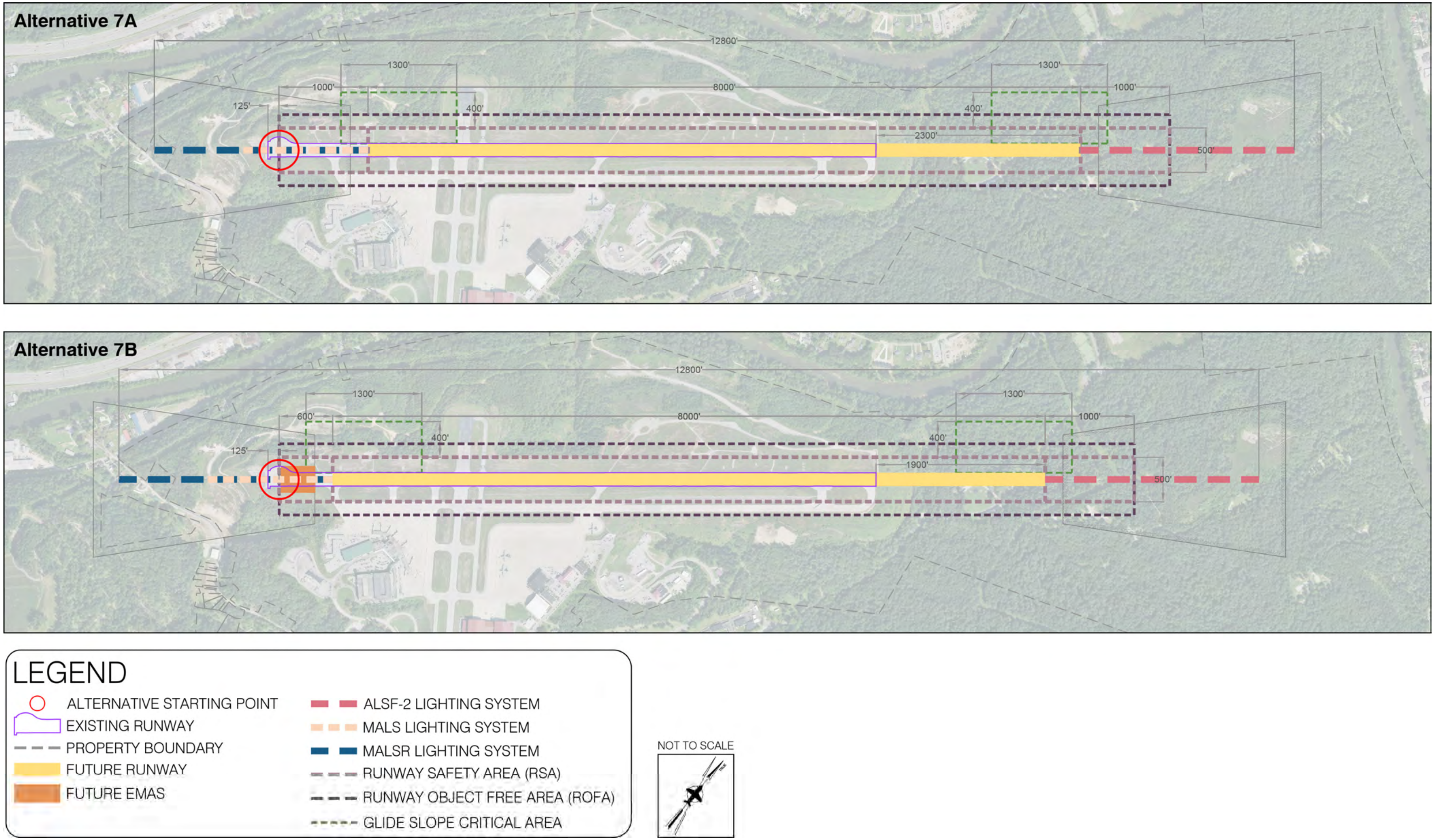
EXHIBIT 4-16 RUNWAY ALTERNATIVES 7A & 7B



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

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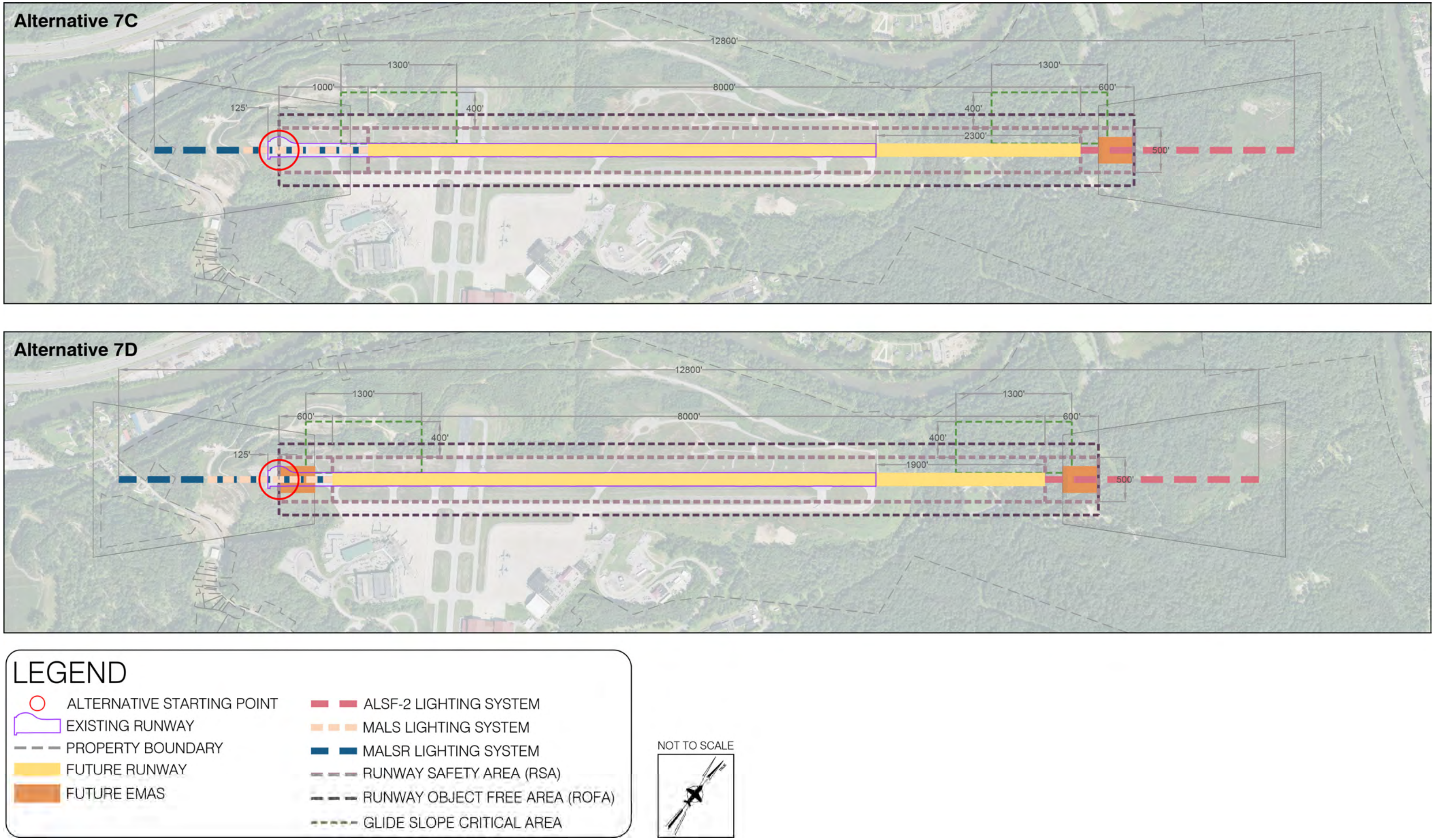
EXHIBIT 4-17 RUNWAY ALTERNATIVES 7C & 7D



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

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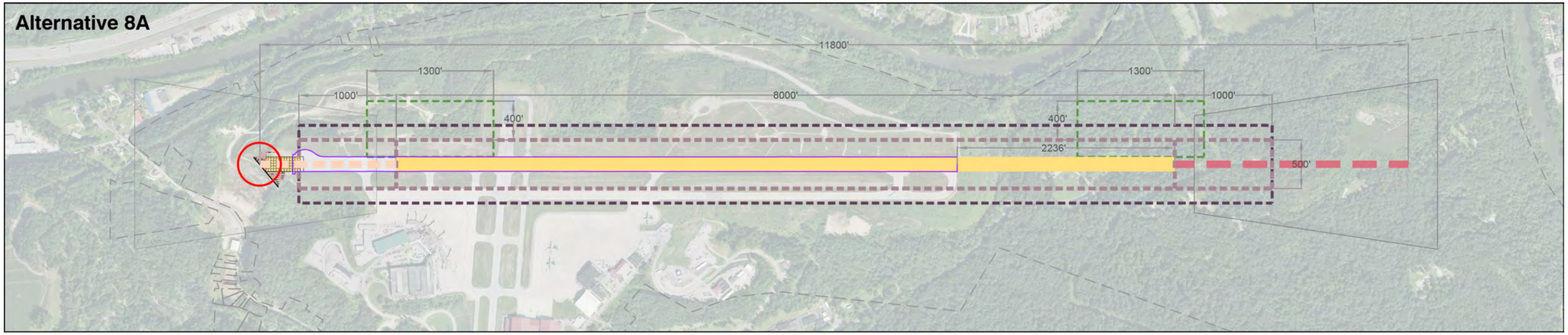
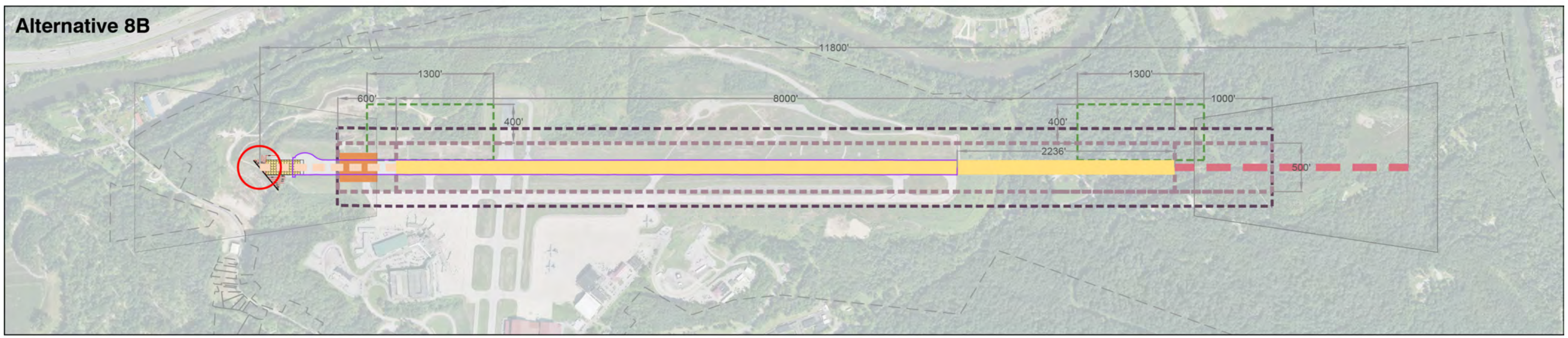
EXHIBIT 4-18 RUNWAY ALTERNATIVES 8A & 8B





LEGEND

- ALTERNATIVE STARTING POINT
- EXISTING RUNWAY
- PROPERTY BOUNDARY
- FUTURE RUNWAY
- FUTURE EMAS
- ALSF-2 LIGHTING SYSTEM
- MALS LIGHTING SYSTEM
- MALSR LIGHTING SYSTEM
- RUNWAY SAFETY AREA (RSA)
- RUNWAY OBJECT FREE AREA (ROFA)
- GLIDE SLOPE CRITICAL AREA

NOT TO SCALE

Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

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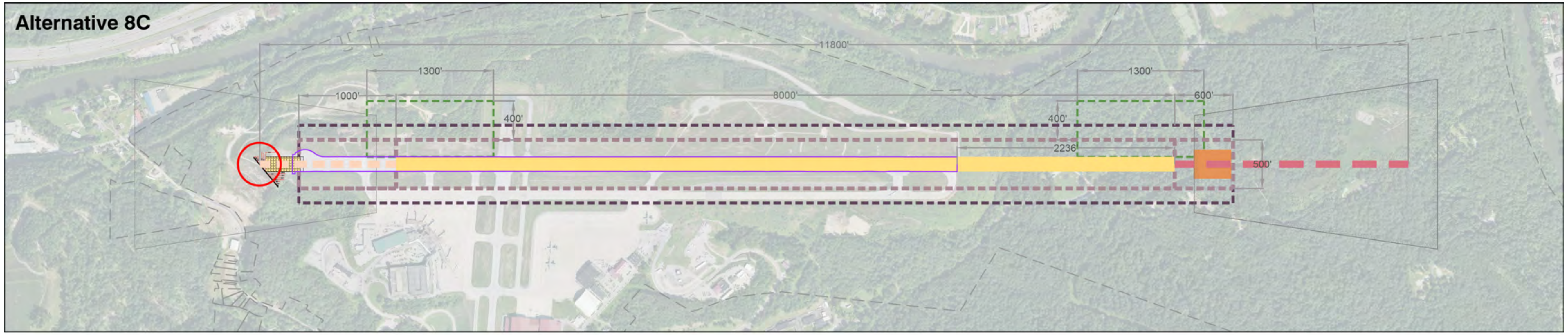
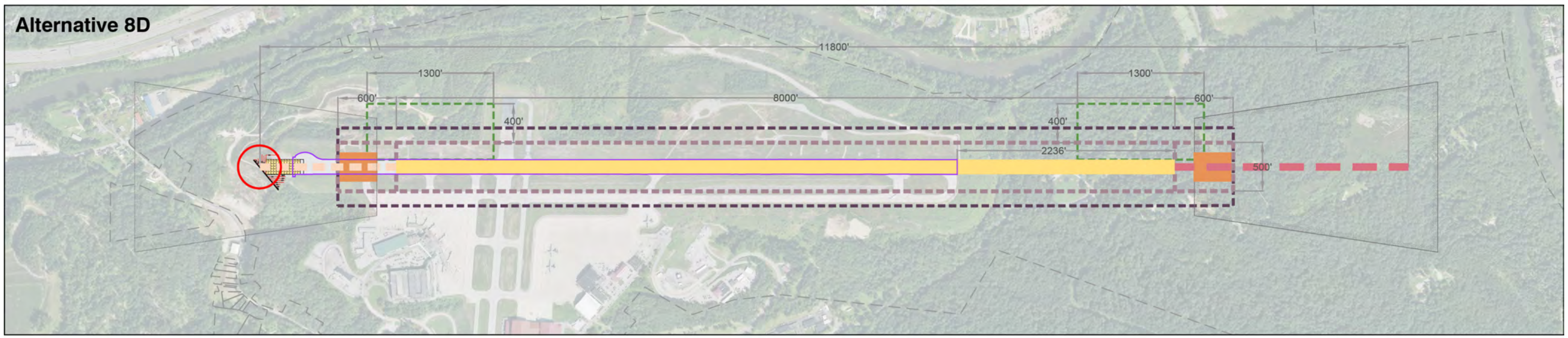
EXHIBIT 4-19 RUNWAY ALTERNATIVES 8C & 8D





LEGEND

- ALTERNATIVE STARTING POINT
- EXISTING RUNWAY
- PROPERTY BOUNDARY
- FUTURE RUNWAY
- FUTURE EMAS
- ALSF-2 LIGHTING SYSTEM
- MALS LIGHTING SYSTEM
- MALSR LIGHTING SYSTEM
- RUNWAY SAFETY AREA (RSA)
- RUNWAY OBJECT FREE AREA (ROFA)
- GLIDE SLOPE CRITICAL AREA

NOT TO SCALE

Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

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4.4 Step 3: Constructability Pre-Screening of Alternatives

The constructability pre-screening of alternatives consisted of eliminating options that did not appear viable based on the following critical impacts:

- Location
- Geometry
- Topography
- Other Constraints

Originally, 32 alternatives were examined. Eight alternatives (Alternatives 1A through1D and 2A through 2D) were eliminated based upon the four preceding criteria.

4.4.1 Alternatives 1A through 1D

Alternatives 1A through 1D would require the furthest westward expansion through an extension of the Runway 05 end. These alternatives would result in significant filling of the valley covering Elk Twomile Creek, Keystone Drive, and Barlow Drive. Based on proximity to the Elk River, Alternatives 1A through 1D would require unreasonably high retaining walls. Additionally, both sides of the runway extension were less than ideal for an installation of the GSCA and for Taxiway A extensions. Significant property acquisitions would be required and covering Elk Twomile Creek would create a high hazard dam scenario with downstream residents and potential for increased upstream flooding. These options were therefore deemed infeasible and eliminated in Step 3.

4.4.2 Alternatives 2A through 2D

On the Runway 05 end, Alternatives 2B and 2D would extend fill over the newly constructed retaining wall and EMAS system and would likely cover Keystone Drive, and possibly Elk Twomile Creek. This could create a high hazard dam scenario with downstream residents, increased potential for flooding upstream, and other property acquisition and drainage issues.

Additionally, for Alternatives 2A through 2D, lighting towers would extend over Keystone Drive and numerous residences; these towers would be over 300 feet. On the Runway 23 end, the proximity of the GSCA to Elk River for Alternatives 2A through 2D would result in having to construct unreasonably high retaining walls. For all these reasons, Alternatives 2A through 2D were eliminated during Step 3.

4.5 Step 4: Level 1 Screening

The remaining runway extension alternatives (3A through 8D) were evaluated based on the following criteria:

- Obstructions
- Air Traffic Control Tower (ATCT) siting
- RPZ impacts
- Terminal impacts
- Construction phasing
- Navigational Aid (NAVAID) siting
- Grading Requirements
- Environmental and local impacts

Each alternative was evaluated against each of the Level 1 criteria and given a green, yellow, or red color in the evaluation matrix based on that evaluation. The color coding is depicted in **Table 4-2, *Evaluation Criteria Coloring***. The color coding is further defined in the subsections that follow. It is important to note that red does not necessarily mean an alternative is infeasible. Rather, the color coding is a tool to show minor (green), moderate (yellow), or more extensive (red) impacts.
The evaluation matrix is presented at the end of Level 1 evaluation section.

TABLE 4-2 EVALUATION CRITERIA COLORING

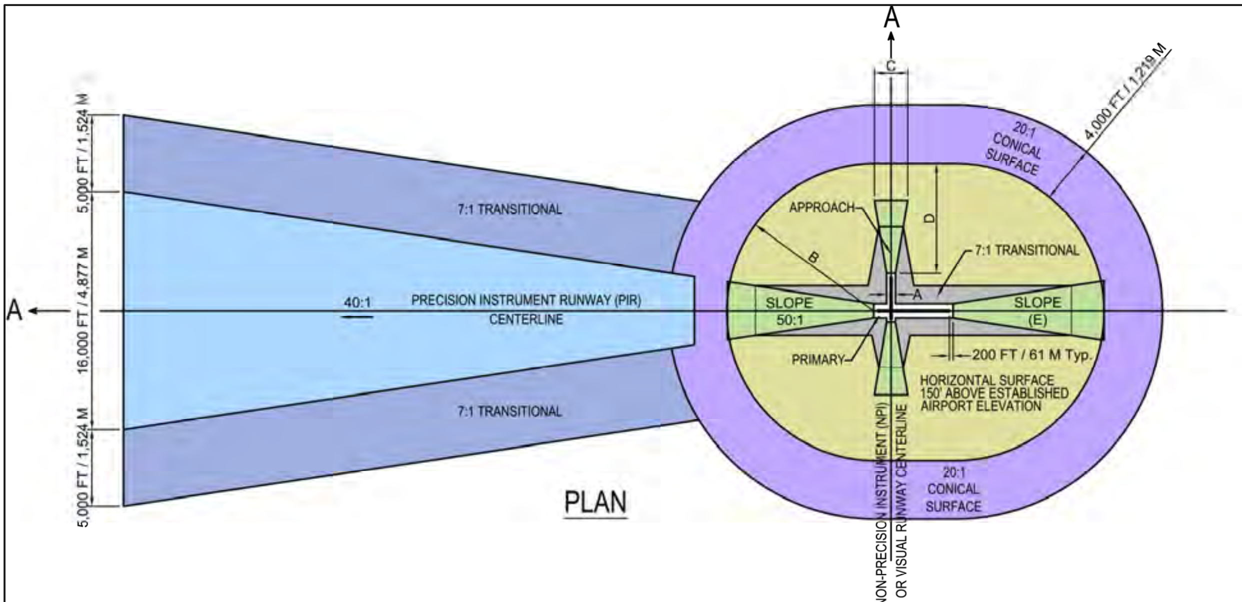
DEFINITION	COLORING
Minor	
Moderate	
More Extensive	

Source: Landrum & Brown, 2018

4.5.1 Obstructions

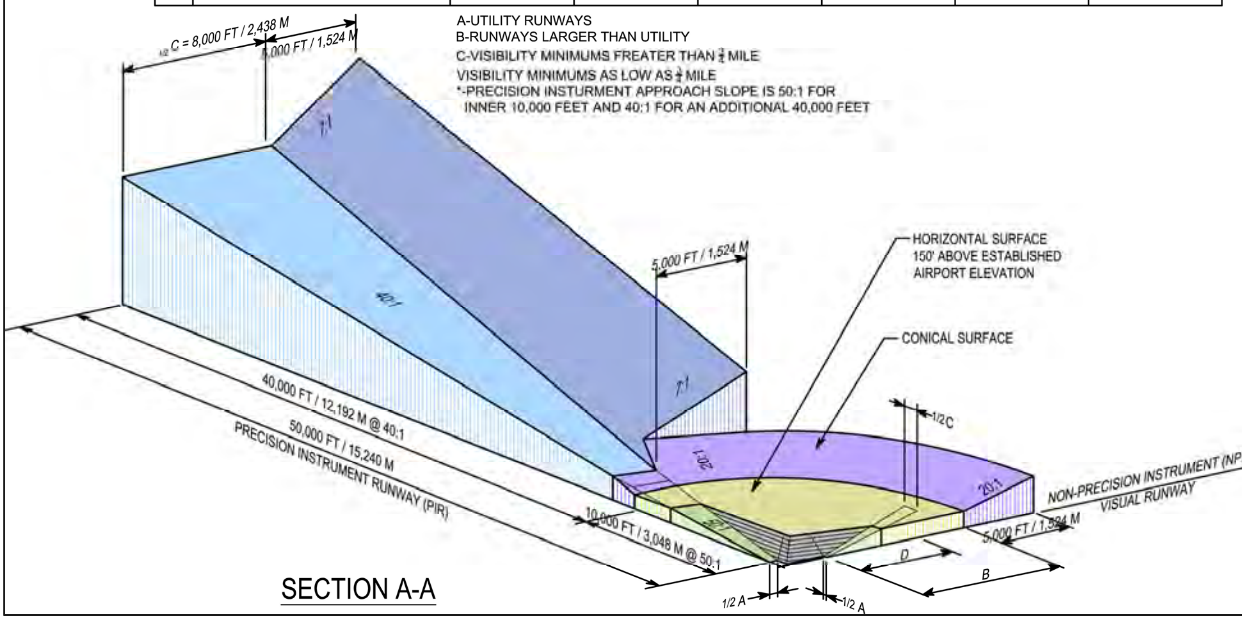
Obstructions to the Runway 23 Part 77 transitional and approach surfaces were evaluated as part of the alternatives evaluation. The Part 77 surfaces for instrument runways are shown on **Exhibit 4-20, *Part 77 Surfaces for Precision Instrument Runways***. Google earth 3D imagery was used to identify obstructions.

EXHIBIT 4-20 PART 77 SURFACES FOR PRECISION INSTRUMENT RUNWAYS



DIM	ITEM	DIMENSIONAL STANDARDS					
		VISUAL RUNWAY		NON-PRECISION INSTRUMENT RUNWAY			PRECISION INSTRUMENT RUNWAY
		A	B	A	B		
					C	D	
A	WIDTH OF PRIMARY SURFACE AND APPROACH SURFACE WIDTH AT INNER END	250 FT / 76 M	500 FT / 152 M	500 FT / 152 M	500 FT / 152 M	1,000 FT / 305 M	1,000 FT / 305 M
B	RADIUS OF HORIZONTAL SURFACE	5,000 FT / 1,524 M	5,000 FT / 1,524 M	5,000 FT / 1,524 M	10,000 FT / 3,048 M	10,000 FT / 3,048 M	10,000 FT / 3,048 M
		VISUAL APPROACH		NON-PRECISION INSTRUMENT APPROACH			PRECISION INSTRUMENT RUNWAY
		A	B	A	B		
					C	D	
C	APPROACH SURFACE WIDTH AT END	1,250 FT / 381 M	1,500 FT / 457 M	2,000 FT / 610 M	3,500 FT / 1,067 M	4,000 FT / 1,219 M	16,000 FT / 4,877 M
D	APPROACH SURFACE LENGTH	5,000 FT / 1,524 M	5,000 FT / 1,524 M	5,000 FT / 1,524 M	10,000 FT / 3,048 M	10,000 FT / 3,048 M	*
E	APPROACH SLOPE	20:1	20:1	20:1	34:1	34:1	*

A-UTILITY RUNWAYS
B-RUNWAYS LARGER THAN UTILITY
C-VISIBILITY MINIMUMS FREATER THAN ¾ MILE
VISIBILITY MINIMUMS AS LOW AS ¾ MILE
*-PRECISION INSTURMENT APPROACH SLOPE IS 50:1 FOR INNER 10,000 FEET AND 40:1 FOR AN ADDITIONAL 40,000 FEET

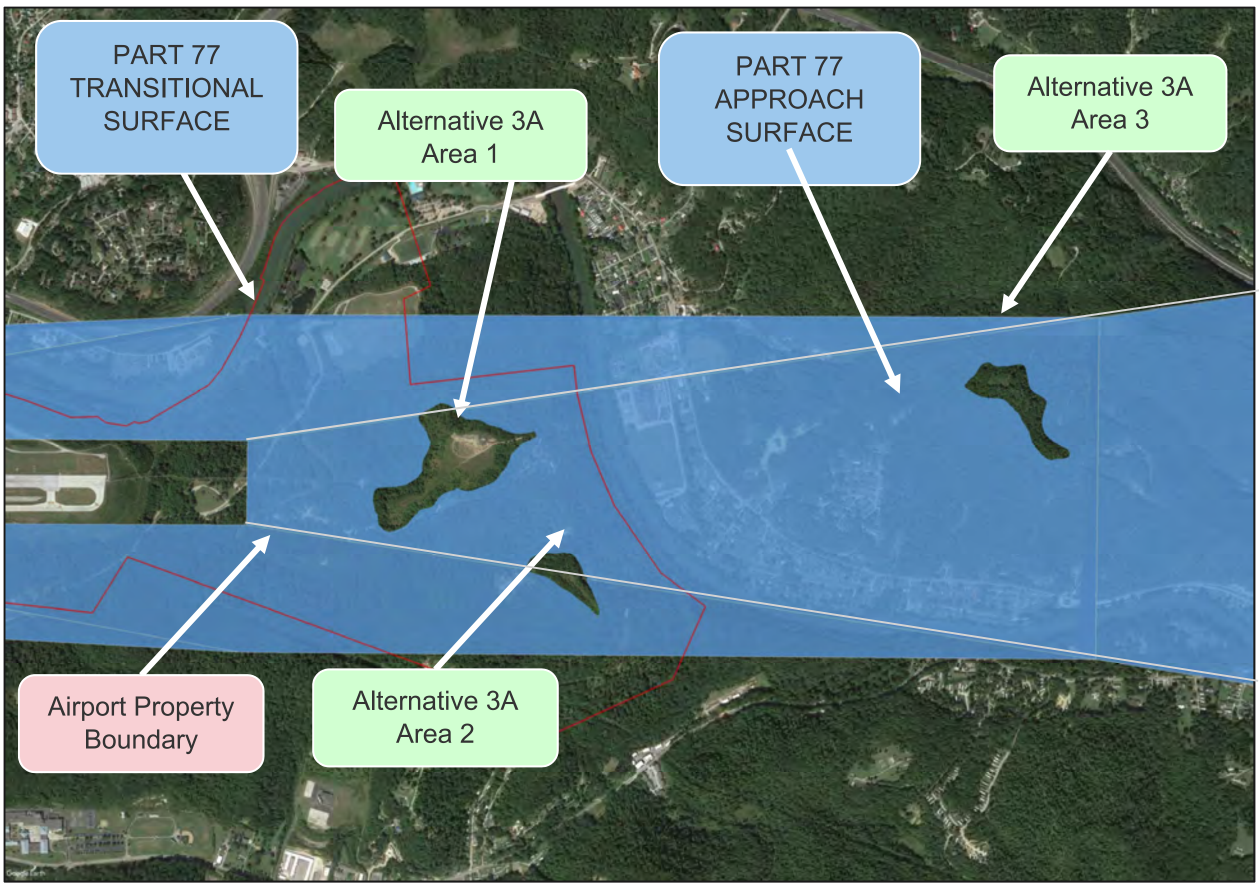


Source: Landrum & Brown analysis.

Obstructions were analyzed for two of the alternatives – Alternatives 3A and 4A. These two alternatives were chosen because Alternative 3A represents the smallest eastward shift of Runway 05-23 and Alternative 4A represents the largest eastward shift. The obstructions for all other alternatives would fall between these two alternatives. **Exhibit 4-21, *Obstructions – Alternative 3A***, and **Exhibit 4-22, *Obstructions – Alternative 4A***, show the areas that are considered obstructions to the Runway 23 approach for the two alternatives that were analyzed.

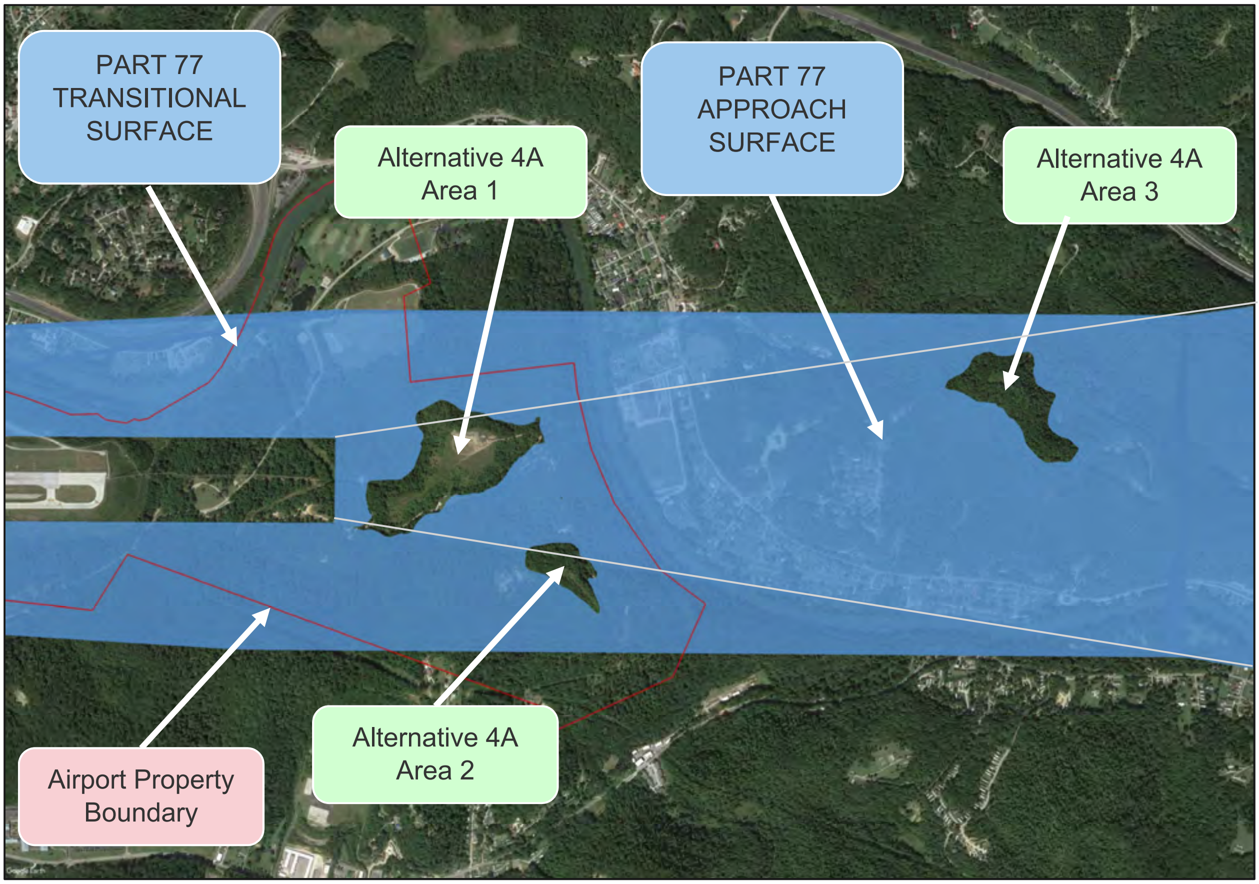
Areas 1 and 2 are on Airport property and have been identified as borrow areas for the runway extension fill requirements (see Section 4.5.7, *Grading*, for more details on the fill requirements). Therefore, these areas would be addressed as part of the construction. Area 3 is off of Airport property. It is a mountain top that is owned by several private individuals. This land may have to be purchased and lowered, trees may need to be cut down, and/or an increased climb gradient for aircraft may be required.

EXHIBIT 4-21 OBSTRUCTIONS – ALTERNATIVE 3A



Sources: Google Earth accessed in April 2018; Landrum & Brown analysis.

EXHIBIT 4-22 OBSTRUCTIONS – ALTERNATIVE 4A



Sources: Google Earth accessed in April 2018; Landrum & Brown analysis.

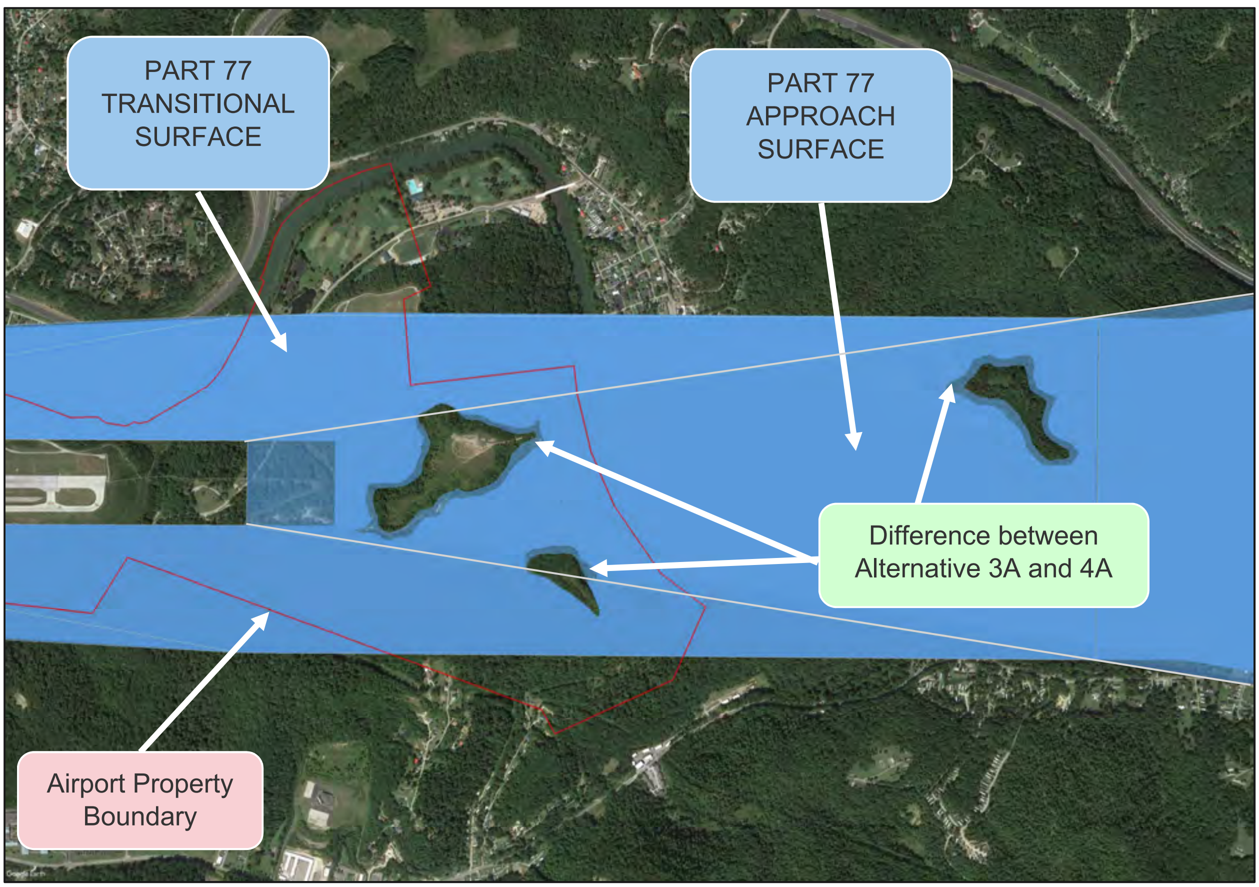
The same three areas were identified as obstructions for both alternatives. **Exhibit 4-23, *Obstructions – Alternative 3 and 4 Combined***, shows how these three areas differ between the two alternatives. In addition to these areas, tree mitigation would likely be needed. A separate study would be required to analyze the tree mitigation associated with the development of the alternatives.

Based on the preceding analysis, the alternatives were color coded in the evaluation matrix as green, yellow, or red for obstructions based on the following criteria:

- **Green:** No obstructions
- **Yellow:** Obstructions can be removed or will not likely result in an increase in approach minima
- **Red:** Obstructions cannot be removed and/or will result in an increase in approach minima

Because there would be similar obstructions for all of the alternatives and it is likely that these areas can be mitigated, all alternatives were color coded yellow in the evaluation matrix. Obstructions do not differentiate the alternatives.

EXHIBIT 4-23 OBSTRUCTIONS – ALTERNATIVE 3 AND 4 COMBINED

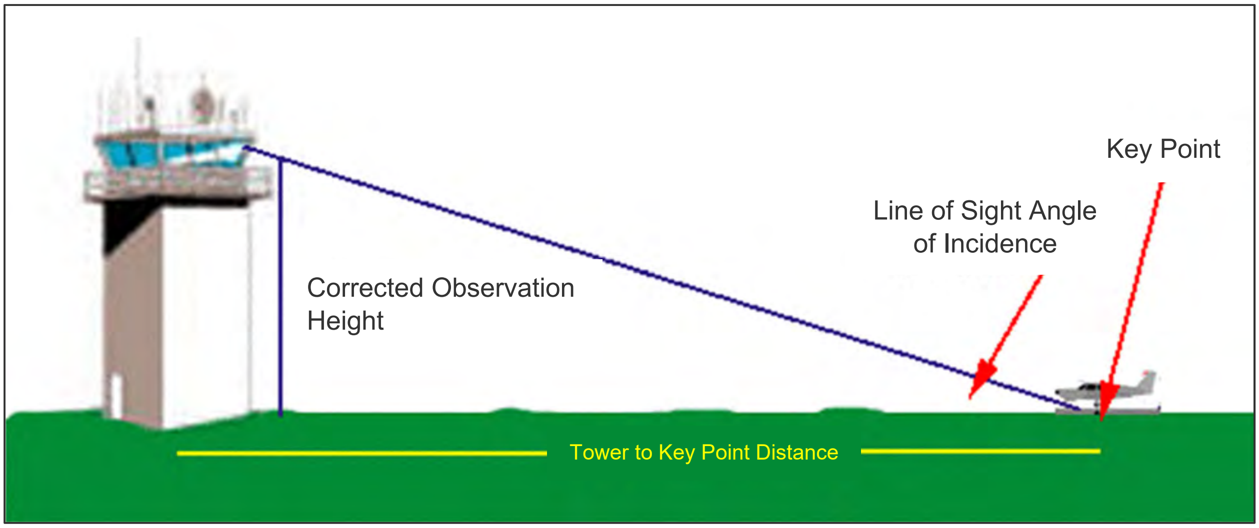


Sources: Google Earth accessed in April 2018; Landrum & Brown analysis.

4.5.2 ATCT Siting

The FAA's Tower Visibility Analysis Tool[4] was used to determine object discrimination/recognition and line-of-sight (LOS) for the alternatives. This tool is illustrated on **Exhibit 4-24, *FAA Air Traffic Control Visibility Analysis Tool***.

EXHIBIT 4-24 FAA AIR TRAFFIC CONTROL VISIBILITY ANALYSIS TOOL



Source: FAA Air Traffic Control Visibility Analysis Tool.

This analysis was completed from the existing ATCT to the furthest possible location of the Runway 23 end, which occurs in Alternative 4A. All of the other alternatives fall within the Alternative 4A bounds for line-of-sight and did not require analysis beyond that of what was conducted for Alternative 4A. The following information was used as input to the FAA model:

- Observer eye height: 5.5 feet (from floor of cab)
- Ground elevation at ATCT: 948.9 feet Above Mean Sea Level (AMSL)
- ATCT Cab Floor elevation: 1,006 feet AMSL
- Ground elevation at LOS critical point5 (Runway 23 end): 881.5 AMSL for Alternative 4A
- Distance from ATCT to LOS critical point: 8,026 feet for Alternative 4A

4 http://www.hf.faa.gov/visibility.
5 LOS critical point is defined as the point with the lowest elevation and longest linear distance from the ATCT.

The alternatives were color coded as green, yellow, or red for ATCT siting based on the following criteria:

- **Green:** Passes FAA Tower Visibility Analysis Tool
- **Yellow:** Fails FAA Tower Visibility Analysis Tool; alternative procedures or mitigation required
- **Red:** Fails FAA Tower Visibility Analysis Tool; new ATCT required

All of the alternatives pass the FAA Tower Visibility Analysis Tool analysis, so all of the alternatives were color coded green in the evaluation matrix. The distance from the Runway 23 end to the ATCT does not differentiate the alternatives.

4.5.3 RPZ Impacts

Structures and roads within the Runway 05 RPZ were identified for each alternative. Objects in the Runway 05 RPZ were identified separately for the central and controlled portions. The alternatives were color coded as green, yellow, or red for Runway 05 RPZ impacts based on the following criteria:

- **Green**: 10 or fewer structures in the central + controlled portions of the RPZ
- **Yellow**: 11 to 20 structures in the central + controlled portions of the RPZ
- **Red**: 21+ structures in the central + controlled portions of the RPZ

Table 4-3, *Runway 05 RPZ Impacts*, shows the Runway 05 RPZ impacts for each alternative. All RPZs contain residential houses, businesses, Keystone Road, and Barlow Road. The series 4 alternatives, as well as 7A and 7C have minor Runway 05 RPZ impacts. Alternatives 5A, 5C, 6A, 6C, and 8A through 8D have moderate RPZ impacts, whereas Alternatives 3A through 3D, 5B, 5D, 6B, 6D, 7B, and 7D have extensive RPZ impacts.

The Runway 23 RPZ impacts were also assessed. The Runway 23 RPZ is fully encompassed by Coonskin Park in all alternatives. Coonskin Park is owned by the Airport. However, since Coonskin Park includes Section 4(f) and/or Section 6(f) lands, defined by the Clean Water Act, all Runway 23 RPZ impacts in all alternatives were color-coded red. The Runway 23 RPZ impacts were not considered to be differentiating factors in the evaluation of alternatives.

TABLE 4-3 RUNWAY 05 RPZ IMPACTS

ALTERNATIVE	CENTRAL PORTION	CONTROLLED PORTION
3A - 3D	- 16 residential houses - 2 businesses - 1 abandoned business - Keystone Drive - Barlow Drive	- 20 residential houses - 3 businesses - 1 abandoned business - Keystone Drive - Barlow Drive
4A - 4D	- 2 residential houses - Keystone Drive	- 2 residential houses - 1 business - 1 church - Keystone Drive - Barlow Drive
5A / 5C	- 12 residential houses - 1 business - Keystone Drive	- 1 business - Keystone Drive - Barlow Drive
5B / 5D	- 17 residential houses - 2 businesses - 1 abandoned business - Keystone Drive - Barlow Drive	- 17 residential houses - 3 businesses - Keystone Drive - Barlow Drive
6A / 6C	- 6 residential houses - 2 businesses - Keystone Drive - Barlow Drive	- 5 residential houses - 2 businesses - Keystone Drive - Barlow Drive
6B / 6D	- 18 residential houses - 1 business - 1 abandoned business - Keystone Drive - Barlow Drive	- 16 residential houses - 3 businesses - 1 abandoned business - Keystone Drive - Barlow Drive
7A / 7C	- 3 residential houses - 2 businesses - Keystone Drive - Barlow Drive	- 1 residential house - 3 businesses - 1 church property - Keystone Drive - Barlow Drive
7B / 7D	- 14 residential houses - 2 businesses - 1 abandoned business - Keystone Drive - Barlow Drive	- 14 residential houses - 3 businesses - Keystone Drive - Barlow Drive
8A - 8D	- 4 residential houses - 1 business - Keystone Drive - Barlow Drive	- 6 residential houses - 3 businesses - 1 church - Keystone Drive - Barlow Drive

Source: Landrum & Brown analysis.

4.5.4 Terminal Impacts

Terminal impacts were assessed for each alternative to determine if there would be any loss of gates due to the location of the relocated RPZ. The alternatives were color coded as green, yellow, or red for terminal impacts based on the following criteria:

- **Green**: No impact, which means no gates are impacted by the alternative
- **Yellow**: Minor impact to the terminal, which means the alternative causes the loss of one to two gates
- **Red**: Major impact to the terminal, which means the alternative causes the loss of three or more gates and/or a portion of the building

The series 4 alternatives would result in the loss of one gate, so these alternatives were color coded as yellow in the evaluation matrix. The remaining alternatives have no impact on the terminal, so they were color coded as green. These results are depicted in **Table 4-4, *Terminal Impact Evaluation***.

TABLE 4-4 TERMINAL IMPACT EVALUATION

ALTERNATIVE	TERMINAL IMPACT
3A - 3D	No gates
4A - 4D	1 gate
5A - 5D	No gates
6A - 6D	No gates
7A - 7D	No gates
8A - 8D	No gates

Source: Landrum & Brown Team analysis.

4.5.5 Construction Phasing

The construction phasing evaluation assessed the impacts for all remaining alternatives (24 alternatives). A primary goal of construction phasing was to keep the airport operating with as much runway length and instrument approach capability as possible, while proceeding with construction that is accomplished with the utmost safety for airport users and construction crews alike. Extra challenges are presented in this planned construction project, since the work area is adjacent to the active runway environment for the duration of construction. To meet the challenges of construction phasing for a runway extension project, ways to perform construction activities outside of the protected surface of the airfield environment (RSAs, approach surfaces, etc.) were reviewed, focusing on limiting closures and delays to existing runway operations.

To limit operational impacts, the existing runway length and the current precision instrument approach capabilities to each runway end should be maintained throughout construction. To do this, phasing should start with work in locations outside the existing RSA, and then proceed with construction within the RSA, which is further explained in the subsections that follow. The nature and duration of construction required in these two work areas will dictate operational impact in terms of runway closures, loss of runway length, or affected instrument approaches.

4.5.5.1 Work Outside the RSA

Runway 23 End

For all alternatives, it is advisable to begin construction on the Runway 23 end to minimize operational impacts and to capitalize on the location of the source material for the fill needed on each runway end. This is an efficient way to provide the runway length needed to maintain airport operations while constructing any alternative that will effectively shorten the runway length on the Runway 05 end. Some alternatives require a change of threshold to address existing RSA deficiencies and provide for an Airport Lighting System (ALS) installation. The extension of the Runway 23 end in the first construction phase will also facilitate the implementation of alternatives that consider an EMAS installation on one or both runway ends.

The Runway 23 RSA is currently set at the existing physical end of the runway because of a drop off in terrain. Any construction that occurs below the current Runway 23 end elevation will be clear of the RSA and will not impact airfield operations until after the site has been brought up to the existing/proposed tie-in elevation. The Runway 23 Part 77, Threshold Siting Surface (TSS), Obstacle Clearance Surface (OCS), and Obstacle Free Zone (OFZ) airspace surfaces do not include the area beneath the existing runway end/RSA elevation, so there would be no penetrations to approach or departure surfaces as a result of construction of any alternative until after the site has been brought up close to the existing/proposed tie-in elevation.

Construction on the Runway 23 end will include earthwork, utility work, paving, and installation of the ALS towers, Runway 23 glide slope, and Runway 05 localizer. Construction in this first phase also should include the Runway 23 localizer installation on the Runway 05 end, as well as the Runway 05 glide slope to reinstate precision instrument approach capability to the extended runway as soon as possible. Construction of the Runway 23 localizer and Runway 05 glide slope can be accomplished without impact to airport operations, since they are located outside of the RSA. Although the ALS towers, glide slope, and localizer can be installed during this phase of work, the Runway 23 precision approach will not be immediately operational. The assumption here is that the Runway 23 end is physically constructed and the new Instrument Landing System (ILS) is in place and functioning during the first phase.

Runway 05 End

Like the Runway 23 end, the Runway 05 end has a steep terrain drop-off shortly beyond the physical runway end. Also like the Runway 23 end, construction occurring before the approach end of Runway 05 can occur outside of the RSA until the site is brought up to the existing/proposed tie-in elevation, minimizing operational impacts. This directly affects the level of operational impacts for each alternative.

The series 3 alternatives propose to construct the ALS starting at the western property limit, outside of the RSA and below the approach and other protected surfaces. This results in less operational impacts than the other alternatives that propose to construct most of the ALS system on portions of the existing runway. Alternative series 4 through 8 require the Runway 05 threshold be relocated. Maintaining a runway length of at least 6,715 feet throughout construction will lessen the degree of operational impact of a Runway 05 threshold relocation. The location of the Runway 05 threshold will directly impact the construction schedule. The closer the Runway 05 threshold is moved towards the Runway 23 end, the longer the construction duration. This is primarily due to impacts to the taxiway system and/or terminal apron.

Depending on the alternative, construction activities for the Runway 05 end will be like the Runway 23 end. The construction will include earthwork and utility work, paving, and installation of Runway 05 ALS towers. The glide slope and localizer installations will have varying timeframes for becoming operational, depending on the alternative.

4.5.5.2 Work Within the RSA

Once all construction is completed outside of the RSA, work must begin within the RSA as part of a second phase of construction, resulting in operational impacts to Runway 05-23 operations. It is expected that impacts to operations can be lessened by construction proceeding primarily at night (off-peak operational hours). This way a 6,715-foot runway length would remain available during daytime hours. Work in this phase would include adjustments to airfield signage and airfield lighting. The potential installation of EMAS on either runway end would result in some additional impact to operations. If any EMAS alternative is selected, it is estimated an additional 30 days of runway closure during non-peak periods would be added to the construction time. Selection of the series 7 alternatives will require work in the RSA to provide full-width RSA standards, and could be scheduled during non-peak periods to minimize operational impacts.

The third phase of construction completes most construction activities and converts operations from the old runway configuration to the new one. Runway conversion activities will include shutting down the existing airfield lighting, glide slopes, and localizer, as well as implementing the new systems; removal and instillation of pavement markings; and establishment of new runway thresholds. The runway conversion will be accomplished by an extended runway closure, possibly over an entire weekend. Switching to the final runway configuration will occur twice – once for the Runway 23 end, and once for the Runway 05 end. Coordination with the FAA on the Airport/Facility Directory and Instrument Approach Plates will be worked into the design and construction schedules well in advance. Milestones will be included for flight checks as well, to ensure the timely publication of new runway approaches. Coordination will be required with the FAA and airport stakeholders to prepare for each of the various construction phases.

The fourth and final construction phase consists of project clean-up and demobilization of the construction site. The work can be performed at night but would require runway closures. During daytime operations, the full 8,000-foot runway length and instrument approach procedures would be available.

4.5.5.3 Evaluation of Construction Phasing

Most of the construction phasing operational impacts are considered moderate. All of the alternatives indicate low impact for starting the runway extension project on the Runway 23 end due to the ability to conduct most construction activities outside of the RSA for the duration of that work.

The primary operational impacts of all alternatives for the runway extension project are associated with the following factors:

- Timing and duration of reduced approach minimums due to loss of ALS
- Timing and duration of loss of ILS approach due to NAVAID relocation and commissioning
- Overall duration of construction contract due to project phasing and complexity
- Duration, number, and nature of runway closures required for construction within the RSA

In reviewing each of the 24 alternatives, the construction phasing impacts can be summarized as either low severity (green) or of moderate severity (yellow) when it came to impact (none of the alternatives had severe construction phasing impacts). These are defined as follows:

- **Green**: Majority of grading and construction activities occur outside of the existing RSA and below operational surfaces. Minor runway impacts for tie-in and construction activities within the RSA. Minimizes loss of ALS and NAVAID systems.
- **Yellow**: Majority of grading and construction activities occur outside of the existing RSA and below operational surfaces. However, the impacts to the existing runway are increased due to the duration of tie-in activities. Requires more coordination of ALS and NAVAID impacts and extends periods of these items being out of service.

All construction phasing was considered to be moderate in severity for impacts, except for the series 3 alternatives, which were considered to be low severity.

4.5.6 NAVAID Siting

The ability to site the glide slope, localizer, and ALS was assessed for each Level 1 alternative. There were no issues with localizer siting in any of the alternatives. However, there are NAVAID challenges present at CRW with regards to siting the ALS and the glide slope:

- **ALS:** In some alternatives, a portion or all of the ALS must be placed on tall towers due to the terrain differences. Tall towers are an issue because they are more difficult to maintain.
- **Glide Slope:** It is preferable to place the glide slope on the side of the runway with no taxiways or other potential sources of traffic interference. In the case of CRW, the north side of the runway is preferred because Taxiway A is located on the south side. Some alternatives have grading issues that preclude the placement of the glide slope and its associated GSCA on the north side of the runway due to the proximity of the Elk River.

Each runway end was evaluated separately. The Level 1 alternatives were color coded as green, yellow, or red in the evaluation matrix for NAVAID siting as follows:

- **Green**: No tall structures are required for ALS system and GSCA is established on north side of runway with no impacts to airport operational capacity on the same runway end.
- **Yellow**: The alternative EITHER requires tall structures for the ALS system OR establishes the GSCA on the south side of runway with impacts to airport operational capacity on the same runway end.
- **Red**: The alternative requires tall structures for the ALS system AND establishes the GSCA on the south side of runway with impacts to airport operational capacity on the same runway end.

These criteria determined the extent of the complications associated with siting NAVAIDS in each alternative. **Table 4-5, *NAVAID Siting Evaluation***, shows the NAVAID siting issues for each alternative. Alternatives 3A, 3B, 3C, 3D, 5B, 5D, and 6D would require tall towers on the west end and have GSCA siting issues on the west end. The series 4 and series 8 alternatives, as well as 5A, 5C, 6A, 6C, 7A, and 7C were found to have no NAVAID siting issues. Alternatives 6B, 7B, and 7D would require tall structures on the west end but have no NAVAID issues on the east end.

TABLE 4-5 NAVAID SITING ISSUES

ALTERNATIVE	RUNWAY 05	RUNWAY 23
3A – 3D	Tall structures required for MALS	GSCA cannot be sited on north side of runway
4A – 4D	None	None
5A / 5C	None	None
5B / 5D	Tall structures required for MALS	GSCA cannot be sited on north side of runway
6A / 6C	None	None
6B	Tall structures required for MALS	None
6D	Tall structures required for MALS	GSCA cannot be sited on north side of runway
7A / 7C	None	None
7B / 7D	Tall structures required for MALS	None
8A – 8D	None	None

Source: Landrum & Brown Team analysis.

4.5.7 Grading Requirements

Each of the alternatives would require significant grading. The criteria used to evaluate the grading requirements are shown in **Table 4-6, *Grading Evaluation Criteria***. These criteria determined the extent of the complications associated with the grading requirements.

TABLE 4-6 GRADING EVALUATION CRITERIA

FILL VOLUME (CUBIC YARDS)	RETAINING WALLS (FEET)	ADDITIONAL GRADING IMPACTS (SQUARE FEET)	ADDITIONAL CONSTRUCTION IMPACTS
Minor fill volumes Runway 05: <1,000,000 Runway 23: < 15,000,000	**Smallest and least complex retaining wall requirements** Runway 05: <76 Runway 23: <76	**Minor impacts requiring mitigation** Runway 05: <30,000 Runway 23: <50,000	**Minor Concerns**
Moderate fill volumes or complexity Runway 05: 1,000,000 – 4,000,000 Runway 23: 15,000,000 – 25,000,000	**Intermediate sized retaining walls requiring complex solutions with extensive limits** Runway 05: 76 – 120 Runway 23: 76 – 124	**Moderate impacts requiring mitigation** Runway 05: 30,000 – 50,000 Runway 23: 50,000 – 75,000	**Moderate Concerns**
Excessive fill volumes or complexity Runway 05: > 4,000,0000 Runway 23: >25,000,000	**Excessively tall/large/ complex retaining walls required** Runway 05: >120 Runway 23: >124	**Excessive Property/ Environmental/ Infrastructure Impacts** Runway 05: >50,000 Runway 23: >75,000	**Critical Concerns**

Source: Landrum & Brown Team analysis.

The criteria evaluated included fill volume, retaining wall height and area, as well as additional construction impacts. The fill volume and retaining wall heights and area were quantitatively evaluated, while the additional construction impacts were qualitatively evaluated. Criteria assessed as additional construction impacts included the following:

- On the Runway 05 End:
  - Impact of removal of slope debris in place
  - Buries new retaining wall and geofoam fill
  - Significant haul distance for borrow
  - Extension beyond Airport property
  - Displacement of residential/commercial property
  - Possibility of sanitary sewer relocation

  - Possibility of gas well relocation
  - Possibility of drainage concern at Deerslayer
  - Possibility of rerouting Elk Two Mile Creek creates regulated dam
  - Relocation of roads (issue on both runway ends)
  - Loss of roads (issue on both runway ends)
  - Continual tunnel maintenance cost (issue on both runway ends)
- On the Runway 23 End:
  - Impact to Coonskin Park and covering of borrow area
  - Impact to wetland/ creek (drainage tunnel)
  - Emergency/maintenance access road
  - Relocation of roads (issue on both runway ends)
  - Loss of roads (issue on both runway ends)
  - Continual tunnel maintenance cost (issue on both runway ends)

The grading requirements analysis estimated and evaluated the fill volume and retaining wall area/heights and identified any additional grading impacts for two alternatives – Alternatives 3A and 4D. These two alternatives were chosen because they represent the furthest extent in the direction of the Runway 23 and Runway 05 ends. These two alternatives are considered the bounding alternatives with all other alternatives analyzed through interpolation using these quantities. In addition to the two bounding alternatives, quantity estimates obtained from prior analyses were used in the interpolations.

The interpolations are based on two criteria:

- The first parameter is proposed extension length, which typically has the most influence over the fill volume.
- The second parameter is the distance to the glide slope area, which typically has the most influence on the amount of retaining wall required.

Both parameters were measured from the edge of the existing runway. A linear trend line was fit to the data of the two alternatives whose wall area and fill volumes were calculated in depth. The relationship between said data was used to estimate quantities for the remaining alternatives based on their respective extension length and glide slope area location.

The Level 1 grading evaluation for Runway 05 is shown in **Table 4-7, *Runway 05 Grading Evaluation***, and the Runway 23 grading evaluation is shown in **Table 4-8, *Runway 23 Grading Evaluation***.

On the Runway 05 end, Alternatives 3A and 3C extend the furthest to the west. These alternatives were considered to be the most challenging (red) when it came to fill volumes and wall impacts. Alternatives 4A through 4D, 6A, 6C, 7A through 7D and 8A through 8D were the best alternatives on the Runway 05 end when it came to grading impacts and were color-coded green.

TABLE 4-7 RUNWAY 05 GRADING EVALUATION

ALT.	RUNWAY 05 FILL VOLUME (CUBIC YARDS)	RUNWAY 05 WALL HEIGHT (FEET)	RUNWAY 05 WALL AREA (SQUARE FEET)	ADDITIONAL GRADING IMPACTS		
				MINOR	MODERATE	SEVERE
3A	6,930,090	90	6,370	– Removal of slope debris in place – Extends beyond CRW property – Sanitary sewer relocation – Gas well relocation – Loss of roads – Continual tunnel maintenance costs	– Buries new retaining wall & geofoam fill – Significant haul distance for borrow – Displacement of residential/commercial – Drainage concerns at Deerslayer	– Reroute Elk Twomile Creek creating regulated dam – Relocation of roads
3B	3,279,030	90	22,052			
3C	6,930,090	90	6,370			
3D	3,279,030	90	22,052			
4A	767,160	0	0	– Continual tunnel maintenance costs – Loss of roads	None	None
4B	773,029	0	0			
4C	767,160	0	0			
4D	773,029	0	0			
5A	1,390,000	15	5,500	– Extends beyond CRW property – Displace of residential/commercial – Sanitary sewer relocation – Gas well relocation – Relocation and loss of roads – Continual tunnel maintenance costs	– Significant haul distance for borrow – Drainage concerns at Deerslayer	None
5B	3,000,000	50	22,000			
5C	1,390,000	15	5,500			
5D	3,000,000	50	22,000			
6A	740,000	0	0	– Removal of slope debris in place – Gas well relocation – Relocation and loss of roads	– Significant haul distance for borrow – Drainage concerns at Deerslayer	None
6B	1,820,000	25	10,500			
6C	740,000	0	0			
6D	1,820,000	25	10,500			
7A	805,320	0	0	– Gas well relocation – Loss of roads	Significant haul distance for borrow	None
7B	818,279	0	0			
7C	805,320	0	0			
7D	818,279	0	0			
8A	570,000	32	11,000	– Removal of slope debris in place – Sig. haul dist. for borrow – Gas well relocation – Relocation and loss of roads	Drainage concerns at Deerslayer	None
8B	170,000	12	2,000			
8C	570,000	32	11,000			
8D	170,000	12	2,000			

Source: Schnabel Engineering analysis.

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TABLE 4-8 RUNWAY 23 GRADING EVALUATION

ALT.	RUNWAY 23 FILL VOLUME (CUBIC YARDS)	RUNWAY 23 WALL HEIGHT (FEET)	RUNWAY 23 WALL AREA (SQUARE FEET)	ADDITIONAL GRADING IMPACTS		
				MINOR	MODERATE	SEVERE
3A	19,160,605	150	104,115	– Coonskin Park impact/covering of borrow area – Wetland/creek impact (drainage tunnel) – Emergency/maintenance access road – Loss of roads – Continual tunnel maintenance costs	None	Relocation of roads
3B	19,160,605	150	104,115			
3C	18,187,239	150	107,110			
3D	18,187,239	150	107,110			
4A	20,251,730	75	48,835	– Wetland/creek impact (drainage tunnel) – Emergency/maintenance access road – Loss of roads – Continual tunnel maintenance costs	Coonskin Park impact/covering of borrow area	None
4B	20,251,730	75	48,835			
4C	20,159,760	75	48,835			
4D	20,159,760	75	48,835			
5A	20,000,000	90	51,000	– Wetland/creek impact (drainage tunnel) – Emergency/maintenance access road – Relocation and loss of roads – Continual tunnel maintenance costs	Coonskin Park impact/covering of borrow area	
5B	19,300,000	125	79,500			
5C	19,700,000	100	59,500	– Coonskin Park impact/covering of borrow area – Wetland/creek impact (drainage tunnel) – Emergency/maintenance access road – Relocation and loss of roads – Continual tunnel maintenance costs	None	
5D	18,800,000	140	93,000			
6A	20,200,000	80	46,500	– Wetland/creek impact (drainage tunnel) – Emergency/maintenance access road – Relocation and loss of roads	Coonskin Park impact/covering of borrow area	
6B	19,600,000	110	66,000	– Coonskin Park impact/covering of borrow area – Wetland/creek impact (drainage tunnel) – Emergency/maintenance access road – Relocation and loss of roads	None	
6C	20,000,000	90	52,500	– Wetland/creek impact (drainage tunnel) – Emergency/maintenance access road – Relocation and loss of roads	Coonskin Park impact/covering of borrow area	
6D	19,200,000	120	78,000	– Coonskin Park impact/covering of borrow area – Wetland/creek impact (drainage tunnel) – Emergency/maintenance access road – Relocation and loss of roads – Relocation of roads	None	
7A	20,347,310	75	48,835	– Wetland/creek impact (drainage tunnel) – Emergency/maintenance access road – Loss of roads	Coonskin Park impact/covering of borrow area	
7B	19,569,445	100	49,614			
7C	20,347,310	75	48,835			
7D	19,569,445	100	49,614			
8A	20,200,000	80	45,500	– Wetland/creek impact (drainage tunnel) – Emergency/maintenance access road – Relocation and loss of roads	Coonskin Park impact/covering of borrow area	
8B	20,200,000	80	45,500			
8C	20,000,000	90	51,000			
8D	20,000,000	90	51,000			

Source: Schnabel Engineering analysis.

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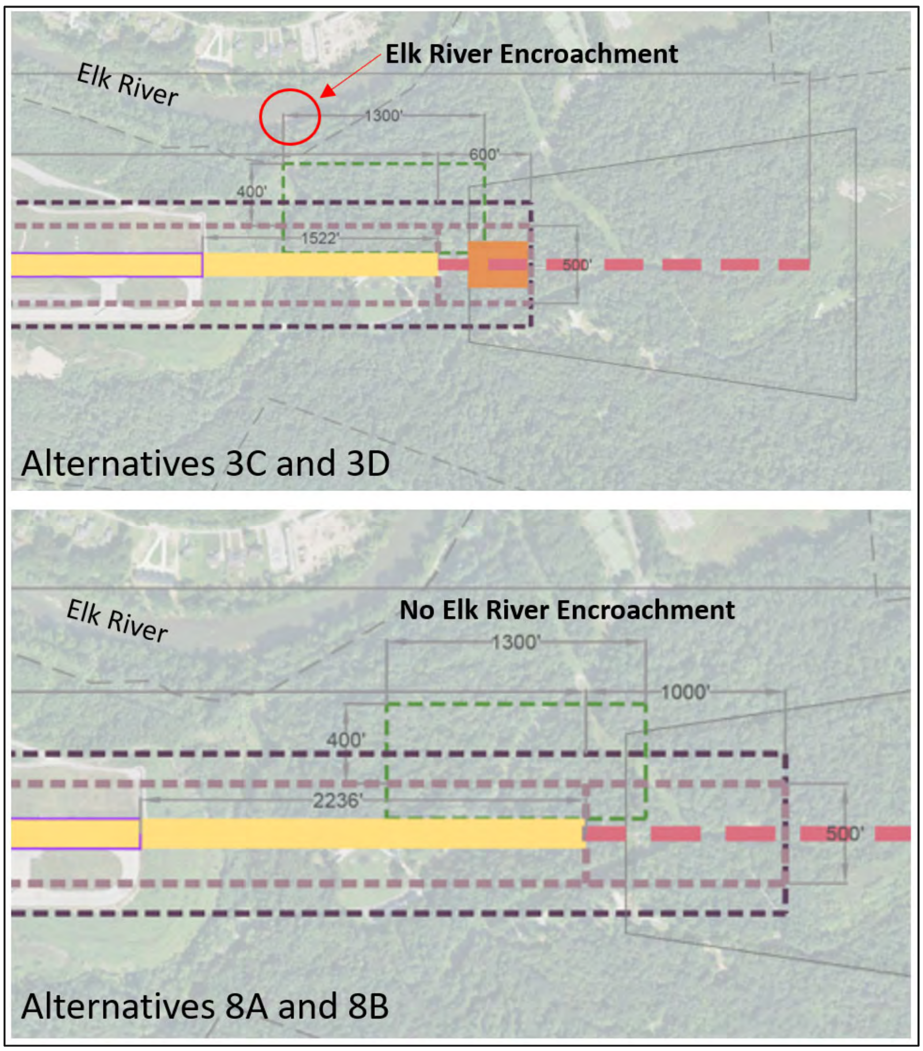
On the Runway 23 end, Alternatives 3A through 3D, 5B, 5D, and 6D would require substantial retaining wall heights and area needs due to the GSCA encroaching on the Elk River. This is further depicted in **Exhibit 4-25**, ***Glide Slope and Elk River Encroachment Areas Comparison***, where Alternatives 3C and 3D (alternatives with the tallest wall heights and greatest wall area needed) are compared to Alternatives 8A and 8B (alternatives with the shortest wall heights and wall area needed where the GSCA does not encroach on the Elk River). In alternatives where the GSCA does not encroach on the river, the Runway 23 retaining wall heights and areas were substantially less (ranked green or yellow with minor to moderate impacts). For alternatives where the GSCA encroaches on the Elk River, the glide slope could be relocated to the south side of the runway. The operational impacts of this move were assessed in the NAVAID siting section (*Section 4.5.6*). When the glide slope is moved to the south side of the runway in Alternatives 3A through 3D, 5B, 5D, and 6D, they are no longer considered for elimination due to grading issues. These grading concerns can be downgraded to minor (green) or moderate (yellow) concerns.

EXHIBIT 4-25 GLIDE SLOPE AND ELK RIVER ENCROACHMENT AREAS COMPARISON



Source: Landrum & Brown analysis.

Additional construction impacts posed the greatest challenge for Alternatives 3A through 3D (ranked red overall) due to the relocation of roads and re-routing of Elk Twomile Creek, while Alternatives 4A through 4D and 7A through 7D (ranked green overall) posed the least challenging due to minimal impacts to the Runway 05 end during construction. All other alternatives were considered to have moderate concerns (ranked yellow overall) when it came to additional construction impacts due to few moderate concerns and slightly higher minor concerns.

4.5.8 Environmental and Local Impacts

The objective of the analysis of environmental and local impacts was to estimate and evaluate the environmental and local impacts associated with the Level 1 alternatives. The criteria used to evaluate the grading requirements are shown in **Table 4-9, *Environmental Evaluation Criteria***. There were either no or minor impacts (green) or significant impacts to the Level 1 alternatives (red). Yellow was not used as a means of defining environmental and local impacts for this analysis because the alternatives either impact the park or they do not impact the park – there is no middle ground.

TABLE 4-9 ENVIRONMENTAL EVALUATION CRITERIA

ENVIRONMENTAL IMPACTS	LOCAL IMPACTS
No or minor impacts	No or minor impacts
N/A	N/A
Significant impacts and mitigation required	Significant impacts and mitigation required

Note: Yellow was not used in the environmental evaluation criteria.
Source: Landrum & Brown Team analysis

Significant impacts and mitigation (red) were discovered for all the Level 1 alternatives in both the environmental and local impacts evaluation. All the Level 1 alternatives had the following potential environmental impacts associated with their development:

- Loss of 3,400 linear feet of Coonskin Branch
- Potential loss of wetlands
- 4(f) Impacts to physical and potential constructive use of Coonskin Park
- 6(f) Impacts to replacement of land and resources purchased with Land and Water Conservation Funds
- Loss of Coonskin Branch Conservation Easement WV 401 / USACE 404
- Potential impacts to rare, threatened and endangered species in Elk River
- Loss of floodplain storage over Elk Twomile & Coonskin Branch
- Potential Cultural Resources impacts
- Potential Noise and noise-compatible land use issues
- Potential Air Quality impacts including construction emissions
- Potential Visual Effects of project
- Potential Compatible Land Use impacts

In addition, the Alternative 3 series of alternatives also result in the loss of 1,100 linear feet of Elk Twomile Creek on the west side of the Airport.

In additional to environmental impacts, local impacts were also evaluated for the Level 1 alternatives. All the alternatives had the following local impacts associated with their development:

- Closure / relocation of 1,300 linear feet of Keystone Drive
- Acquisition / removal of 3 homes
- Acquisition / removal of church building
- Relocation 2,000 linear feet of active service utilities
- Closure / relocation of 5,000 linear feet of Coonskin Drive
- Loss of 20 picnic shelters / sites
- Loss of 10 hiking trails
- Interrupted access to Kanawha Railroad Club
- Potential loss of return to service of inactive Norfolk Southern Corporation railroad in Coonskin Park
- Potential Socioeconomic, Environmental Justice and Children's Environmental Health impacts to Keystone Drive residents and Coonskin Park users

All of the alternatives are color coded red for environmental and local impacts. The only differentiator is the loss of 1,100 linear feet of Elk Twomile Creek in Alternatives 3A through 3D.

4.6 Step 5: Identify Short List of Alternatives

The Level 1 evaluation criteria and alternative results are summarized in **Table 4-10, *Evaluation Matrix Summary***. The matrix allows the alternatives to be easily compared against one another using the Level 1 evaluation criteria. The following alternatives were screened out:

- **Alternatives 3A, 3B, 3C, and 3D:** Alternatives 3A through 3D differ from the other alternatives because they would have the most extensive Runway 05 impacts. Extensive grading would be required on the Runway 05 end, but the Runway 23 grading would not be significantly less. In addition, the environmental impacts are estimated to be greater on the Runway 05 end with the Alternative 3 series of alternatives compared to the other alternatives.
- **Alternatives 4B, 4D, 8B, and 8D:** It was determined that Alternative 4B was the same as 4A, Alternative 4D was the same as 4C, Alternative 8B was the same as 8A, and Alternative 8D was the same as 8C in terms of the Level 1 evaluation criteria. This occurs because the Runway 05 end for these alternatives is fixed based on the starting point of the Runway 05 MALS. The 400 feet gained from the Runway 05 EMAS is already graded and was not considered an impact to the fill needed on the Runway 05 end. Alternatives 4B and 8B would have the exact same impacts as their A counterparts along with the additional cost of one EMAS. Similarly, Alternatives 4D and 8D would have the exact same impacts as their C counterparts along with the additional cost of one EMAS.
- **Alternatives 5B, 5D, and 6D:** These alternatives were eliminated because they would have similar impacts as their A and C counterparts but worse Runway 05 RPZ impacts. In addition, the Runway 23 glide slope cannot be sited in the most ideal location (to the north).
- **Alternatives 5A, 5C, 6A, 6B, 6C, 7B, 7D, 8A, and 8C:** These alternatives were eliminated because they have similar Runway 23 impacts but more Runway 05 RPZ impacts and higher Runway 23 wall heights when compared to the other remaining alternatives (4A, 4C, 7A, and 7C).

Alternatives 4A, 4C, 7A, and 7C remain and will be carried forward into Level 2. These alternatives were found to have the lowest Runway 05 RPZ impacts, the least amount of NAVAID siting issues, the lowest wall heights, and the least amount of construction impacts.

TABLE 4-10 EVALUATION MATRIX SUMMARY

ALT.	EVALUATION CRITERIA												
	OBSTRUC-TIONS	ATCT SITING	RPZ IMPACTS		TERMINAL IMPACTS	CONSTR. PHASING	NAVAID SITING		GRADING REQUIREMENTS			ENV. & LOCAL IMPACTS	
			RWY 05	RWY 23			RWY 05	RWY 23	RWY 05 GRADING/ WALLS	RWY 23 GRADING/ WALLS	ADD'L CONSTR. IMPACTS	ENV.	LOCAL
Series 3 Alternatives: Start MALS from Western Property Limit													
3 (A ,C)													
3 (B ,D)													
Series 4 Alternatives: Start MALS from Current Rwy 05 End													
4 (A, C)													
4 (B, D)													
Series 5 Alternatives: Start RSA from South End of Runway 05 Wall													
5 (A ,C)													
5 (B, D)													
Series 6 Alternatives: Start RSA from Current Rwy 05 End													
6 (A ,C)													
6B													
6D													
Series 7 Alternatives: Start RSA from Current Rwy 05 Full-Width RSA													
7 (A, C)													
7 (B, D)													
Series 8 Alternatives: Start MALS from Center of Rwy 05 Wall													
8 (A, C)													
8 (A, D)													

Source: Landrum & Brown Team analysis.

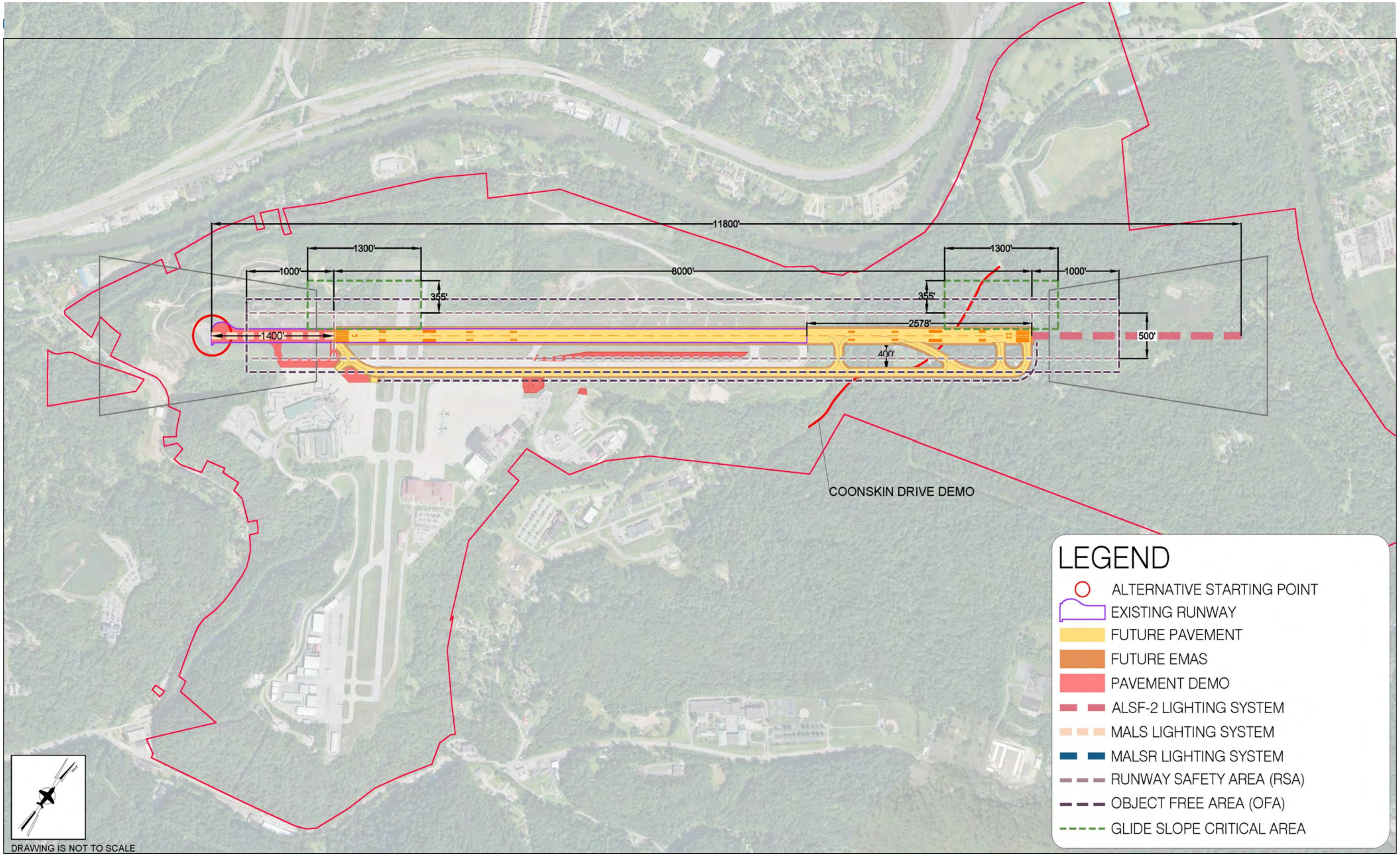
4.7 Step 6: Refine Remaining Alternatives

As described in Section 4.6, Alternatives 4A, 4C, 7A, and 7C were shortlisted for further analysis. The following provides a summary of these four alternatives:

- **Alternative 4A:** Shifts Runway 05-23 to the east by 1,400 feet. This shift starts the Runway 05 MALS at the current Runway 05 end. The runway is extended to the east by 2,578 feet. This alternative has a full-dimension RSA on both ends (no EMAS).
- A**lternative 4C:** Shifts Runway 05-23 to the east by 1,400 feet and extends the runway to the east by 2,300 feet (same as Alternative 4A). This alternative has a full-dimension RSA on the Runway 05 end and an EMAS on the Runway 23 end.
- **Alternative 7A:** Shifts Runway 05-23 to the east by 1,125 feet. This shift starts the Runway 05 end RSA at the point at which the standard 500-foot RSA width can be provided without any changes to the grading on the Runway 05 end. The runway is extended to the east by 2,300 feet. This alternative has a full-dimension RSA on both ends (no EMAS).
- **Alternative 7C:** Shifts Runway 05-23 to the east by 1,125 feet and extends the runway to the east by 2,300 feet (same as Alternative 7A). This alternative has a full-dimension RSA on the Runway 05 end and an EMAS on the Runway 23 end.

These alternatives were refined to add runway exits and include the relocation of Taxiway A to a standard separation of 400 feet from Runway 05-23. The refined alternatives are shown on **Exhibit 4-26 through Exhibit 4-29**.

YEAGER AIRPORT



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown and ADCI analysis.

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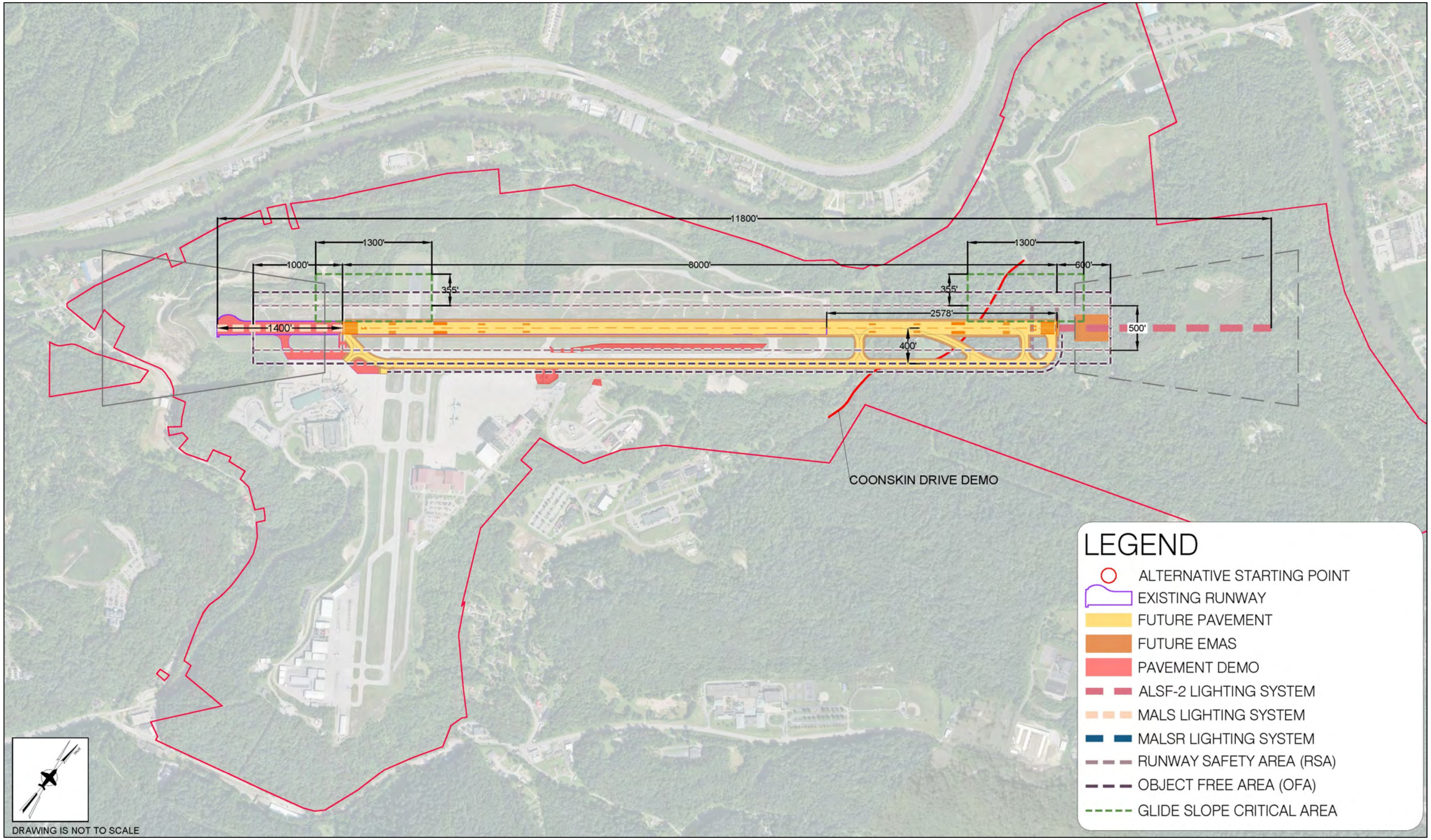
EXHIBIT 4-27 LEVEL 2 ALTERNATIVE 4C



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown and ADCI analysis.

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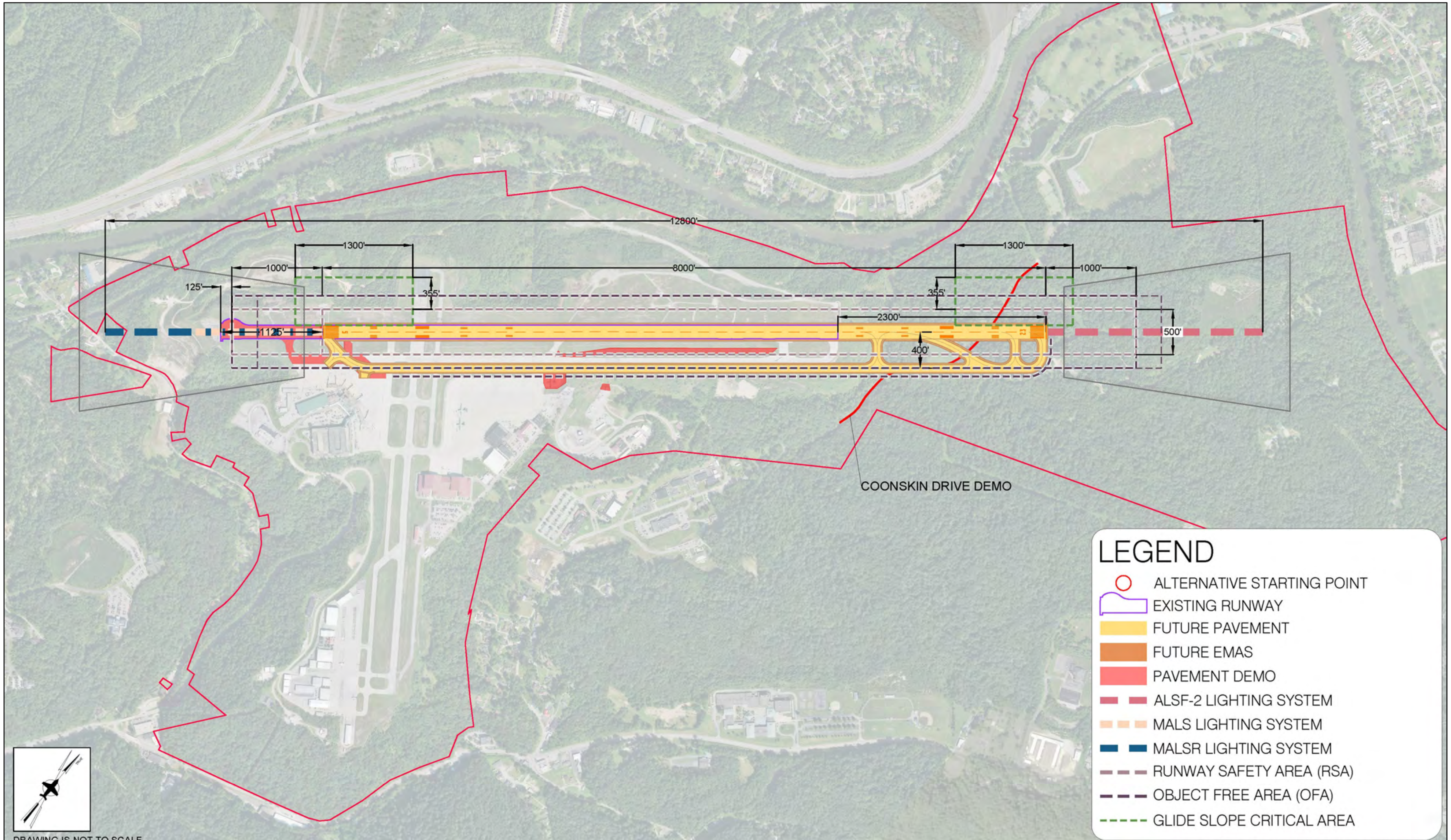
EXHIBIT 4-28 LEVEL 2 ALTERNATIVE 7A



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown and ADCI analysis.

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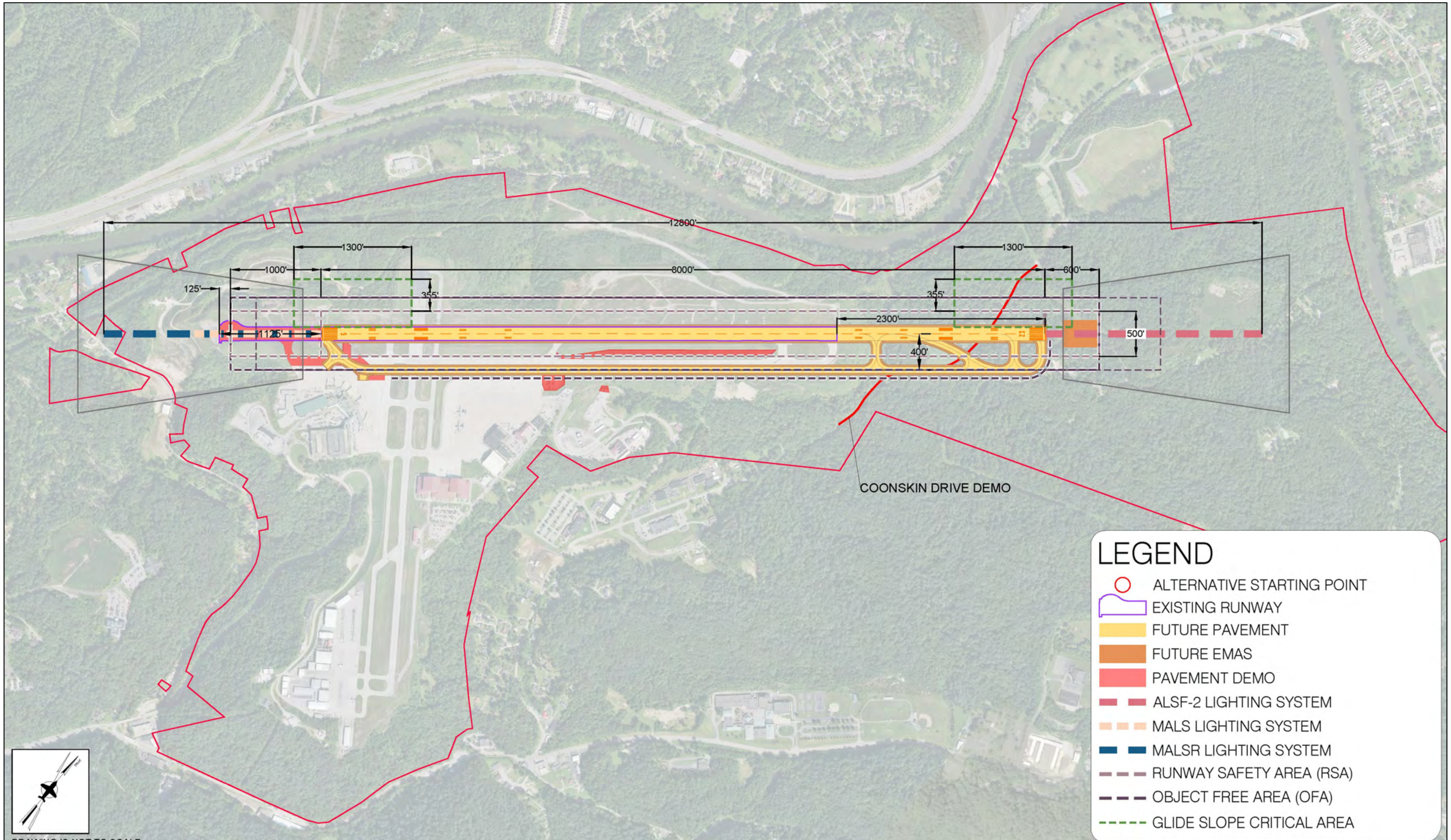
EXHIBIT 4-29 LEVEL 2 ALTERNATIVE 7C



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown and ADCI analysis.

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4.8 Step 7: Level 2 Screening

The four shortlisted alternatives were evaluated based on the factors that differentiated the alternatives in the Level 1 screening (Runway 05 RPZ impacts and terminal impacts). In addition, the alternatives were screened based on Taxiway A relocation impacts and cost.

4.8.1 Taxiway A Relocation Impacts

There is an existing modification of standards for the non-standard separation distance between the centerlines of Runway 05-23 and Taxiway A. The current separation from Taxiway A to Runway 05-23 ranges from 283 to 328 feet. The impact of realigning Taxiway A to standard 400-foot separation to Runway 05-23 was assessed for the four alternatives. The realignment of Taxiway A focuses on four distinct areas of the airfield. Area 1 is the existing terminal area, Area 2 is the existing military apron, Area 3 extends from Area 2 to the existing east end of Taxiway A, and Area 4 is the future portion of Taxiway A that will be constructed parallel to the extension of Runway 05-23. The Taxiway A realignment impacts for each alternative area shown by area on **Exhibit 4-30** through **Exhibit 4-33**.

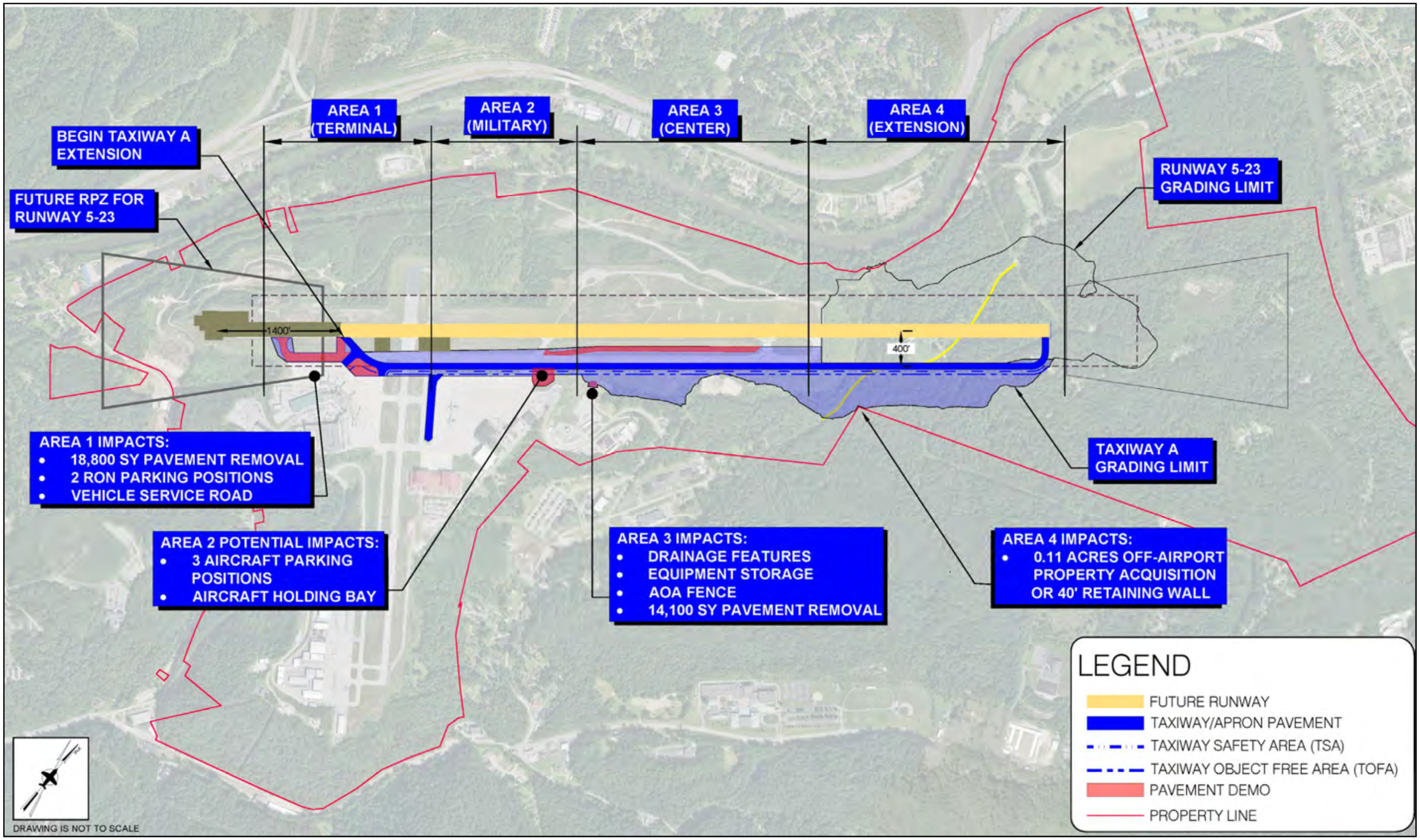
4.8.1.1 Area 1

Area 1 includes the existing aircraft parking apron to the north of the terminal building. With each of the shortlisted alternatives, the impacts within this area from the realignment of Taxiway A are similar. The existing Vehicle Service Road (VSR) and both existing Remain Over Night (RON) parking positions adjacent to the terminal building would be within the OFA of the future Taxiway A. As such, the RON positions and VSR would need to be removed and relocated outside of the OFA for the realigned taxiway. Additional impacts within Area 1 include construction of a new connector taxiway at the Runway 05 threshold to allow aircraft to taxi to the end of the runway and removal of existing apron and taxiway pavement to reduce the potential for runway incursions. The total quantity of pavement removal in Area 1 is approximately 24,000 square yards for Alternatives 4A and 4C and 18,000 square yards for Alternatives 7A and 7C.

4.8.1.2 Area 2

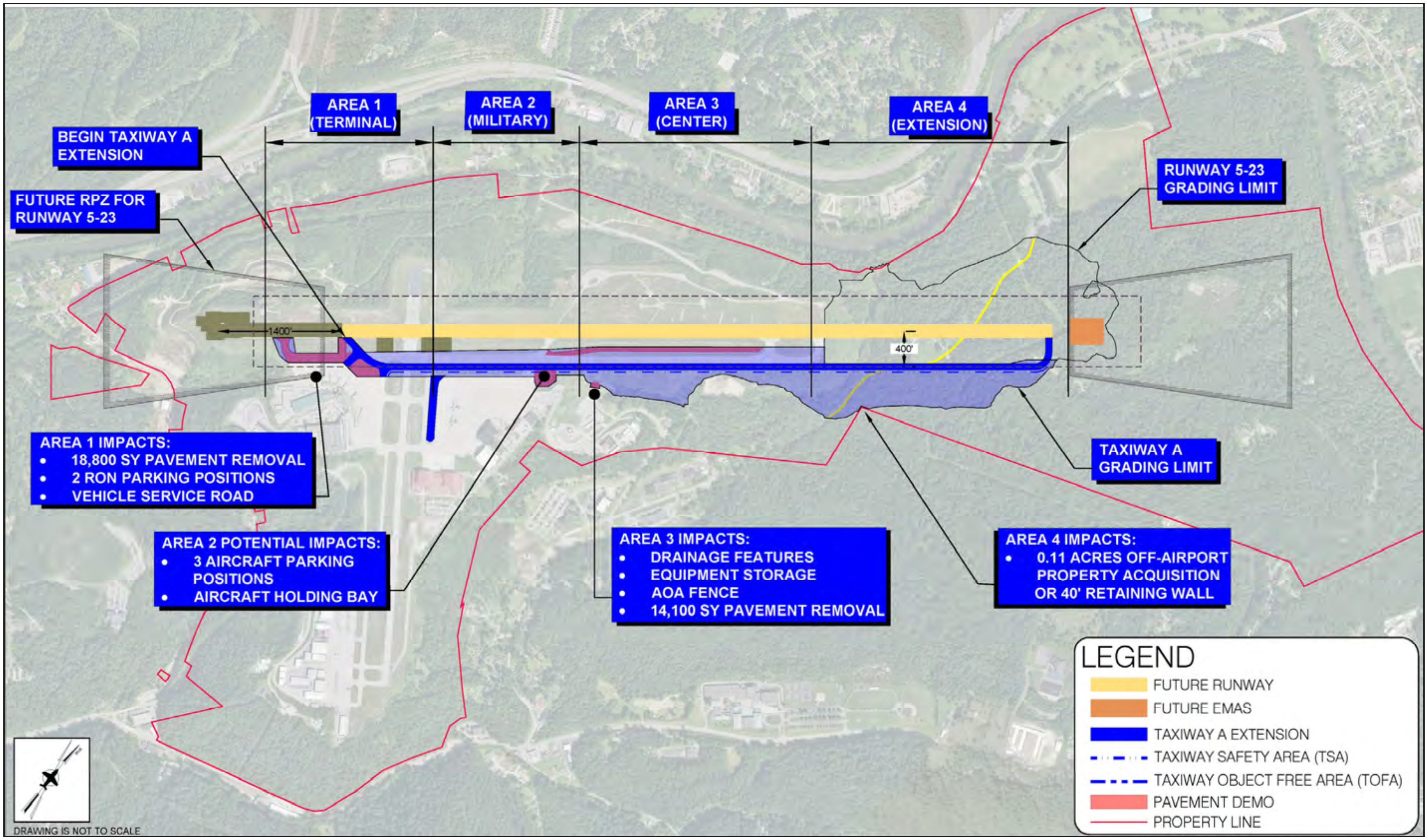
Area 2 extends from Area 1 to the existing military apron, West of Commando Road. With each of the shortlisted alternatives, the impacts within this area are similar. There are three existing aircraft parking positions which would need to be relocated outside of the OFA of the future Taxiway A. There is also an existing parallel apron taxiway and an aircraft holding bay/run-up pad which is serviced by a blast fence. Each of these items would need to be replaced or relocated. Additional information is required to determine the existing nature and potential relocation requirements for this equipment, and to confirm that the parallel taxiway centerline separation distance criteria is similar for military and commercial aircraft. FAA criteria requires a minimum of 152 feet between parallel taxiway centerlines, which appears to be achievable for the apron taxiway, but which may not be considered an adequate separation distance for military aircraft. Detailed coordination with the military would be needed to determine the full extent of impacts within Area 2.

EXHIBIT 4-30 ALTERNATIVE 4A – TAXIWAY A REALIGNMENT IMPACTS



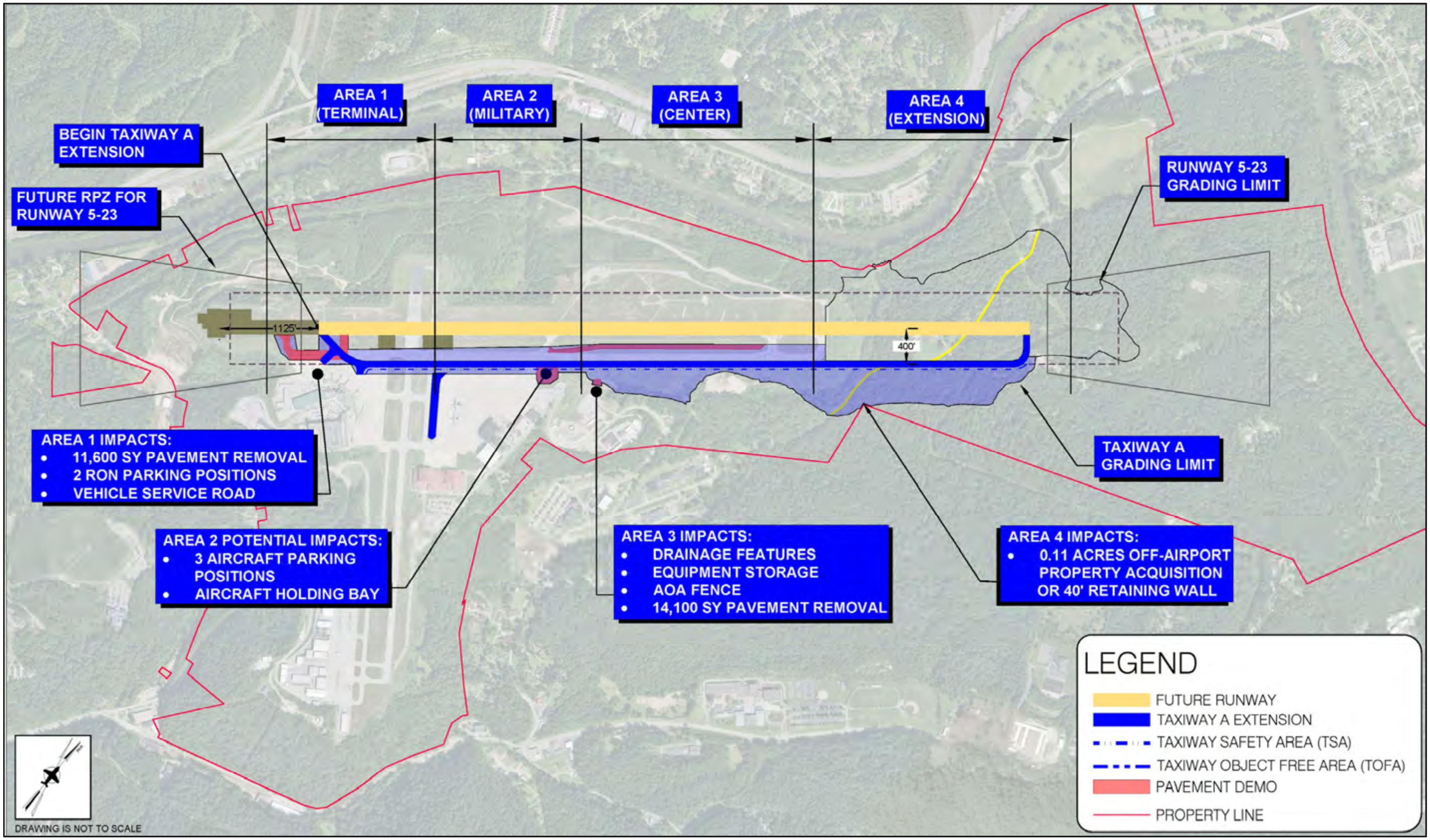
Sources: Aerial photography by Quantum Spatial, 2017; ADCI analysis.

EXHIBIT 4-31 ALTERNATIVE 4C – TAXIWAY A REALIGNMENT IMPACTS



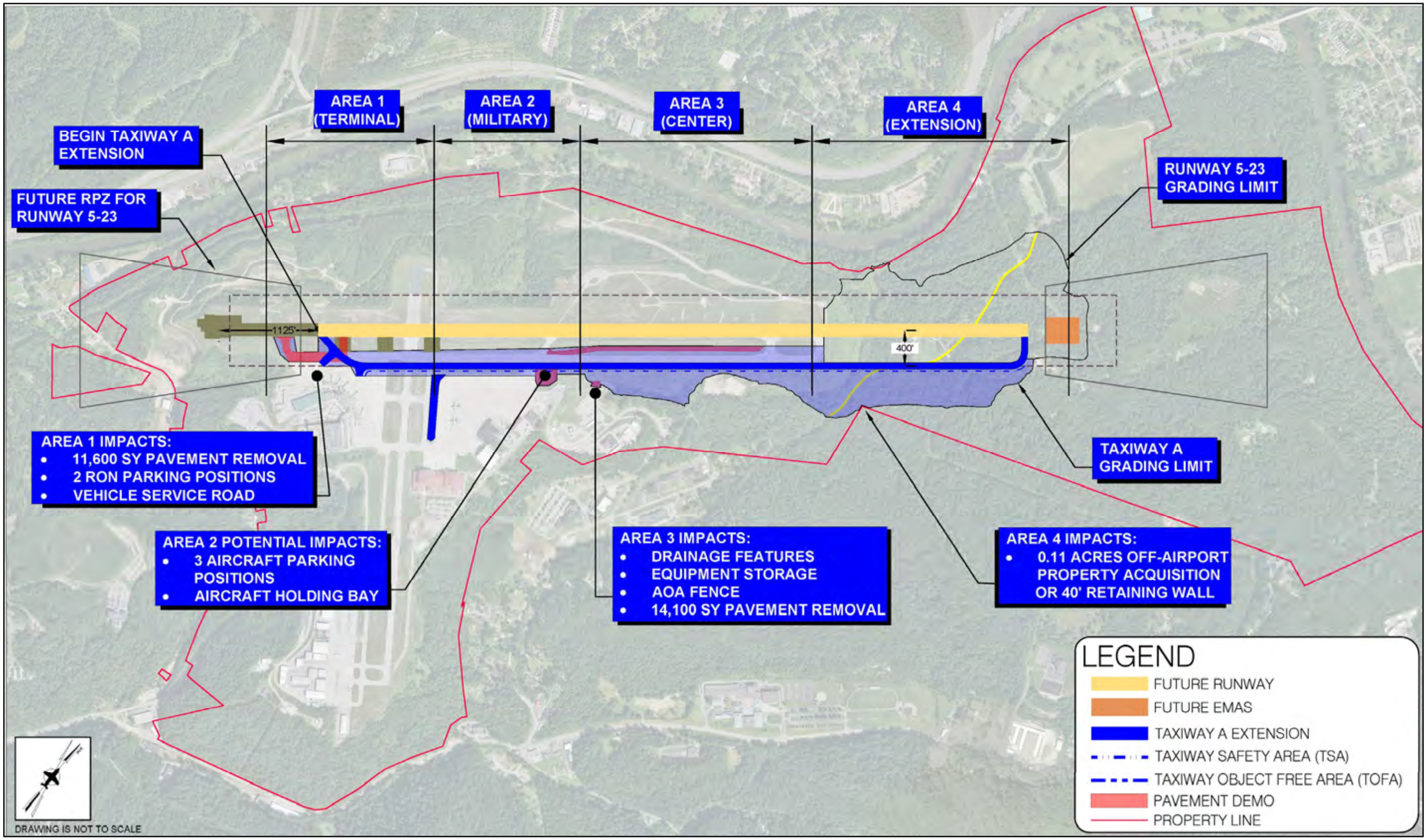
Sources: Aerial photography by Quantum Spatial, 2017; ADCI analysis.

EXHIBIT 4-32 ALTERNATIVE 7A – TAXIWAY A REALIGNMENT IMPACTS



Sources: Aerial photography by Quantum Spatial, 2017; ADCI analysis.

EXHIBIT 4-33 ALTERNATIVE 7C – TAXIWAY A REALIGNMENT IMPACTS



Sources: Aerial photography by Quantum Spatial, 2017; ADCI analysis.

4.8.1.3 Area 3

Area 3 extends from Area 2 to the eastern end of the taxiway. As with Areas 1 and 2, the impacts associated with achieving standards in Area 3 are similar for each of the remaining alternatives. Within Area 3, the edge of existing OFA for Taxiway A is at the top of an existing 2:1 slope. If the taxiway is shifted 100 feet to the south, the finished grade will have to extend into an equipment storage area southeast of the existing airfield. In addition, there are also drainage features and an Airport Operations Area (AOA) fence that would need to be removed and relocated from their existing locations to final locations that are more appropriate with the ultimate surface topography of the site. Between Runway 05-23 and existing Taxiway A, there is approximately 13,500 square yards of existing pavement, from a previous alignment of Taxiway A that will need to be removed to achieve FAA RSA standards on the airfield for all alternatives.

4.8.1.4 Area 4

Area 4 is the future portion of Taxiway A that will be constructed parallel to the extension of Runway 0-23. In Area 4, the new taxiway pavement can simply be constructed to meet the standard, with virtually no impact from construction to existing airfield features. The taxiway extension impacts in Area 4 are nearly identical to the impacts from extending Runway 05-23. Environmental and local impacts within the RPZ of Runway 23 will also be similar for the area within the OFA of the Taxiway A extension, especially within Coonskin Park. Area 4 impacts include loss of wetlands, impact to rare and threatened species, loss of floodplain, and impact to cultural resources and compatible land uses. Roadways, hiking trails, picnic shelters, and other features of Coonskin Park will also be removed and/or relocated when the runway and taxiway are extended to their ultimate planned lengths.

For all alternatives, additional grading would be required. There are two options to provide the grading necessary for the OFA in the alternatives. The first is a retaining wall, approximately 40 feet tall at its maximum height and 1,800 feet long at its base. The second is to acquire approximately 0.11 acres of off-Airport property within the encroachment area.

Unlike Areas 1, 2, and 3, the impacts within Area 4 include some variation between the alternatives. Alternatives 4A and 4C shift the runway further to the west, resulting in a longer extension of Taxiway A than in Alternatives 7A and 7C. The additional lengths of taxiway require larger quantities of earthwork and pavement, as well as more significant off-airport impacts within Coonskin Park.

4.8.1.5 Taxiway A Realignment Impacts Summary

Table 4-11, *Taxiway A Impacts*, provides a summary of the Taxiway A realignment differences between the alternatives for each area analyzed. The most significant difference between the alternatives relates to Area 4 and the length of the Taxiway A extension. Taxiway A would have to be extended 400 feet more with Alternatives 4A and 7A as compared to Alternatives 7A and 7C.

TABLE 4-11 TAXIWAY A IMPACTS

<table>
<tr><th>ALTERNATIVE</th><th>AREA 1</th><th>AREA 2</th><th>AREA 3</th><th>AREA 4</th></tr>
<tr><td>4A</td><td rowspan="2">24,000 SY of RON apron;
2 RON parking positions;
VSR</td><td rowspan="4">3 parking positions;
Parallel taxiway;
Aircraft holding bay</td><td rowspan="4">Equipment storage area;
Drainage features;
AOA fence;
Removal of 14,000 SY of pavement</td><td rowspan="2">Construction of a 2,578-foot long taxiway; Environmental and local impacts</td></tr>
<tr><td>4C</td></tr>
<tr><td>7A</td><td rowspan="2">18,000 SY of RON;
2 RON parking positions;
VSR</td><td rowspan="2">Construction of a 2,300-foot long taxiway; Environmental and local impacts</td></tr>
<tr><td>7C</td></tr>
</table>

Source: ADCI analysis.

4.8.2 Cost

Cost plays a significant role in the evaluation of the alternatives. The cost of each alternative (including Taxiway A realignment) was calculated using an earthwork estimate of $4 per cubic yard based on industry and regional examples. However, the actual cost for earthwork could end up being higher or lower, which would significantly affect the cost of each alternative. A set cost of $15.5 million was assumed for each alternative to mitigate environmental and local impacts to Coonskin Park. The cost of each alternative includes the following line items:

- Earthwork, Retaining Walls, and Tunnels
- Pavement and Markings
- EMAS (applicable on Alternatives 2, 3, and 4)
- NAVAID Installation
- Airfield Electrical Work
- Storm Drainage Systems
- Topsoil and Seeding
- Fencing and Perimeter Controls
- Coonskin Park[6]
- Design Contingency
- Construction Security Plan
- Additional Program Costs (Design and Cost Management and Inspection (CMI) Fees)

Obstruction mitigation costs were not considered at this time since it is unknown which surface the Airport will be required to clear.

[6] A cost estimate was developed for Coonskin Park mitigation for purposes of evaluating the alternatives. Other environmental mitigation (e.g. streams, wetlands, Endangered Species Act of 1973, potential cultural resources, etc.) was not included in this analysis.

Cost estimates for each alternative are summarized in **Table 4-12, *Cost Estimates (Level 2)***. The alternatives with EMAS (4C and 7C) are more expensive than those without (4A and 7A).

TABLE 4-12 COST ESTIMATES (LEVEL 2)

ITEM DESCRIPTION	4A	4C	7A	7C
Runway Elements				
Pavement	$8,369,000	$8,369,000	$7,500,000	$7,500,000
Pavement Marking Removal/Installation	750,000	750,000	725,000	725,000
Airfield Electrical (Edge and Centerline Lights, Conduits, Signage)	1,300,000	1,300,000	1,200,000	1,200,000
NAVAID Installation	5,000,000	5,000,000	5,000,000	5,000,000
EMAS Bed & Anchor Beam; Lifecycle Costs	0	7,150,000	0	7,150,000
Storm Drainage System	1,200,000	1,200,000	1,050,000	1,050,000
Topsoil (4") & Seeding, E&S/SWM	2,000,000	2,000,000	2,000,000	2,000,000
AOA Fence and Perimeter Controls	900,000	900,000	900,000	900,000
Runway Subtotal	**$19,519,000**	**$26,669,000**	**$18,375,000**	**$25,525,000**
Taxiway Elements	34,991,000	34,991,000	33,127,000	33,127,000
SUBTOTAL	**$54,510,000**	**$61,660,000**	**$51,502,000**	**$58,652,000**
TOTAL GRADING COST[1]	119,386,000	117,538,000	119,611,000	118,931,000
ESTIMATED COONSKIN PARK MITIGATION COST	15,500,000	15,500,000	15,500,000	15,500,000
SUBTOTAL A	**$189,396,000**	**$194,698,000**	**$186,613,000**	**$193,083,000**
Temporary Items, Mobilization/Demo, etc. (1.5% of A)	2,842,000	2,921,000	2,800,000	2,897,000
SUBTOTAL B	**$192,238,000**	**$197,619,000**	**$189,413,000**	**$195,980,000**
Design Contingency (15% of B)	28,837,000	29,647,000	28,414,000	29,410,000
SUBTOTAL C	**$221,075,000**	**$227,266,000**	**$217,827,000**	**$225,390,000**
Construction Security Plan (4 years)	1,000,000	1,000,000	1,000,000	1,000,000
TOTAL CONSTRUCTION COST D	**$222,075,000**	**$228,266,000**	**$218,827,000**	**$226,390,000**
Design Fee (4% of D)	8,884,000	9,131,000	8,754,000	9,056,000
CMI Fee (4% of D)	8,884,000	9,131,000	8,754,000	9,056,000
FAA Reimbursable[2]	4,000,000	4,000,000	3,500,000	4,000,000
TOTAL COST ESTIMATE (Program)	**$243,843,000**	**$250,528,000**	**$239,835,000**	**$248,502,000**

1 Includes earthwork ($4/cubic yard), retaining walls, and tunnels.
2 Includes RVR, windsocks, flight checks, FAA equipment, and technical review.

4.8.3 Runway 05 RPZ Impacts

The Level 1 analysis included a high-level evaluation of Runway 05 RPZ impacts. This Level 2 analysis reflects a more detailed evaluation of types of structures and roadways that are in the Runway 05 RPZ. **Table 4-13, *Runway 05 RPZ Impacts for Shortlisted Alternatives (Level 2)***, presents the results of this refined analysis. **Exhibit 4-34, *Runway 05 RPZ Impacts – Alternatives 4A and 4C (Level 2)***, and **Exhibit 4-35, *Runway 05 RPZ Impacts – Alternatives 7A and 7C (Level 2)***, show the Runway 05 RPZs for Alternatives 4A/4C and 7A/7C, respectively.

Keystone Apostolic Church property is in the Runway 05 RPZ of all four alternatives. The church was damaged in the 2015 slope failure and is currently unused. The church members are currently worshiping at Ruffner Memorial Presbyterian in Charleston.

Alternatives 7A and 7C have greater RPZ impacts to houses and businesses than Alternatives 4A and 4C (three more houses and one more business). Impacted businesses include a contracting company for all four alternatives and a facility leased to Segra (a telecommunications company) in Alternatives 7A and 7C. Parts of the contracting company are in an airport avigation easement, while the Segra facility resides inside of the Airport property boundary. Alternatives 7A and 7C also have more roadway impacts than Alternative 4A and 4C.

TABLE 4-13 RUNWAY 05 RPZ IMPACTS FOR SHORTLISTED ALTERNATIVES (LEVEL 2)

<table>
<tr><th>ALTERNATIVE</th><th>RUNWAY 05 RPZ IMPACTS</th></tr>
<tr><td>4A</td><td rowspan="2">4 houses
1 business
1 church property & building
1,180 LF Keystone Drive
650 LF Barlow Drive</td></tr>
<tr><td>4C</td></tr>
<tr><td>7A</td><td rowspan="2">7 houses
2 businesses
1 church property
1,400 LF Keystone Drive
880 LF Barlow Drive</td></tr>
<tr><td>7C</td></tr>
</table>

Source: Landrum & Brown analysis.

EXHIBIT 4-34 RUNWAY 05 RPZ IMPACTS – ALTERNATIVES 4A AND 4C (LEVEL 2)

Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

EXHIBIT 4-35 RUNWAY 05 RPZ IMPACTS – ALTERNATIVES 7A AND 7C (LEVEL 2)

Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

Table 4-14, *Potential Additional Costs for Alternative 7A and 7C due to RPZ Impacts*, shows the estimated additional cost for Alternatives 7A and 7C due to RPZ mitigation, as compared to Alternatives 4A and 4C. Mitigation for the additional three houses and one business that are in the Runway 05 RPZ for Alternatives 7A and 7C, but not in Alternatives 4A and 4C, could increase the cost that was presented in Section 4.8.2. These impacts would add $2.024 million to the cost of Alternatives 7A and 7C as compared to Alternatives 4A and 4C.

TABLE 4-14 POTENTIAL ADDITIONAL COSTS FOR ALTERNATIVE 7A AND 7C DUE TO RPZ IMPACTS

ELEMENT	COUNT	UNIT COST	TOTAL COST
Houses	3	$110,000/house	$330,000
Business	1	$120/SF	$1,494,000
Road Relocation	503 LF	$1M/lane-mile	$200,000
		TOTAL	**$2,024,000**

Sources: Commercial facility values obtained from LoopNet.com; highest cost/square foot was used for the purpose of comparing alternatives. Home unit cost was based on median house value for Charleston, WV obtained from Zillow.com.

Roadway relocations would add to the cost as well. Portions of Keystone and Barlow Drives are located within the Runway 05 RPZ in all four alternatives. Roads in the controlled activity (outer portion) of the RPZ are sometimes permitted to remain in the RPZ. Barlow Drive is mostly in the controlled activity portion of the RPZ in all four alternatives so it was assumed that it would not require relocation. Keystone Drive is located in both the controlled activity and central portion of the RPZ in all four alternatives so at least part of the road will likely require relocation. If it is assumed that only the portion of Keystone Drive that is within the central portion is realigned, Alternatives 7A and 7C would require constructing 530 additional linear feet of roadway versus Alternative 4A and 4C. Assuming a unit cost of $1 million per lane-mile of road, the relocation of Keystone Drive would add $200,000 to the cost of Alternatives 7A and 7C as compared to Alternatives 4A and 4C.

4.8.4 Terminal Impacts from Runway Shift

The Level 1 analysis identified that Alternatives 4A and 4C would result in the loss of one contact gate at the terminal because the Runway 05 RPZ is shifted closer to the terminal. Alternatives 7A and 7C do not shirt the Runway 05 end as far to the east as Alternatives 4A and 4C so there is no terminal impact from these alternatives. A replacement gate/holdroom and apron could add $3.215 million to the cost of Alternatives 4A and 4C. This cost was calculated based on 5,000 square feet of holdroom/circulation space at $500/square foot and 3,575 square yards of apron at $200/square yard.

4.9 Step 8: Identify Preferred Alternative

The Level 2 evaluation focused primarily on cost and a comparison of the factors that differentiated the alternatives – EMAS, Runway 05 RPZ impacts, and terminal impacts. Alternatives 4C and 7C have EMAS, resulting in a higher cost than Alternatives 4A and 7A, which do not have EMAS. Alternatives 4A and 4C result in the loss of one contact gate whereas Alternatives 7A and 7C have higher Runway 05 RPZ impacts. **Table 4-15, *Level 2 Alternatives Comparison***, compares the four alternatives based on the base cost of the alternatives plus the incremental RPZ impact cost and the gate replacement cost.

TABLE 4-15 LEVEL 2 ALTERNATIVES COMPARISON

ALTERNATIVE	COST	INCREMENTAL COST OF RPZ IMPACTS	ADDITIONAL COST DUE TO TERMINAL IMPACTS
4A	$243,843,000	$0	Replace one gate/holdroom at an estimated cost of $3,215,000
4C	$250,528,000		
7A	$239,835,000	530 LF of additional roadway relocation, 3 additional houses, and 1 additional business at an estimated cost of $2,024,000	$0
7D	$248,502,000		

Source: Landrum & Brown Team analysis.

The EMAS alternatives (4C and 7C) cost $7 to 9 million more than the non-EMAS alternatives (4A and 7A). The EMAS cost is a known quantity that is not subject to significant variation. Alternatives 4C and 7C were therefore dismissed from further consideration on the basis of cost. The cost differential between Alternative 4A and 7A is about 2%. Given that a detailed roadway alignment analysis and property valuation was not completed as part of this Master Plan, the road alignments and house/business replacement costs have a high margin of error. As a result, the cost difference between Alternative 4A and 7A is not sufficient to justify the selection of one alternative over the other. Replacing a gate is more within the Airport's control more than relocating roads, houses, and businesses. In addition, it is likely that the Airport will need to expand and/or reconfigure its terminal by the time the 8,000-foot long runway is needed, which could reduce the unit cost because it could be done as part of a larger project. Therefore, Alternative 4A is the preferred alternative for this Master Plan.

4.10 Apron Development Opportunity

The cut and fill that will be required to develop the long-term runway extension (8,000 feet) will result in a swath of land that is at the runway elevation on the Runway 23 end. This land provides an opportunity for future expansion of facilities at CRW. **Exhibit 4-36, *Potential Apron Expansion Area***, shows one possible layout for this type of expansion. The site is approximately 50 acres. Further study would be required to determine the timing and need for this expansion.

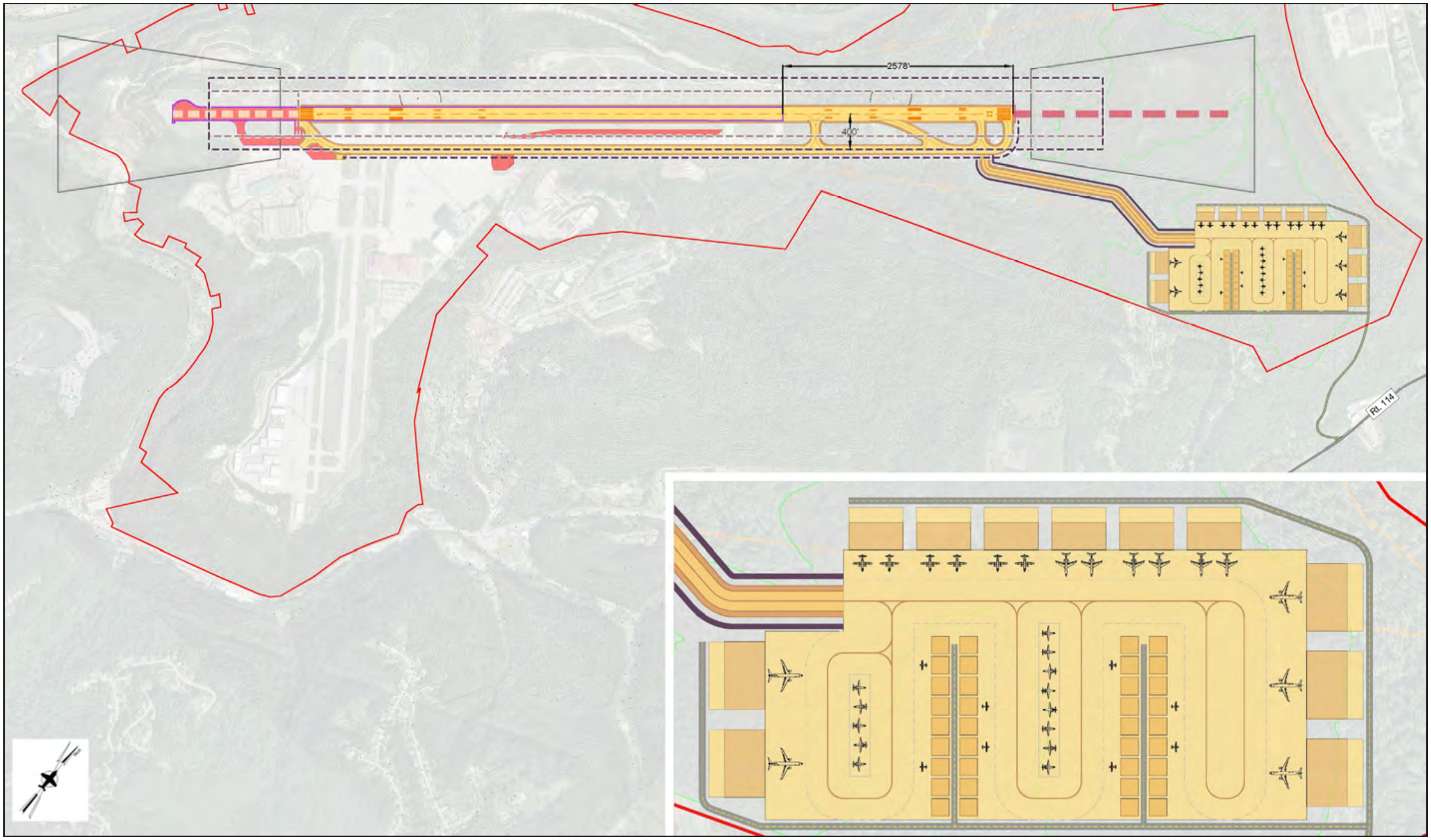
4.11 Phasing

While the Master Plan alternatives analysis was ongoing, the FAA notified the Airport that the runway project needed to be completed in two phases. The first phase focuses on the short-term needs of providing standard RSAs and meeting existing runway length needs, whereas the second phase focuses on meeting future runway length needs.

An RSA Study was completed in August of 2019 that identifies the most appropriate way to meet the immediate needs. The preferred alternative from the August 2019 RSA Study is shown on **Exhibit 4-37, *Phase 1 – RSA Project***. This Phase 1 project includes full RSAs and a 7,000-foot long runway. The environmental process for this project is expected to kick off in 2020, with construction finishing by 2030.

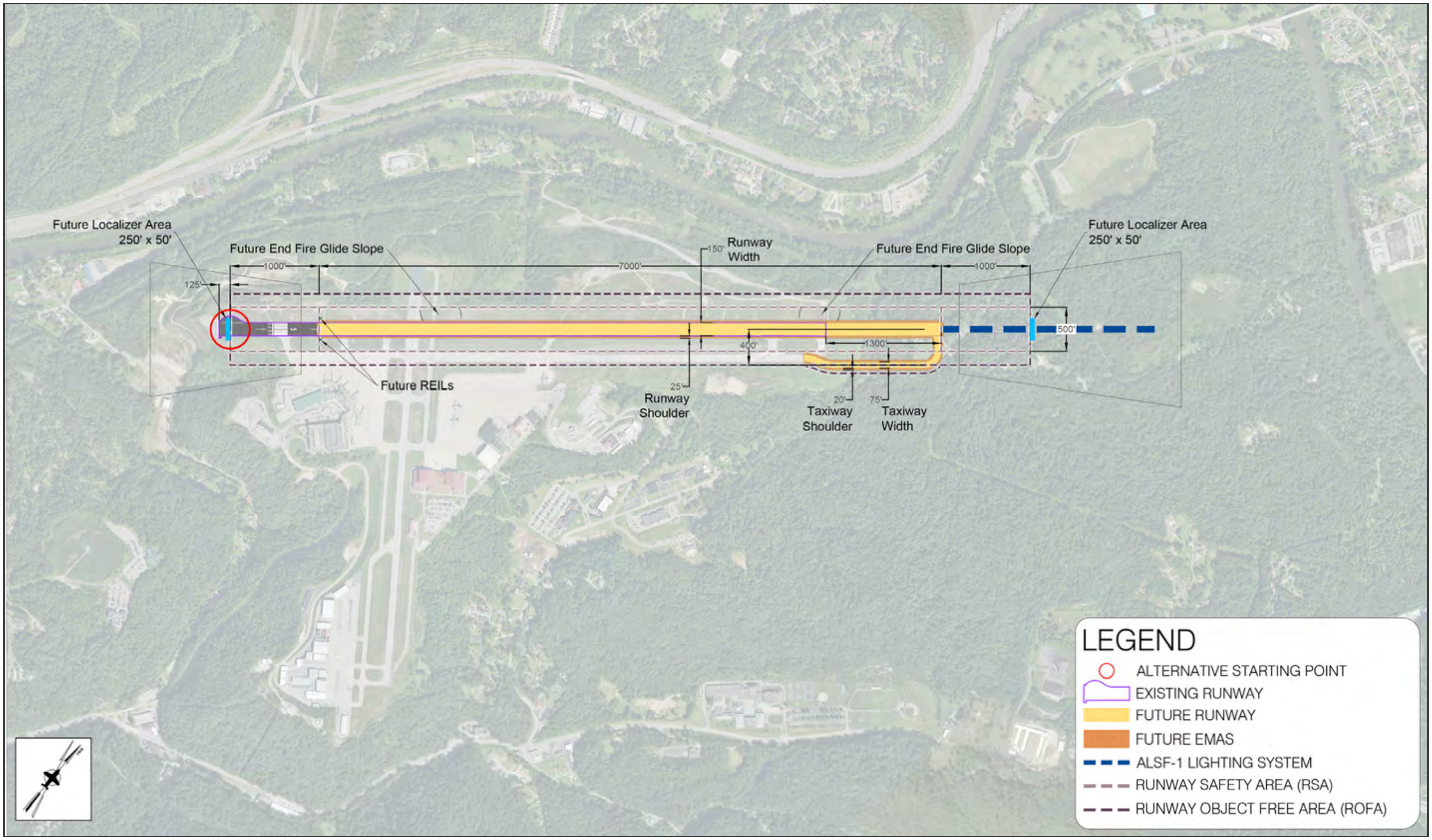
The Phase 2 project reflects the long-term alternatives evaluated in this chapter. Phase 2 includes full RSAs, an 8,000-foot long runway, NAVAID improvements, and the relocation of Taxiway A to meet runway-to-taxiway separation standards. This project, which reflects Alternative 4A from Section 4.9, is shown on **Exhibit 4-38, *Ultimate Runway Extension and Taxiway A Relocation***. The long-term project is expected to be initiated after 2030.

EXHIBIT 4-36 POTENTIAL APRON EXPANSION AREA



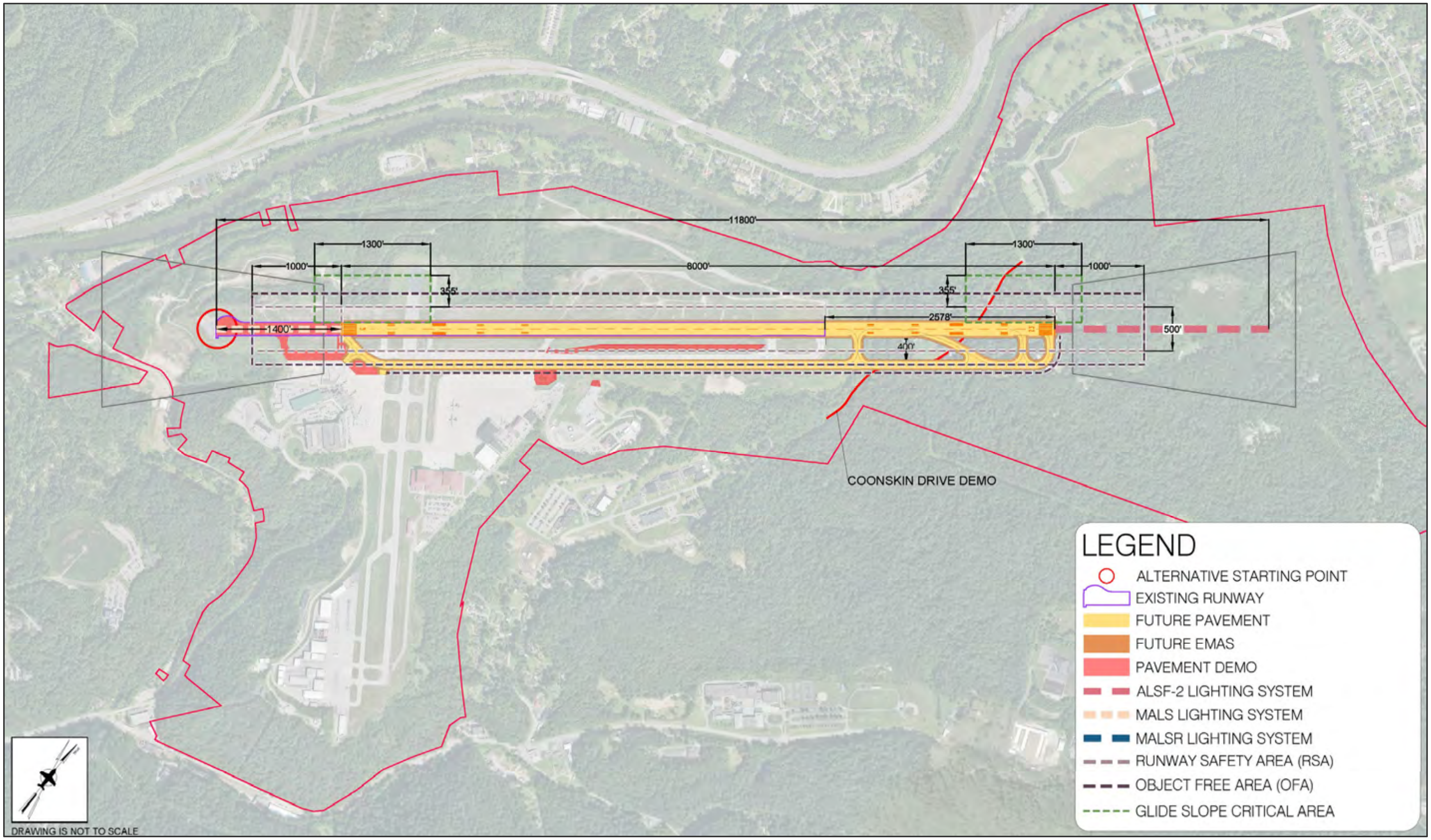
Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

EXHIBIT 4-37 PHASE 1 – RSA PROJECT



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown analysis.

EXHIBIT 4-38 ULTIMATE RUNWAY EXTENSION AND TAXIWAY A RELOCATION



Sources: Aerial photography by Quantum Spatial, 2017; Landrum & Brown and ADCI analysis.

5 Implementation Plan

The previous chapters of the Yeager Airport (CRW) Airfield Master Plan evaluated the existing facilities, projected future activity levels, identified potential facility needs, developed and evaluated alternatives, and made recommendations for addressing the facility needs throughout the 20-year planning period. Regardless of the identified need for improvements, the ability to pay for a project will ultimately influence when the project is implemented. This chapter addresses the financial implications of the proposed projects.

5.1 Recommended Master Plan Projects

Three primary projects were identified in the previous chapters:

- **RSA Project:** Provide standard Runway Safety Area (RSA) and meet existing runway length needs for Runway 05-23
- **Runway 05-23 Extension:** Extend Runway 05-23 to a length of 8,000 feet
- **Taxiway A Relocation:** Relocate Taxiway A to provide the required 400 feet of separation from Runway 05-23

The RSA Project is a short-term need. The environmental process for this project is expected to kick off in 2020, with construction finishing in 2030. The Runway 05-23 Extension and Taxiway A Relocation are long-term needs which are expected to be implemented in the post-2030 time period.

5.2 Financial Plan

In general, the financial plan for the Master Plan was conducted as follows:

- An overview of CRW's financial structure was prepared to present the current accounting practices, financial operating environment, and key provisions of certain governing documents.
- Rough order of magnitude (ROM) cost estimates for the 20-year development program were calculated and presented along with the current Capital Improvement Program (CIP).
- Potential funding sources were identified, including the Federal Aviation Administration's (FAA's) Airport Improvement Program (AIP), West Virginia Department of Transportation (WVDOT) funding, and other funding sources. Project costs not funded by these sources are expected to be funded by some combination of Passenger Facility Charges (PFCs), Airport funds, and/or Airport debt.
- CRW's existing financial operating results were projected over the next 10 years (through FY 2030) to determine primary revenue generating sources, its major expenses, and the ability of the Airport to fund its proposed projects over the next 10 years.

5.3 Financial Structure Overview

This section discusses CRW's accounting practices, including the cost center structure utilized for airline rate-setting purposes, and a summary of the airline agreement between the Airport and the airlines.

5.3.1 Airport Accounting

The Central West Virginia Regional Airport Authority (CWVRAA) was created as a public corporation under the provisions of Article 29 of Chapter 8 of the West Virginia Code, as amended, effective April 15, 1968. The purpose of the CWVRAA is the operation of a regional airport known as Yeager Airport, in Charleston, West Virginia.

The CWVRAA's fiscal year ends on June 30 of each year, and its financial statements are presented on a full accrual basis in accordance with Generally Accepted Accounting Practices (GAAP), whereby revenues are recorded when earned and expenses are recorded when incurred. No local taxes are used to fund the Airport's operation. It derives a majority of its income from tenant leases, user fees, and other real estate activities. It reinvests profits to maintain CRW and advance further redevelopment.

5.3.2 Airline Agreement

The term of the airline agreement between the CWVRAA and the signatory airlines expires June 30, 2021 and allows for one three-year extension period through June 30, 2024 upon mutual consent of the parties.

As per the airline agreement, operating expenses, debt service, and operating revenues are categorized into cost centers. Cost centers include those areas or functional activities used for the purposes of accounting for the financial performance. There are six cost centers included in CRW's financial structure:

- **Airfield Area:** Those portions of CRW (including runways, taxiways, aprons, approach and clear zones, safety areas, infield areas, cargo facilities, and apron, together with all associated landing and navigational aids) as it now exists or hereafter may be modified, changed or developed, which provide for the landing and takeoff, taxiing, parking and other operations of aircraft.
- **Terminal Area:** Those facilities that support the operation of the terminal building including access, service, and terminal circulation roads, together with associated rights-of-way and landscaped areas.
- **Terminal Building:** The terminal building, together with associated exterior curbs, lighting, sidewalks, and landscaped areas.
- **General Aviation Area:** That portion of CRW that includes the access roadways, automobile and aircraft parking areas, interior taxiways, fuel farms and buildings, and all utilities, as said area has been developed to accommodate that aviation segment exclusive of the scheduled, passenger-carrying airlines and based military units.

- **Other Buildings and Areas:** That portion of CRW representing all remaining facilities and lease sites on the Airport exclusive of special facilities. The other buildings and areas cost center includes, but is not limited to, buildings known as the FAA Building and the S&S Engineering Building, as they now exist or may be developed or improved from time to time.
- **Parking Facilities:** The special facility consisting of the parking garage and all long-term, short-term, metered, and employee parking lots in the general area of the terminal building.

As defined in the airline agreement, airline rates and charges are established based on the following airline rate-setting methodology:

- Compensatory terminal rental rates whereby total terminal costs allocable to the terminal building are divided by airline rentable space plus 45% of public space as the divisor.
- Security fees which are prorated among the airlines, according to the relative number of passengers enplaned by each airline as reimbursement to the CWVRAA for those costs incurred in providing the airlines with certain elements of an "Airport Security Program" as required by and approved by the Department of Homeland Security or the FAA, less any state or federal reimbursements. Security fees are not to be included in the calculation of the terminal building requirement.
- Ramp use fees in the amount of fifteen thousand dollars ($15,000) per month which are prorated among the signatory airlines according to the number of each signatory airline's landings in relation to the total landings of all signatory airlines' aircraft. All ramp use fees collected are credited to the airfield cost center.
- Hybrid residual landing fees whereby total costs of the Airport system are credited with Gross Operating Revenue derived by CWVRAA from all sources including Airport concessions; rentals and charges from non-signatory airlines; and miscellaneous service fees, all exclusive of any net income from CWVRAA parking facilities and any other special facilities, the Fixed-base Operator (FBO), and/or any mineral royalties. CRW's landing fee rate is then calculated using airline landed weight as the divisor.

5.4 Estimated Project Costs and Airport CIP

5.4.1 Short-term Projects

For the purposes of this financial plan, CRW's capital program over the next 10 years consists of the RSA Project and the existing CIP projects. **Table 5-1, *Estimated RSA Project Costs by Year***, and **Exhibit 5-1, *Estimated RSA Project Costs by Year (Dollars in Millions)***, present a summary of the estimated ROM costs for the RSA Project by year.

As shown, total costs for the RSA Project are estimated at $172.9 million in 2019 dollars.
When construction costs are inflated to account for inflation (assumed to be 3% per year), the total cost of the RSA Project is estimated to be approximately $208.4 million through FY 2029. It is important to note that the RSA Project cost estimates and timing must be viewed as preliminary, reflecting a master plan level of detail subject to refinement in subsequent implementation steps.

In addition to the RSA Project, CRW's current CIP projects are estimated to cost $38.6 million through FY 2021. **Table 5-2, *Current CRW Capital Improvement Program (CIP)***, presents a summary of the Airport's current CIP.

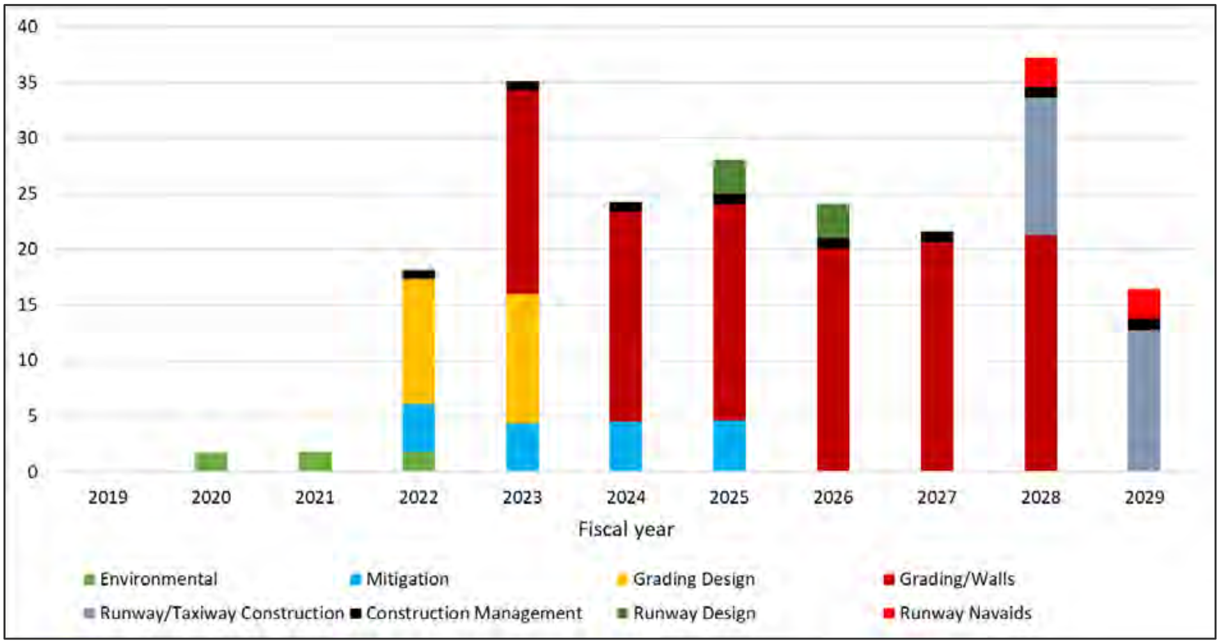
YEAGER AIRPORT

TABLE 5-1 ESTIMATED RSA PROJECT COSTS BY YEAR

SUMMARY OF ESTIMATED RSA PROJECT COSTS BY YEAR – FISCAL YEAR ENDING JUNE 30 (DOLLARS IN THOUSANDS)											
PROJECT COMPONENTS	**TOTAL COST**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
2019 Dollars											
Environmental (EIS)	$5,000	$1,667	$1,667	$1,667	$0	$0	$0	$0	$0	$0	$0
Mitigation	15,500	0	0	3,875	3,875	3,875	3,875	0	0	0	0
Grading Design	20,594	0	0	10,297	10,297	0	0	0	0	0	0
Construction Management	6,072	0	0	759	759	759	759	759	759	759	759
Grading/Walls	97,676	0	0	0	16,279	16,279	16,279	16,279	16,279	16,279	0
Runway Design	5,148	0	0	0	0	0	2,574	2,574	0	0	0
Runway/Taxiway Construction	18,954	0	0	0	0	0	0	0	0	9,477	9,477
Runway NAVAIDS	4,000	0	0	0	0	0	0	0	0	2,000	2,000
Total Cost (2019 Dollars)	**$172,944**	**$1,667**	**$1,667**	**$16,597**	**$31,210**	**$20,913**	**$23,488**	**$19,613**	**$17,038**	**$28,515**	**$12,236**
Future Dollars											
Environmental	$5,306	$1,717	$1,768	$1,821	$0	$0	$0	$0	$0	$0	$0
Mitigation	17,715	0	0	4,234	4,361	4,492	4,627	0	0	0	0
Grading Design	22,841	0	0	11,252	11,589	0	0	0	0	0	0
Construction Management	7,375	0	0	829	854	880	906	933	961	990	1,020
Grading/Walls	118,518	0	0	0	18,323	18,872	19,438	20,022	20,622	21,241	0
Runway Design	6,240	0	0	0	0	0	3,074	3,166	0	0	0
Runway/Taxiway Construction	25,102	0	0	0	0	0	0	0	0	12,365	12,736
Runway NAVAIDS	5,297	0	0	0	0	0	0	0	0	2,610	2,688
Total Cost (Inflated)	**$208,393**	**$1,717**	**$1,768**	**$18,136**	**$35,127**	**$24,244**	**$28,045**	**$24,121**	**$21,584**	**$37,206**	**$16,444**

Source: Landrum & Brown Team analysis.

EXHIBIT 5-1 ESTIMATED RSA PROJECT COSTS BY YEAR (DOLLARS IN MILLIONS)



Source: Landrum & Brown Team analysis.

TABLE 5-2 CURRENT CRW CAPITAL IMPROVEMENT PROGRAM (CIP)

CURRENT CRW CIP (DOLLARS IN THOUSANDS)	
PROJECT	**ESTIMATED COST**
Drainage/Slip Repairs	$10,600
General Aviation Apron	$5,000
Rehabilitate Taxiways	$5,000
Energy Efficiency (Solar)	$12,000
Runway 05-23 Rehabilitation	$6,000
Total	**$38,600**

Source: Airport data.

5.4.2 Long-term Projects

There are two long-term projects which would be implemented in the post-2030 time period – the extension of Runway 05-23 to 8,000 feet and the Taxiway A relocation. The costs for these two projects are shown in **Table 5-3, *Runway 05-23 Extension Project Cost***, and **Table 5-3, *Taxiway A Relocation Project Cost***.

TABLE 5-3 RUNWAY 05-23 EXTENSION PROJECT COST

ITEM DESCRIPTION	ESTIMATED COST (2019 DOLLARS)
Pavement and Markings	$8,714,500
NAVAID Relocation/Replacement	$3,927,500
Other Components	$12,396,000
Grading/walls	$21,951,000
SUBTOTAL A	$46,989,000
Temporary Items, Mobilization/Demo, etc. (1.5% of A)	$704,800
SUBTOTAL B	**$47,693,800**
Design Contingency (15% of B)	$7,154,100
SUBTOTAL C	**$54,848,000**
Construction Security Plan (4 years)	$1,000,000
SUBTOTAL D	**$55,848,000**
ADDITIONAL PROGRAM COSTS	
Design Fee (4% of D)	$2,234,000
CMI Fee (4% of D)	$2,234,000
FAA Reimbursable	$1,500,000
TOTAL COST ESTIMATE (Program)	**$61,816,000**

Note: Includes Taxiway A extension to the relocated Runway 23 end.
Source: Landrum & Brown Team analysis.

TABLE 5-4 TAXIWAY A RELOCATION PROJECT COST

ITEM DESCRIPTION	ESTIMATED COST (2019 DOLLARS)
Pavement and Markings	$10,425,000
Other Components	$5,131,500
Grading/walls	$9,792,000
SUBTOTAL A	**$25,348,500**
Temporary Items, Mobilization/Demo, etc. (1.5% of A)	$380,000
SUBTOTAL B	**$25,728,500**
Design Contingency (15% of B)	$3,859,000
SUBTOTAL C	**$29,587,500**
Construction Security Plan (4 years)	$1,000,000
SUBTOTAL D	**$30,587,500**
ADDITIONAL PROGRAM COSTS	
Design Fee (4% of D)	$1,224,000
CMI Fee (4% of D)	$1,224,000
TOTAL COST ESTIMATE (Program)	**$33,035,500**

Source: Landrum & Brown Team analysis.

5.5 Funding Sources

It was assumed that the costs for the Master Plan projects will be funded from a combination of sources, including:

- FAA Grants
- WVDOT Funds
- Local Funds (including PFCs and Airport funds)

5.5.1 FAA Grants

Federal participation in airport projects is based on the AIP as reauthorized under the FAA Modernization and Reform Act of 2012. Federal grants are provided in the form of entitlement grants (based on annual enplaned passenger levels), discretionary grants, and letter-of-intent (LOI) grants. FAA AIP funds are distributed each year based on the appropriation received from Congress. If AIP is authorized by Congress at a level above $3.2 billion, the current legislation provides eligible Primary airports with entitlement funds which are calculated based on the airport's number of enplaned passengers each year.

Allocation of funds from the FAA to the nation's airports is based upon a number of eligibility criteria and tied to a priority system that is used to rank each request and determine which projects will be funded and which will not during any given fiscal year. The priority system employed by the FAA has different criteria for different projects. For instance, planning projects are assessed using specific criteria that are applicable to planning types of projects. Generally, projects that enhance the safety of aircraft operations and those that enhance capacity in the system are higher priority projects.
The priority system also ranks projects based on the size of the airport and the number of aircraft and aircraft operations at the facility. Discretionary and LOI grants are distributed by each FAA region on the basis of availability and project priorities. Discretionary grants are generally made available to fund project costs on an annual basis, while LOI grants are used to fund capacity enhancement projects and are distributed to the Airport over a number of years at defined annual funding levels.

Guidance on issues of eligibility is provided in FAA Order 5100.38A, *Airport Improvement Program Handbook*. The Federal funding share for these projects is generally 90% for small commercial service airports such as CRW. In general, only those projects that are related to non-revenue producing items, such as land acquisition, airfield construction, certain public areas of the terminal area building, and safety/security projects are eligible for FAA AIP funding. Under most circumstances, projects which qualify for FAA AIP funding are eligible for up to 90% of total project costs. Close agency coordination is often required to address more complex issues relative to project eligibility. Additionally, it is reasonable to assume that there may be changes in eligibility criteria over the course of the planning period.

More importantly as it relates specifically to CRW and its RSA Project, as part of the FAA Reauthorization Act of 2018, the FAA specifically prioritized that funds from the Small Airport Fund could be used for "Airport Development for Eligible Mountaintop Airports."[1] As part of the revised code for the Small Airports Fund, the FAA shall give priority consideration to mass grading and associated structural support (including access road, duct banks, and other related infrastructure) at mountaintop airports, provided that the airport would not otherwise have sufficient surface area for eligible and justified airport development projects (such as the RSA Project or additional hangar space).

Overall, since 2012, CRW has received an average of approximately $9.2 million in FAA AIP grant funds per year. Based on the AIP Entitlement formulas defined in FAA's AIP Handbook, CRW is entitled to a minimum of approximately $1.9 million in funding from the FAA annually (not including any additional discretionary funds).

5.5.2 WVDOT Grants

The WVDOT Aeronautics Commission administers grant programs to encourage and support needed capital improvements to the state's public airports. Airports that meet the criteria for FAA AIP funds also qualify for funding from the state program. Currently, airports that meet the Aeronautics Commission's criteria can qualify for up to half of the local share required to match FAA funds. The grant program is supported by the state tax on aircraft fuel and general revenue funds. As of FY 2019, the WVDOT Aeronautics Division has awarded $1.195 million to 20 AIP projects, which has been matched by $28.63 million in FAA funds.

5.5.3 Local Funds

The balance of project costs (after consideration of FAA, State grants, and other funding sources) must be funded through the local sponsor. Local funding of airport improvements can come from PFCs, Customer Facility Charges (CFCs), Airport cash, or through the issuance of bonds or other debt.

5.5.3.1 PFCs

PFCs may be used by CRW to fund the local share of eligible project costs (PFC eligibility for projects generally follows the same general guidelines for determining AIP grant eligibility outlined earlier). In accordance with the Aviation Safety and Capacity Expansion Act of 1990, as amended by the Aviation Investment and Reform Act for the 21st Century, CRW is currently imposing a $4.50 PFC.

CRW currently collects just under $1.0 million in PFC revenues each year. Currently, a portion of the Airport's PFC collections are being used to pay for an existing BB&T loan that will be paid off in 2021. In 2019, the CWVRAA anticipates issuing another bank loan of approximately $7.5 million to help fund additional PFC eligible projects.

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[1] Source: Title 49 U.S. Code, Section 47116. Small Airport Fund.

5.5.3.2 Rental Car CFCs

CRW currently collects a rental car CFC of $4.00 per customer to pay for debt service, maintenance, capital improvements, and certain other uses related to rental car operations approved by the CWVRAA. The CFC is charged and collected by the various rental car companies operating at CRW, and then remitted to CRW on a monthly basis.

5.5.3.3 Airport Cash and Bonds

All remaining local funds not funded with PFCs or CFCs must be funded from Airport cash available or through the issuance of airport revenue bonds. CRW has several unrestricted funds that it can use towards capital projects at its sole discretion. These various funds are funded from any remaining net revenues after the payment of operating expenses, outstanding debt service, and funding of other reserves. At the end of May 2019, CRW had an unencumbered cash balance of approximately $5.2 million in its various funds.

Any additional local funding beyond what can be funded from CRW's cash reserves would require the issuance of General Airport Revenue bonds. Depending on the exact timing and magnitude of future capital expenditures, it may be necessary to issue future debt to help defray upfront expenditures and mitigate the impacts to its available cash balances.

5.6 Funding Plan

Based on the estimated project costs and eligible funding sources, a proposed funding plan was developed for CRW. In developing the funding plan, the overriding objective was to maximize the use of external resources and minimize the amount of funding from local public resources. A detailed funding analysis was completed for the short-term projects only; a general analysis was completed for the long-term projects due to uncertainties that exist in terms of project costs, project timing, and funding availability after 2030.

5.6.1 Short-term Projects

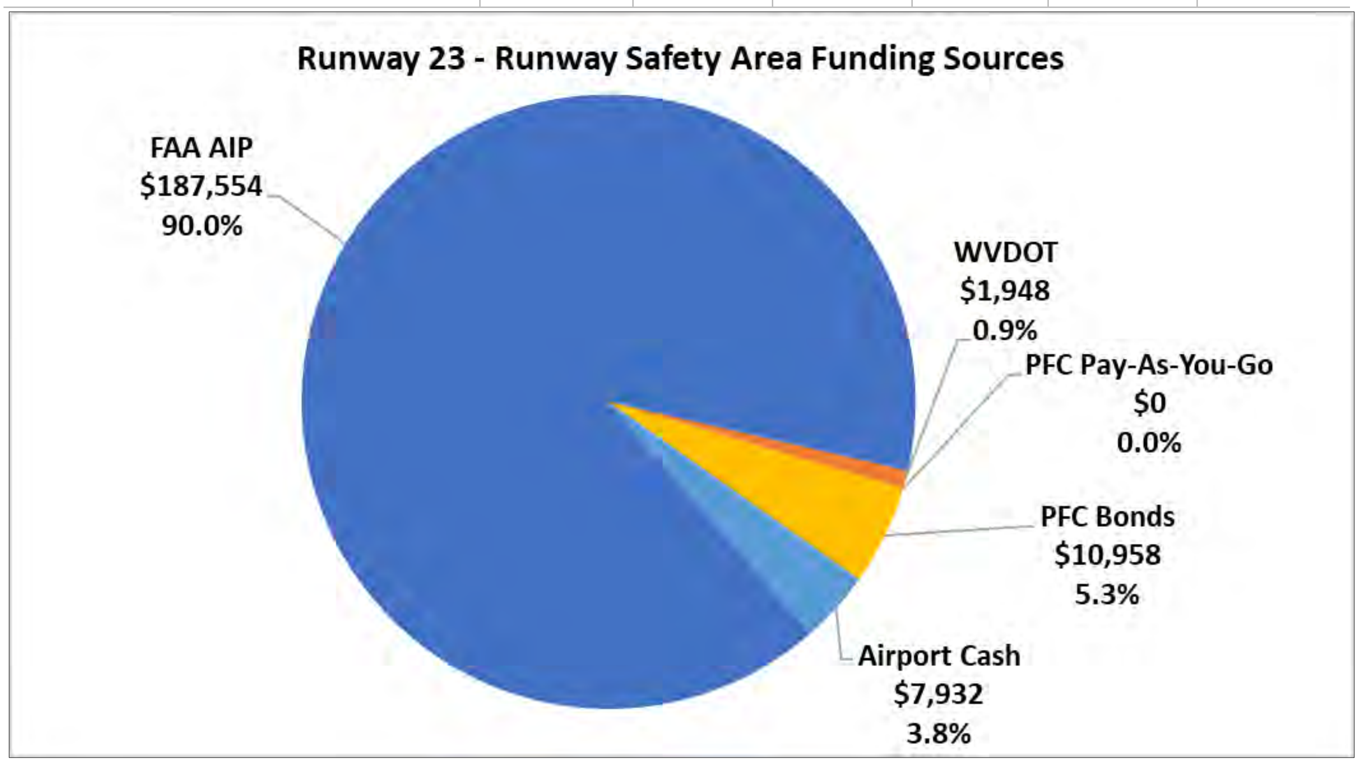
Table 5-5, *Eligible Funding Sources – Short-Term Projects*, presents the eligible funding sources for the RSA Project and the existing CIP projects, including FAA, WVDOT, and local funding sources by year through 2029. The RSA Project is estimated to cost $208.4 million. Of this total, approximately $187.6 million was estimated to be eligible for federal funds through the FAA's AIP Program, $1.9 million from the WVDOT, $11.0 million from PFCs, and $7.9 million from local Airport funds.

It is important to note that these funding estimates represent the amount of project costs that are eligible for federal, state, and PFC funding. Depending on actual federal and state funding appropriations made each year, competition with other airport funding needs throughout the U.S. and the State of West Virginia, and prior commitments of PFCs, these levels of funding may not be attainable.

The RSA Project was assumed to be eligible for up to 90% funding from the FAA, which equates to approximately $187.6 million. This would equate to an average of approximately $18.8 million over the 10-year construction period, with FAA funding peaking at $25 million to $33 million in certain peak spending years.

TABLE 5-5 ELIGIBLE FUNDING SOURCES – SHORT-TERM PROJECTS

ELIGIBLE FUNDING SOURCES (DOLLARS IN THOUSANDS)						
	FAA AIP	WVDOT	LOCAL SHARE			
			PFC PAY-AS-YOU-GO	PFC BONDS	AIRPORT CASH	TOTAL COSTS
Runway 23 - Runway Safety Area	$187,554	$1,948	$0	$10,958	$7,932	$208,393
Current Airport CIP Projects						
Drainage/Slip Repairs	$9,540	$1,060	$0	$0	$0	$10,600
General Aviation Apron	$4,500	$500	$0	$0	$0	$5,000
Rehabilitate Taxiways	$4,500	$500	$0	$0	$0	$5,000
Energy Efficiency (Solar)	$10,800	$1,200	$0	$0	$0	$12,000
Runway 05-23 Rehabilitation	$5,400	$600	$0	$0	$0	$6,000
Total Airport CIP	**$34,740**	**$3,860**	**$0**	**$0**	**$0**	**$38,600**
Total RSA Project & Airport CIP	**$222,294**	**$5,808**	**$0**	**$10,958**	**$7,932**	**$246,993**



Source: Landrum & Brown analysis.

Given that the level of eligible FAA funding is estimated to be approximately $18.8 million per year over the next 10 years, CRW would need to apply for additional discretionary funding from the FAA to fully fund all AIP eligible project costs. If these additional FAA discretionary funds are not successfully secured, CRW will need to either defer project costs until later years or secure additional funding from alternative funding sources including PFCs, Airport cash, bonds, or other sources.

Based on the 90% eligibility levels from the FAA, the RSA Project would be eligible for one half of the remaining amount from the state (5% of the project costs, representing approximately $10.4 million). However, given CRW's other planned CIP projects and the WVDOT Aeronautics Commission's limited funding resources available, it was assumed that a maximum funding amount of only $200,000 per year would be available from the WVDOT Aeronautics Commission for the RSA Project. As a result, a total of approximately $2.0 million of WVDOT funding was assumed for the RSA Project over the 10-year forecast period.

Approximately $18.9 million of project funds were anticipated to be funded from local funds generated by CRW over the 10-year forecast period:

- Once the RSA Project is underway, the CWVRAA will refund the 2019 PFC loan and at the same time, issue new PFC-eligible general airport revenue bonds to help fund the local share of the RSA Project.
- As shown in **Table 5-6, *Passenger Facility Charge (PFC) Cash Flow Projections***, it is anticipated that nearly all of CRW's annual PFC collections will be used to pay the annual debt service on the RSA Project (approximately 1.1 million annually). As such, 100% of CRW's annual PFC collections will be committed toward the repayment of debt service over the entire 30-year amortization period of the bonds.
- The RSA Project would not eligible for CFC funding. In addition, no future rental car projects were assumed as part of the CIP. As a result, the use of CFCs has not been assumed as part of the financial plan.
- After utilizing all of its PFC funding capacity, it is estimated that approximately $7.9 million of CRW's cash reserves will be needed to help fund the costs of the RSA Project.

TABLE 5-6 PASSENGER FACILITY CHARGE (PFC) CASH FLOW PROJECTIONS

PASSENGER FACILITY CHARGE (PFC) CASH FLOW PROJECTS – FISCAL YEAR ENDING JUNE 30 (DOLLARS IN THOUSANDS)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Annual PFC Collections												
Enplaned Passengers (000s)	228	234	236	238	243	252	257	262	274	291	308	315
% Enplaned Passengers paying PFCs	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%
PFC Enplaned Passengers	**217**	**223**	**224**	**226**	**231**	**240**	**244**	**249**	**261**	**277**	**293**	**299**
PFC Rate	$4.50	$4.50	$4.50	$4.50	$4.50	$4.50	$4.50	$4.50	$4.50	$4.50	$4.50	$4.50
Less: Admin. Fee	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Adjusted PFC Rate	**$4.39**	**$4.39**	**$4.39**	**$4.39**	**$4.39**	**$4.39**	**$4.39**	**$4.39**	**$4.39**	**$4.39**	**$4.39**	**$4.39**
Annual PFC Collections	**$951**	**$977**	**$984**	**$992**	**$1,015**	**$1,052**	**$1,070**	**$1,093**	**$1,144**	**$1,216**	**$1,285**	**$1,314**
PFC Fund												
Beginning Balance	$450	$971	$745	$514	$363	$235	$142	$67	$50	$52	$128	$271
Annual PFC Collections	951	977	984	992	1,015	1,052	1,070	1,093	1,144	1,216	1,285	1,314
Interest Earnings	0	0	0	0	0	0	0	0	0	0	0	0
Total PFC Collections	$951	$977	$984	$992	$1,015	$1,052	$1,070	$1,093	$1,144	$1,216	$1,285	$1,314
PFC Uses												
Existing BB&T Loan	431	509	382	0	0	0	0	0	0	0	0	0
Future PFC Pay-Go Project Costs	0	0	0	0	0	0	0	0	0	0	0	0
2019/20 PFC Debt	0	694	832	0	0	0	0	0	0	0	0	0
Future PFC Debt	0	0	0	1,143	1,144	1,145	1,145	1,110	1,142	1,140	1,141	1,142
Total Uses	$431	$1,203	$1,214	$1,143	$1,144	$1,145	$1,145	$1,110	$1,142	$1,140	$1,141	$1,142
Ending PFC Balance	**$971**	**$745**	**$514**	**$363**	**$235**	**$142**	**$67**	**$50**	**$52**	**$128**	**$271**	**$443**

Source: Landrum & Brown analysis.

5.6.2 Long-term Projects

Table 5-7, *Eligible Funding Sources – Long-Term Projects*, presents the eligible funding sources for the runway extension and Taxiway A relocation projects, including FAA, WVDOT, and local funding sources. These two projects are estimated to cost $94.1 million. Of this total, approximately $84.7 million was estimated to be eligible for federal funds through the FAA's AIP Program, $1.4 million from the WVDOT, and $5.1 million from PFCs and/or local Airport funds.

TABLE 5-7 ELIGIBLE FUNDING SOURCES – LONG-TERM PROJECTS

PROJECT	ELIGIBLE FUNDING SOURCES (DOLLARS IN THOUSANDS)			
	FAA AIP	WVDOT	LOCAL FUNDS	TOTAL
Runway Extension	$55,634	$1,050	$5,132	**$61,816**
Taxiway A Relocation	$29,732	$350	$2,954	**$33,036**
Total	**$85,366**	**$1,400**	**$8,085**	**$94,852**

Source: Landrum & Brown analysis.

It is important to note that these funding estimates represent the amount of project costs that are eligible for federal and state funding. Depending on actual federal and state funding appropriations made each year and competition with other airport funding needs throughout the U.S. and the State of West Virginia, these levels of funding may not be attainable.

The Phase 2 projects were assumed to be eligible for up to 90% funding from the FAA, which equates to approximately $85.4 million. Based on the 90% eligibility levels from the FAA, the RSA Project would be eligible for one half of the remaining amount from the state (5% of the project costs, representing approximately $4.7 million). However, given that CRW will likely have other CIP projects and the WVDOT Aeronautics Commission's limited funding resources available, it was assumed that a maximum funding amount of only $200,000 per year would be available from the WVDOT Aeronautics Commission for the RSA Project. As a result, a total of approximately $1.4 million of WVDOT funding was assumed for the RSA Project, assuming a seven-year timeline. Approximately $8.1 million of project funds were anticipated to be funded from local funds generated by CRW.

5.7 Operating Expenses

Operating expenses at CRW are assigned to various expense categories including personnel and benefits, utilities, maintenance/materials/supplies, general administration, advertising, promotional and transfers. Operating expenses were then allocated to the various Airport cost centers for rate-setting purposes.

Table 5-8, *Projected Operating Expenses*, presents projected operating expenses at CRW for FY 2020 through FY 2030. In general, projections of future operating expenses were based on a review of historical trends and anticipated impacts of inflation. Operating expenses were estimated to increase from approximately $10.3 million in FY 2020 to approximately $13.9 million in FY 2030, representing a compounded annual growth rate of 3.0%.

TABLE 5-8 PROJECTED OPERATING EXPENSES

PROJECTED OPERATING EXPENSES – FISCAL YEAR ENDING JUNE 30 (DOLLARS IN THOUSANDS)											
OPERATING EXPENSES BY CATEGORY	BUDGET	FORECAST									
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Salaries	$4,097	$4,219	$4,346	$4,476	$4,611	$4,749	$4,892	$5,038	$5,189	$5,345	$5,505
Benefits	1,521	1,566	1,613	1,662	1,712	1,763	1,816	1,870	1,926	1,984	2,044
Utilities	488	500	512	525	538	552	566	580	594	609	624
Maintenance, Materials, Supplies	1,313	1,366	1,420	1,477	1,536	1,598	1,662	1,728	1,797	1,869	1,944
General Administration	1,163	1,198	1,233	1,270	1,309	1,348	1,388	1,430	1,473	1,517	1,563
Advertising	122	125	129	133	137	141	145	149	154	159	163
Promotional	46	47	48	50	51	53	54	56	58	59	61
Transfers to Other Funds	1,550	1,570	1,591	1,632	1,671	1,690	1,735	1,796	1,871	1,931	1,953
Total Operating Expenses	**$10,298**	**$10,591**	**$10,894**	**$11,226**	**$11,564**	**$11,893**	**$12,258**	**$12,648**	**$13,063**	**$13,474**	**$13,857**

Sources: Airport data (Budget 2020); Landrum & Brown analysis.

5.8 Operating Revenues

CRW is provided with a diverse revenue stream from a number of different sources. These revenue sources include revenues from the airlines (landing fees and terminal rent), terminal concessions (food & beverage and retail merchandise), parking, rental car, general aviation, cargo, and other miscellaneous revenues. In FY 2019, CRW's revenue sources were budgeted to be approximately $10.8 million.

Table 5-9, *Projected Operating Revenue*, presents projected operating revenues at CRW for each year in the short-term (FY 2020 through FY 2030). In general, projections of future operating revenues were based on a review of historical trends, projected passenger activity levels, and the anticipated impacts of inflation. Operating revenues were estimated to increase from approximately $10.8 million in FY 2020 to approximately $14.6 million in FY 2030, representing a compounded annual growth rate of 3.1%.

5.8.1 Airline Revenues

Airline revenues, including terminal rentals, landing fees, ramp fees, and security fees payable by the airlines, are estimated to total approximately 21% of CRW's operating revenues in FY 2020. Airline terminal rentals, landing fees, and ramp fees are calculated pursuant to CRW's Airline Agreement described previously. In general, the items included in the total requirement for the terminal rental rate and landing fee include the following components:

- **Operating Expenses:** Includes the operating expenses (direct and allocated indirect) attributable to the airfield or terminal cost centers.
- **Debt Service:** Includes the portion of debt service allocated to the airfield or terminal cost centers.
- **Capital Expenses:** Includes amounts budgeted for capital improvement expenses within the specific rate-setting area.

Terminal rents at CRW are established based on a compensatory terminal rental rate calculation. The terminal rent is calculated by combining the items described above for the terminal cost center in order to determine CRW's total terminal requirement. The terminal rental rate is then calculated by dividing the net requirement by airline rentable square feet plus 45% of public space in the terminal building. Overall, CRW's terminal rental rate is projected to be approximately $28.91 per square foot in FY 2020 and increase to approximately $39.29 in FY 2030.

Landing fees at CRW are established based on a "residual" formula, which results in the airlines covering the net remaining requirement attributable to the airport fund after crediting total terminal building rental revenues, non-airline revenues, and other fund transfers. In addition, CRW may apply additional credits to the landing fee requirement at its discretion to lower airline landing fees. The landing fee is then calculated by dividing the net requirement by passenger airline landed weight per thousand pounds. Overall, CRW's landing fee is projected to be approximately $2.87 per thousand pounds landed weight in FY 2020 and increase to approximately $3.86 in FY 2030.

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TABLE 5-9 PROJECTED OPERATING REVENUES

PROJECTED OPERATING REVENUES – FISCAL YEAR ENDING JUNE 30 (DOLLARS IN THOUSANDS)											
	BUDGET	FORECAST									
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Airport Fund											
Airline Revenues											
Landing Fees	$820	$889	$959	$974	$1,000	$1,086	$1,135	$1,077	$1,014	$999	$1,103
Ramp Fees	180	180	180	180	180	180	180	180	180	180	180
Terminal Rentals	1,081	1,114	1,149	1,185	1,221	1,260	1,299	1,339	1,381	1,424	1,469
Security Reimbursement	164	169	174	179	184	190	195	201	207	214	220
Subtotal – Airline Revenues	$2,245	$2,352	$2,461	$2,517	$2,585	$2,716	$2,809	$2,798	$2,782	$2,817	$2,971
Non-Airline Revenues											
Terminal Concessions	$180	$184	$188	$199	$208	$212	$224	$240	$260	$276	$280
Terminal Space Rentals	199	205	211	218	224	231	238	245	252	260	268
Rental Car Revenues	1,079	1,104	1,131	1,190	1,246	1,270	1,336	1,426	1,540	1,630	1,657
Ground Transportation	9	9	9	9	10	10	11	11	12	13	13
Other Buildings & Areas	308	317	327	336	347	357	368	378	390	401	413
Miscellaneous	2	2	2	2	2	2	2	2	2	2	2
Security Reimbursement	110	110	110	110	110	110	110	110	110	110	110
Transfers from Other Funds	1,430	1,450	1,471	1,512	1,551	1,570	1,615	1,676	1,751	1,811	1,833
Subtotal – Non-Airline Revenues	$3,316	$3,380	$3,449	$3,576	$3,697	$3,761	$3,902	$4,087	$4,317	$4,503	$4,576
Total Airport Fund Revenue	**$5,560**	**$5,733**	**$5,910**	**$6,093**	**$6,282**	**$6,477**	**$6,711**	**$6,885**	**$7,099**	**$7,320**	**$7,547**

PROJECTED OPERATING REVENUES – FISCAL YEAR ENDING JUNE 30 (DOLLARS IN THOUSANDS)											
	BUDGET	FORECAST									
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Other Funds											
Parking Fund[1]	$2,280	$2,331	$2,387	$2,517	$2,638	$2.686	$2,831	$3,032	$3,290	$3,491	$3,545
Rental Car Fund	767	773	779	810	836	839	871	919	982	1,026	1,027
Marketing Fund	373	376	380	388	396	399	409	422	438	451	455
Special Facilities Fund	108	109	109	109	109	109	109	109	110	110	110
CRW Services Fund[1]	172	177	182	188	194	199	205	212	218	224	231
Capital Jet Center Fund[1]	3,153	3,215	3,279	3,343	3,409	3,461	3,513	3,565	3,619	3,673	3,728
Total Other Fund Revenue	**$6,853**	**$6,981**	**$7,115**	**$7,355**	**$7,582**	**$7,693**	**$7,938**	**$8,259**	**$8,656**	**$8,975**	**$9,096**
TOTAL AIRPORT REVENUES	**$12,413**	**$12,713**	**$13,025**	**$13,448**	**$13,864**	**$14,170**	**$14,649**	**$15,144**	**$15,755**	**$16,295**	**$16,643**

[1] Revenues for the Parking Fund, CRW Services Fund and Capital Jet Center (CJC) Fund do not include transfers out of revenues to the Airport and Marketing Funds.
Note: CAGR = Compound average growth rate.
Sources: Airport data (Budget 2020); Landrum & Brown analysis.

Security fees are charged to the airlines as a reimbursement to the CWVRAA for those costs incurred in providing the airlines with Airport security as required by and approved by the Department of Homeland Security and the Transportation Security Administration (TSA), less any state or federal reimbursements. Security fees are projected to increase from $164,000 in FY 2020 to approximately $220,000 in FY 2030, representing a compound annual growth rate (CAGR) of 3.0%.

Based on the projected airline terminal rents, landing fees, and security fees, **Exhibit 5-2, *Projected Airline Cost Per Enplanement***, CRW's projected airline cost per enplanement in the short-term (through FY 2030). The airline cost per enplanement (all airline fees and rentals divided by enplaned passengers) is a metric used to compare the overall cost of airline operations to other airports throughout the U.S. CRW's airline cost per enplanement is projected to increase from $9.42 budgeted for 2020 to approximately $10.57 in FY 2026 and then decrease thereafter to approximately $9.31 in FY 2030. By comparison, the average airline cost per enplanement at all non-hub airports in the U.S. such as CRW was $9.13 in 2018.

EXHIBIT 5-2 PROJECTED AIRLINE COST PER ENPLANEMENT

Source: Landrum & Brown analysis.

5.8.2 Non-airline Revenues

Non-airline revenues consist of terminal concessions, terminal space rentals, rental car revenues, ground transportation, other buildings & areas, miscellaneous, security reimbursement, and transfers from other funds. The following provides key assumptions regarding non-airline revenues:

- Terminal concession revenues are generated from terminal concession tenants including food & beverage, news and gift, and others. Future terminal concession revenues are projected to increase based on forecast increases in enplaned passengers at CRW and the impacts of inflation.
- Terminal space revenues are generated from rent charged to other tenants located within the terminal, including areas leased for the FAA Air Traffic Control Tower (ATCT) and Transportation Security Administration (TSA) space.
- Rental car revenues include revenue derived from the four rental car companies and included fees associated with rental car concession fees (assessed to the rental car operators for the right to provide services to users of the Airport), terminal space rentals, service area rentals, and ready/return area rentals.
- Revenues from other buildings & areas consist of revenues generated from building and ground rental fees assessed to various tenants located on the Airport such as the FAA, the S&S building, and other Airport buildings. These revenues are generally charged to tenants based on a per square foot basis for the building and/or land contained within their leasehold for which their facilities occupy.
- Revenues from transfers from other funds consists of inter-fund transfers from the Parking, CRW Services, and Capital Jet Center (CJC) funds to the airport fund primarily as a credit to lower airline rates and charges CRW. These transfers are determined each year at the discretion of the Authority.

5.8.3 Parking Fund Revenues

Revenues in the parking fund are generated primarily from short-term and long-term. As of August 2020, existing parking rates are:

- **Short-term Parking:** $1.00 for the first hour and an additional $2.00 for each hour thereafter; up to a maximum of $10.00 per day after five hours.
- **Long-term Parking:** $4.00 for the first two hours and an additional $1.00 for each additional four hours thereafter; up to a maximum of $9.00 per day after 10 hours.

In FY 2020, total parking revenue is budgeted at just over $2.3 million. After the transfer of revenues out to other funds (the airport and marketing funds), net parking revenues are budgeted at approximately $1.2 million in FY 2020. Future parking revenues are expected to increase based on periodic parking rate increases as well as forecast increases in enplaned passengers. By FY 2030, total parking revenues are projected to increase to approximately $3.5 million, and after transfer of revenues out to other funds (the airport and marketing funds), net parking revenues are budgeted at approximately $2.1 million in FY 2030.

5.8.4 Rental Car Fund Revenues

Revenues in the rental car fund are derived from rental car CFCs assessed to rental car customers. Future rental car CFC revenues are projected to increase based on forecast increases in enplaned passengers. Rental car CFC revenues are projected to increase from approximately $767,000 in FY 2020 to approximately $1.0 million in FY 2030.

5.8.5 Marketing Fund Revenues

Revenues in the marketing fund are derived primarily from advertising at CRW. Including the transfer in from the parking fund, marketing fund revenues are projected to increase from approximately $373,000 in FY 2020 to approximately $455,000 in FY 2030.

5.8.6 Special Facilities Fund

Special facilities fund revenues are derived from the TSA office suite and revenue from the gas wells at CRW. Special facilities fund revenues are projected to increase from approximately $108,000 in FY 2020 to approximately $110,000 in FY 2030.

5.8.7 CRW Services Fund

Revenues in the CRW services fund are derived from equipment services provided by the Airport and charged to airline and rental car tenants for the baggage systems and airline and rental car equipment. Including the transfer out to the airport fund, CRW services fund revenues are projected to increase from approximately $72,000 in FY 2020 to approximately $131,000 in FY 2030.

5.8.8 Capital Jet Center Fund

CJC fund revenues are derived from the FBO which it took over the operation of in FY 2020. In FY 2020, total CJC fund revenue is budgeted at $3.2 million. After transfer of revenues out to other the airport fund, net CJC fund revenues are budgeted at approximately $2.7 million in FY 2020. By FY 2030, total CJC fund revenues are projected to increase to approximately $3.7 million, and after transfer of revenues out to the airport fund, net CJC fund revenues are budgeted at approximately $3.2 million in FY 2030.

5.9 Financial Plan Results

The results of the financial plan are presented in terms of the resulting cash flow, or the net operating income generated. CRW's net operating income was calculated after subtracting total operating expenses and annual debt service from total operating revenues. The financial plan analysis was completed for the short-term (through FY 2030). Detailed financial analysis was not completed for the time period after FY 2030 due to the uncertainties that exist in terms of project costs, project timing, and funding availability in the long-term.

As shown in **Table 5-10, *Projected Airport Cash Flow***, and **Exhibit 5-3, *Projected Net Operating Income***, after payment of operating expenses and debt service, the net operating income is estimated to be approximately $929,000 in FY 2020, increasing to approximately $2.4 million in FY 2030. The projected increase in net operating income is largely a function of passenger-related revenues (i.e., terminal concessions, rental car, and parking revenues) driven by the projected enplaned passenger activity, as well as the retirement of existing debt service in FY 2021 and again in FY 2028.

The Airport's annually generated net operating income is shown to be used to fund CRW's local share of equipment and capital improvement costs associated with the RSA Project. During the construction of the RSA project between FY 2022 and FY 2029, approximately $620,000 to $1.6 million per year in Airport net operating income is projected to be applied toward the RSA project, totaling approximately $7.9 million over the 10-year projection period.

The financial projections and overall feasibility of the RSA Project are highly dependent on receiving a majority or all of its eligible grant funding from the FAA and the WVDOT. In order to examine the sensitivity of the airline cost per enplanement, an analysis was undertaken to measure the overall impacts to the airline cost per enplanement if it were to receive less than the maximum FAA AIP eligibility levels of 90%.

Any reduction in the amount of FAA AIP grants received from the FAA would require CRW to issue additional debt which would be collected directly through airline landing fees, thereby directly increasing the airline cost per enplanement. As a general rule, it was found that for every $10 million decrease in the amount of FAA AIP funding received from the FAA for the RSA Project, the airline cost per enplanement would increase by roughly an additional $2.20 to $2.30. For example, if the FAA AIP funding levels for the RSA Project were lowered from $187.6 million (90% funding) to approximately $177.6 million (85% funding), the airline cost per enplanement could expected to increase to approximately $11.50 in FY 2030.

CRW currently has an informal policy of not exceeding an airline cost per enplanement of $12 in any given year. Using this target airline cost per enplanement, it was found that FAA AIP funding of the RSA Project of roughly $170.9 million (approximately 82% funding), or a reduction of approximately $16.7 million over the maximum funding level of 90%, would result in an airline CPE of $12 in each year of the 10-year projection period. Any further reductions to FAA AIP funding beyond this level would increase the airline cost per enplanement above the $12 target level.

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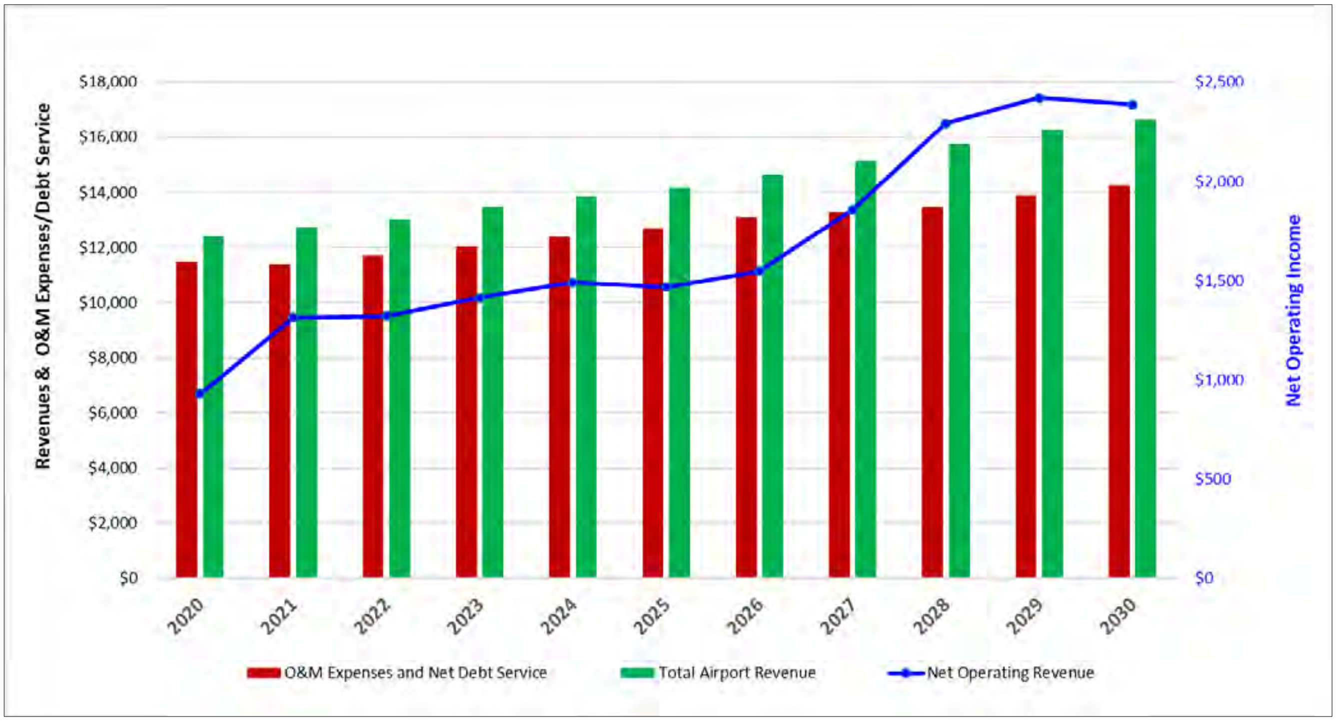
TABLE 5-10 PROJECTED AIRPORT CASH FLOW

PROJECTED AIRPORT CASH FLOW – FISCAL YEAR ENDING JUNE 30 (DOLLARS IN THOUSANDS)											
	BUDGET	FORECAST									
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Revenues											
Airport	$5,560	$5,733	$5,910	$6,093	$6,282	$6,477	$6,711	$6,885	$7,099	$7,320	$7,547
Parking	2,280	2,331	2,387	2,517	2,638	2,686	2,831	3,032	3,290	3,491	3,545
Rental Car	767	773	779	810	836	839	871	919	982	1,026	1,027
Marketing	373	376	380	388	396	399	409	422	438	451	455
Special Facilities	108	109	109	109	109	109	109	109	110	110	110
CRW Services	172	177	182	188	194	199	205	212	218	224	231
Capital Jet Center	3,153	3,215	3,279	3,343	3,409	3,461	3,513	3,565	3,619	3,673	3,728
Total Revenue	**$12,413**	**$12,713**	**$13,025**	**$13,448**	**$13,864**	**$14,170**	**$14,649**	**$15,144**	**$15,755**	**$16,295**	**$16,643**
Expenses											
Airport	$5,531	$5,704	$5,881	$6,064	$6,253	$6,448	$6,649	$6,856	$7,070	$7,291	$7,518
Parking	1,424	1,451	1,480	1,529	1,576	1,604	1,658	1,728	1,813	1,884	1,916
Rental Car	79	82	85	88	91	95	98	102	106	110	114
Marketing	370	381	393	405	417	430	442	456	470	484	498
Special Facilities	100	104	108	112	117	122	127	132	137	142	148
CRW Services	125	128	133	137	141	146	150	155	160	165	170
Capital Jet Center	2,668	2,740	2,814	2,890	2,969	3,050	3,133	3,219	3,307	3,398	3,492
Total Expenses	**$10,298**	**$10,591**	**$10,894**	**$11,226**	**$11,564**	**$11,893**	**$12,258**	**$12,648**	**$13,063**	**$13,474**	**$13,857**
Net Operating Revenue	**$2,116**	**$2,123**	**$2,132**	**$2,222**	**$2,300**	**$2,276**	**$2,392**	**$2,497**	**$2,693**	**$2,821**	**$2,786**
Debt Service (Net of PFCs)	1,186	810	810	810	810	810	843	640	400	400	400
Net Operating Income	**$929**	**$1,313**	**$1,322**	**$1,412**	**$1,490**	**$1,467**	**$1,548**	**$1,856**	**$2,293**	**$2,421**	**$2,386**
Equipment/Capital Improvement	154	0	622	712	790	767	848	1,156	1,593	1,444	0
Reserve Funds	200	200	200	200	200	200	200	200	200	200	200
Net Operating Income	**$575**	**$1,113**	**$500**	**$500**	**$500**	**$500**	**$500**	**$500**	**$500**	**$777**	**$2,186**

Sources: Airport data (Budget 2020); Landrum & Brown analysis.

EXHIBIT 5-3 PROJECTED NET OPERATING INCOME (DOLLARS IN THOUSANDS)



Sources: Airport data (Budget 2020); Landrum & Brown analysis.

5.10 Summary

Implementing and funding the CIP and runway and taxiway projects will largely be a function of federal, state, and local funding sources available at the time of specific project implementation. Due to the conceptual nature of a master plan, implementation of most of these capital projects should occur only after further refinement of their costs and timing. The financial feasibility of the CIP and projects is based on a number of factors, most notably of which is the level of external funding sources CRW is able to secure. While the previous sections identified the maximum eligibility levels available for the RSA Project from the FAA, WVDOT, PFCs and other local sources, there is no guarantee that these funds will be made available in any given year, or if they are, that they will be funded at the full eligibility levels.

CRW's financial projections and overall feasibility of the projects are highly dependent on receiving a majority or all of its eligible grant funding from the FAA and the WVDOT. In the event CRW were to receive less than the maximum eligible grant levels from FAA and/or WVDOT, there are a number of approaches that can be explored in order to undertake the RSA Project, including:

- **Defer or Delay Capital Project Cost Expenditures:** In the event that certain funding sources are not available for the RSA Project and/or if financial feasibility cannot be achieved when the RSA project is needed, CRW may need to defer certain projects until appropriate funding sources can be obtained. In addition, rather than deferring whole projects, in some cases, projects can be completed in several smaller phases over several years to help increase the participation from other funding sources and spread out local funding requirements. Constant monitoring and updating of capital needs and available funding sources will be critical to successful implementation of the runway and taxiway projects.
- **Seek FAA Discretionary Small Airport Grant Funds:** As discussed previously, based on CRW's annual FAA entitlement grant collections and the estimated level of eligible RSA Project costs, CRW would need to apply for additional discretionary funding from the FAA to fully fund all of its AIP eligible project costs. As part of the FAA Reauthorization Act of 2018, the FAA specifically prioritized that funds from the Small Airport Fund could be used for "Airport Development for Eligible Mountaintop Airports." The CWVRAA should make every effort to take advantage of this funding priority, as it is directly applicable to its projects. If these additional FAA discretionary funds are not successfully secured, CRW will need to either defer project costs until later years or secure additional funding from other funding sources including the WVDOT, PFCs, Airport cash, bonds, or other sources.
- **Focus on Revenue-Producing Efforts:** In an effort to improve Airport revenues and generate additional operating income needed to support additional local funding for the RSA Project, CRW could focus on additional revenue-producing efforts. These efforts could include the expansion of the FBO, hangar expansions, non-aeronautical land development, and other revenue-producing projects. As such, it will be important for CRW to thoroughly review any revenue-producing projects to ensure that they will be supported by anticipated demand and generate positive cash flow.

- **Issue Airport Bonds:** As discussed previously, in order to fund the local share of large capital projects, airports typically will issue long-term debt to help defray upfront expenditures and mitigate the impacts to its available cash balances. While issuing long-term debt can be an effective approach for implementing certain projects and minimizing up-front cash expenditures, it is important to ensure that expected net operating income (revenues minus expenses) will be enough to not only pay for the expected annual debt service, but also generate a minimum debt service coverage ratio of 1.25.

As previously mentioned, due to the conceptual nature of a master plan, implementation of most of these capital projects should occur only after further refinement of their costs. As a result, the RSA Project capital costs must be viewed as preliminary, reflecting a master plan level of detail subject to refinement in subsequent implementation steps.

6 Airport Layout Plan

6.1 Introduction

The Federal Aviation Administration (FAA) requires an Airport to maintain a current and approved Airport Layout Plan (ALP). The last approved Yeager Airport (CRW) ALP was dated 2017 and was a Pen & Ink Update to show the Runway 05 Engineered Materials Arresting System (EMAS) project. The EMAS was installed in July of 2019.

In 2018, CWVRAA embarked on an Airfield Master Plan with a focus on future opportunities. The Master Plan had two primary goals: (1) provide an RSA that fully complies with FAA requirements and (2) meet the short- and long-term runway length needs of the users of the Airport.

While the current Airfield Master Plan was underway, the FAA notified the Airport that the runway project needs to be completed in two phases. The first phase would focus on providing a standard RSA and meeting existing runway length needs, whereas the second phase would focus on meeting long-term needs. An RSA Study was completed in September of 2019 that identified the most appropriate way to meet the short-term needs. This Phase 1 project shifts Runway 05-23 to the east by 1,125 feet, extends Runway 05-23 to the east by 1,300 feet, and provides a full-dimension RSA on both runway ends. A Pen & Ink Update was completed and submitted to the FAA in October 2019 to show this Phase 1 development.

Since the last two ALP updates were submitted to the FAA, the Airport has continued working on the Airfield Master Plan Update and associated ALP, which shows the ultimate recommended plan for CRW. This Phase 2 plan includes an 8,000-foot runway and a relocated Taxiway A. This chapter documents the background and rationale for the changes and modifications depicted on the ALP. The provided in this chapter includes the following:

- What is an ALP?
- Overview of Major Projects and Development
- ALP Sheet Information
- ALP Checklist
- ALP Sheets

6.2 What is an ALP?

The ALP highlights both existing facilities and proposed development at the Airport and is often prepared or updated in conjunction with a Master Plan. The FAA requires the approval of two documents for an airport, the forecast and the ALP. In order to encompass all development goals of the Airport, the team working on the ALP update must follow the requirements listed in Appendix F, *Airport Layout Plan,* of Advisory Circular (AC) 150/5070-6B, *Airport Master Plans,* and work closely with the airport sponsor, FAA, and any other government agencies.

FAA AC 150/5070-6B, *Airport Master Plans,* and FAA Order 5100.38, *Airport Improvement Program Handbook,* provides background and additional insight into ALPs. Additionally, U.S. Code (USC) 47107(a) requires, in part, a current ALP approved by the airport sponsor and FAA prior to the approval of an airport development project. United States Code 47107(a)(16) requires that the airport sponsor maintain an ALP that ensures the safety, utility and efficiency of the airport. Grant Assurance 29 requires that the sponsor keep the ALP up to date at all times. As stated in Order 5100.38, *Airport Improvement Program Handbook,* an ALP remains current for a five-year period or longer unless major changes at the airport are made or planned. The primary objectives of the ALP are:

- **Financial Assistance:** In order for an airport to obtain financial assistance according to the terms outlined in the Airport and Airway Improvement Act of 1982 (AIP), and to be in a position to accept certain Passenger Facility Charge (PFC) funding, an approved ALP is required. It is essential that the sponsor ensure the ALP is current and up to date to ensure federal assistance with proposed development.
- **Blueprint for Future Airport Development:** An ALP illustrates the proposed airport developments and aids the sponsor by providing recommendations that are in accordance with FAA airport design standards and safety requirements, as well as maintaining the goals of the airport and community in regard to land use and future development.
- **Record of Aeronautical Requirements:** The ALP is considered a public document and as such may be used to illustrate existing and future development as well as a reference document for other planning issues.
- **Planning:** An approved ALP provides opportunities to plan for proposed improvements relative to budget priorities and safeguard airspace needed for anticipated improvements.
- **Working Tool:** The ALP serves as a mechanism that can be utilized by airport staff.

6.3 ALP Update

The ALP Update was initiated in October 2019 in conjunction with the CRW Airfield Master Plan. The Airfield Master Plan process concluded with a recommended runway extension alternative which will provide the Airport with standard RSAs and 8,000 feet of usable runway length. In addition to the 2,578-foot runway extension, Taxiway A was shifted to provide 400 feet of separation to the runway centerline.

6.4 ALP Sheets

Each sheet included in an ALP is tailored to identify the needs of the airport. As FAA AC 150/5070-6B, Airport Master Plans, Section 1002.a. indicates, "the ALP preparer, airport sponsor, FAA, and any other approving agency must determine which sheets are necessary during the project scoping activities." Appendix F of AC 150/5070-6B, Airport Master Plans, includes a detailed list of required items to be included in an ALP set. The AC also indicates that certain agencies may have their own criteria that should also be included depending on the airport location. **Table 6-1, *2019 CRW ALP Set***, on the following page lists the sheets for the 2019 CRW Airport Layout Plan. Each sheet is set up to be printed on 24-inch by 36-inch paper.

TABLE 6-1 2019 CRW ALP SET

SHEET NUMBER	TITLE / DESCRIPTION
1	Title Sheet
2	Future Airport Layout Plan
3	Airport Data Sheet
4	Future Part 77 Airspace Plan
5	Inner Portion of the Approach Surface – Runway 05
6	Inner Portion of the Approach Surface – Runway 23
7	Outer Portion of the Approach Surface – Runway 05
8	Outer Portion of the Approach Surface – Runway 23
9	40:1 Departure Surface – Runway 05
10	40:1 Departure Surface – Runway 23
11	Future On-Airport Land Use

6.1.1 Sheet 1: Title Sheet

This sheet is the ALP set cover sheet and provides basic information that includes the official airport name, airport owner, associated City and State, and the party responsible for preparing the ALP set. An index of drawings, graphic representation of the airport location and the airport vicinity are also presented on the cover sheet. According to FAA AC 150/5070-6B, *Airport Master Plans,* Section 1002.b(1), "approval signature blocks ... and other pertinent information as required by the local FAA Airports office "are identified as components of the title sheet."

6.1.2 Sheet 2: Future Airport Layout Plan

The ALP is a graphical representation of the proposed airport facilities in plan view. The ALP provides clearance and dimensional information required to show conformance with applicable FAA design standards. Major functional areas of the airport are established on the drawing and the future airfield configuration. This sheet provides the ultimate development plan for CRW.

6.1.3 Sheet 2a: Future Airport Layout Plan - Interim

This future ALP sheet shows the Phase 1 program in plan view.

6.1.4 Sheet 3: Airport Data Sheet

The scale and size of the ALP sheet limits the amount of information that may be presented. The data sheet provides additional space for information typically presented in tabular form on the ALP sheet. Tables and graphics on the data sheet include wind data, the airport data table, the runway data table, and other appropriate information. Information specific to the airport such as airport elevation (highest point of the usable landing area), airport reference point coordinates, runway identification, airfield lighting and marking, runway instrumentation, pavement surface type, and electronic navigational aids are listed in the tables.

6.1.5 Sheet 4: Future Part 77 Airspace Plan

The Future Part 77 Airspace Plan drawing is a graphic representation of the imaginary surfaces described within 14 CFR Part 77, *Objects Affecting Navigable Airspace*, and is also a required drawing for the ALP set. The imaginary surfaces are established in relation to the airport elevation, runway end points and elevations. These surfaces define those areas where the heights of objects should be regulated for maintaining the safe operation of aircraft. The size of each imaginary surface is based on the runway category and the planned approach.

6.1.6 Sheets 5 & 6: Inner Portion of the Approach Surface

The Inner Portion of the Approach Surface drawings depict the plan and profile views of the approach to all existing and future runway ends. The horizontal and vertical scales for the plan and profile views are shown as per FAA guidelines. All known obstructions to navigable airspace within these extents are typically identified through the use of the National Oceanic and Atmospheric Administration (NOAA) Obstruction Chart and any aerial mapping. CRW had LiDAR mapping done in 2017, which is what was used for the obstruction analysis. FAA AC 150/5070-6B, *Airport Master Plans*, also indicates that "the drawing may also depict other approach surfaces, including the threshold-siting surface, or those required by the local FAA office or state agency." Typically, Inner Portion of the Approach Surface drawings show the first 5,000 feet of the approach surface and a small portion of the runway end. These sheets typically show any public roads, railroads, and highways within the approach surface.

6.1.7 Sheets 7 & 8: Outer Portion of the Approach Surface

Similar to the Inner Portion of the Approach Surface sheets, the Outer Portion sheets show the plan and profile view of any obstructions located within the outer portion of the approach surface. This sheet extends 40,000 feet from the beginning of the outer approach surface to the end of the surface. These sheets typically show any public roads, railroads, and highways within the approach surface.

6.1.8 Sheets 9 & 10: 40:1 Departure Surface

The Departure Surface Sheets depict the 40:1 Threshold Siting Surface (TSS) Departure Surface in both plan and profile view. These sheets show the obstructions to the 40:1 surface, as well as any roads, railroads, and highways that fall within this boundary.

6.1.9 Sheet 11: Future On-Airport Land Use

FAA AC 150/5070-6B, *Airport Master Plans,* describes this sheet as "a drawing depicting the land uses within the airport property boundary." This sheet typically shows the different land use categories within the airport property line, such as cargo, general aviation, airfield, etc. Public facilities located around the airport may also be depicted on this sheet.

6.5 Obstructions

Obstructions to the approach and departure surfaces are identified on Sheets 4 through 10. Due to the high volume of similar-type obstructions in certain areas, obstruction "clusters" were created to simplify the airspace drawings. For the most part, the obstruction data tables are not provided on the airspace sheets, but instead are included in the plans package in both PDF and Excel table format. For sheets with only a handful of obstructions, the obstruction data tables are included on the sheet.

There are five major areas of obstructions to the Part 77 surfaces as shown on **Exhibit 6-1, *Obstruction Clusters***, and described below.

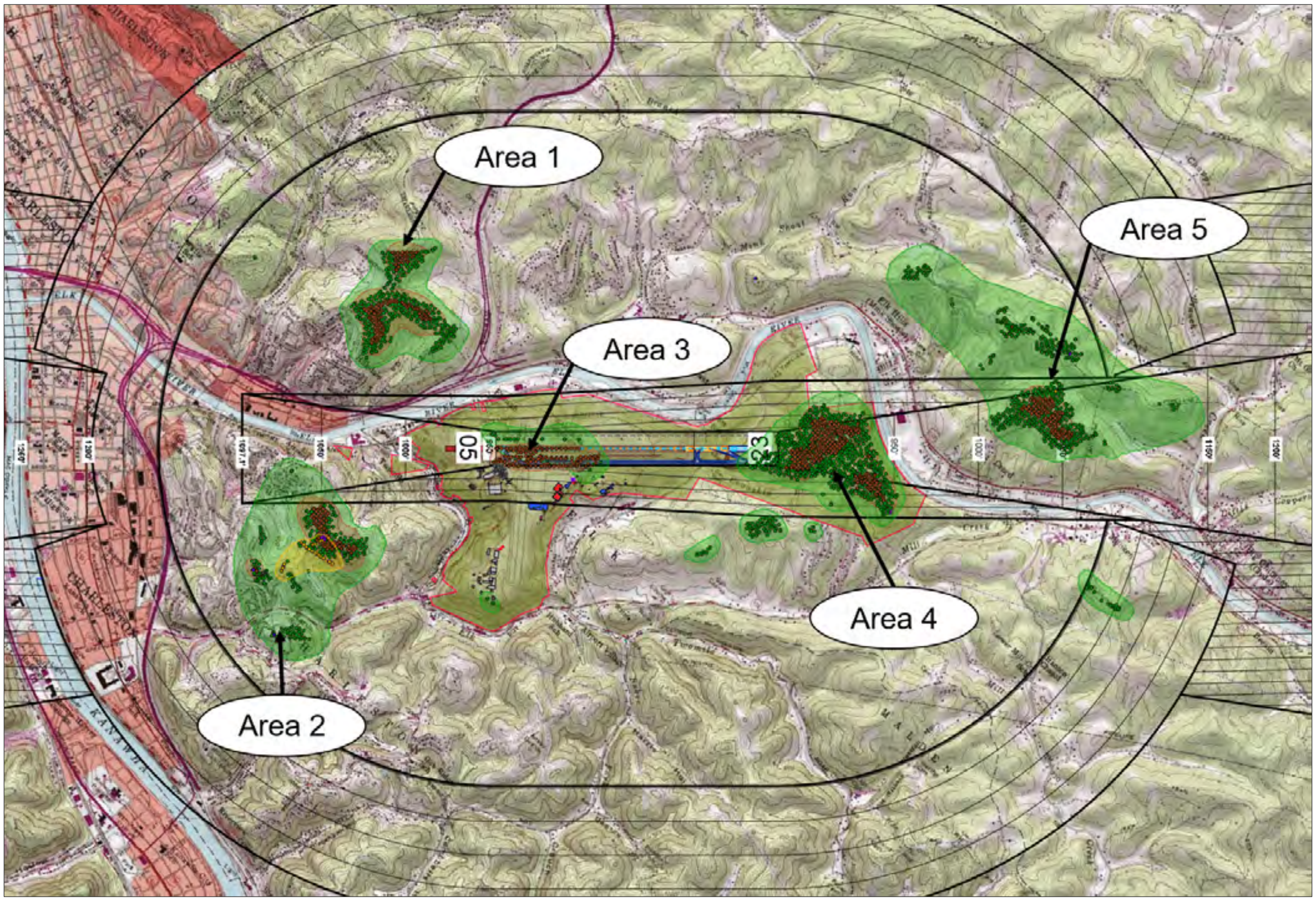
- **Areas 1 and 2:** The obstructions in these areas are mostly penetrations to the horizontal surface. The vast majority are likely obstructions currently, with the exception of those that fall within the Runway 05 inner approach surface.
- **Area 3:** The obstructions in Area 3 are penetrations to the primary surface. Most of these obstructions are terrain and trees and could be obstructions today.[1] Some could be occurring because the Airport elevation decreased by half a foot.[2] Parts of the apron and terminal building are obstructions to the primary surface. The terminal is an obstruction today and is currently lighted.
- **Area 4:** The majority of obstructions are in Area 4. These obstructions are penetrations to the Runway 23 inner approach and consist of terrain and vegetation, in addition to one tower/ antenna. Most of the obstructions are in the proposed borrow area and will therefore be removed as part of the project. The proposed fil land borrow areas are shown on **Exhibit 6-2, *Fill and Borrow Areas***.
- **Area 5:** This area includes obstructions to the horizontal surface and the Runway 23 inner approach surface; most are in the inner approach surface. These obstructions are located off Airport property.

In addition to the Part 77 obstructions, the airspace analysis for the TSS departure surface revealed that three gates in the terminal area are obstructions to the new departure surface. One of these gates was already determined to be an issue because it falls within the Runway 05 RPZ. The other two gates were discovered to be penetrations to the departure surface upon conclusion of the airspace analysis.

Yeager Airport officials will need to work with FAA to determine which obstructions should be mitigated, and when, as funds become available.

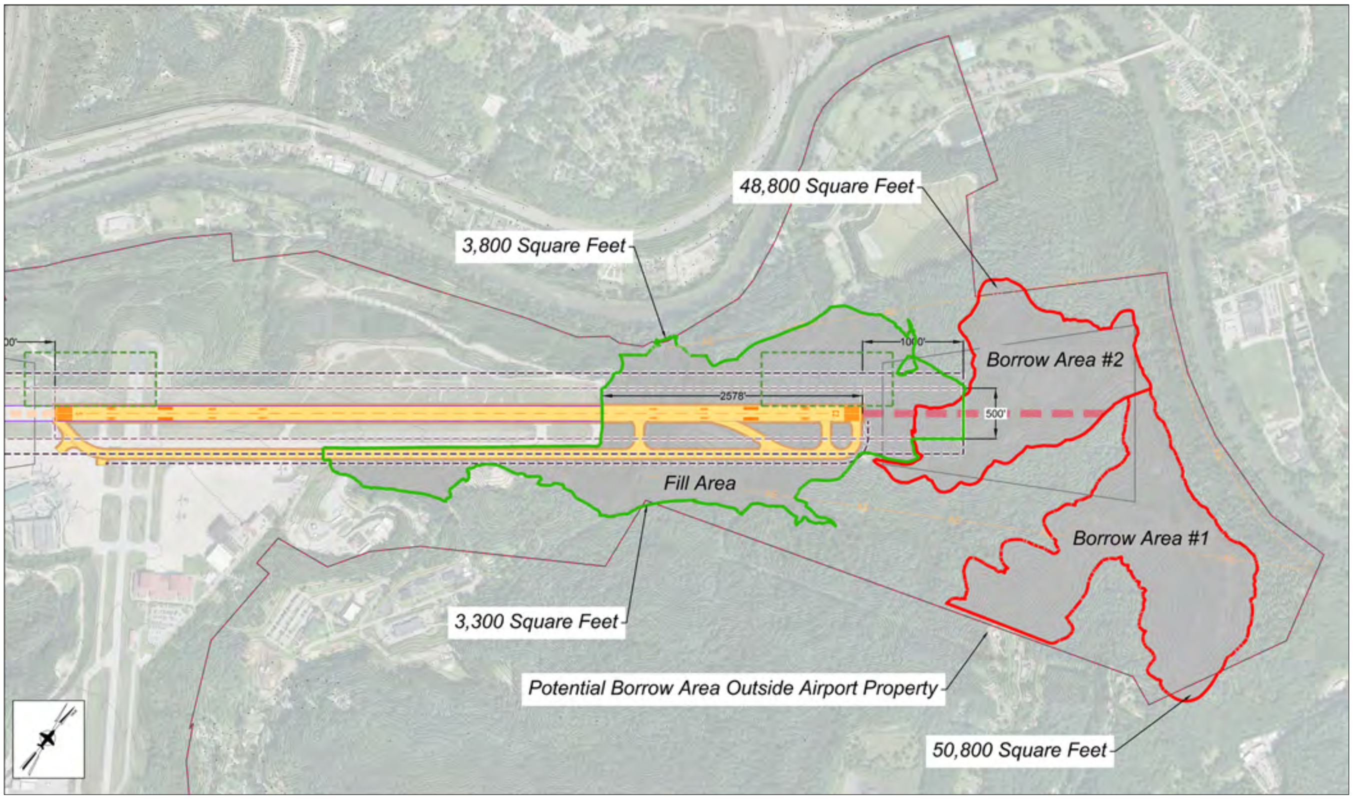
1 Obstruction analysis for current runway ends was not completed as part of the Airfield Master Plan.
2 The airport elevation is determined by the highest point on the usable runway. For the future ALP, the Runway 05 end shifts to the east, resulting in a lower airport elevation.

EXHIBIT 6-1 OBSTRUCTION CLUSTERS



Source: Landrum & Brown analysis.

EXHIBIT 6-2 FILL AND BORROW AREAS



Source: Schnabel Engineering and Landrum & Brown analysis.

6.6 ALP Checklist

The ALP submittal will also include a completed checklist. The FAA developed the ARP SOP 2.00, *Standard Procedure for FAA Review of Airport Layout Plans (ALPs),* in order to provide an instructive review checklist for all ALP submittals. Consultants and/or sponsors should indicate "Yes," "No" or "N/A" (not applicable) for every item on the checklist. For this submittal, any item which was marked "No" contains an explanation in the "Remarks" section of each sheet's checklist.

6.7 ALP Sheets

Sheets 1 through 11 are provided on the pages that follow on **Exhibits 6-3 through 6-14**.

EXHIBIT 6-3 ALP SHEET 1- TITLE SHEET

AIRPORT LAYOUT PLAN
AIRFIELD MASTER PLAN
YEAGER AIRPORT
CHARLESTON, WEST VIRGINIA
February 2020

COUNTY MAP
West Virginia County Outline Map

U.S. Department of Transportation
Federal Aviation Administration

Beckley Airports Field Office
176 Airport Circle, Rm 101
Beaver, WV 25813

July 1, 2020

Mr. Nick Keller
Airport Director
100 Airport Road
Suite 175
Charleston, WV 25311

RE: Conditional Airport Layout Plan Approval
Yeager Airport, Charleston, WV

Dear Mr. Keller:

The Airport Layout Plan (ALP) for Yeager Airport, dated June 17, is hereby approved.

The contents of the ALP do not necessarily reflect the official views or policies of the FAA. Approval of the ALP by the FAA does not in any way constitute a commitment on the part of the United States to participate in any development depicted therein.

The approval indicated by my signature is given subject to the following conditions:

1. FAA's approval of this ALP represents acceptance of the general location of future facilities depicted. During the preliminary design phase, the airport sponsor is required to resubmit for approval final locations, heights and exterior finish of structures. FAA's concerns are obstructions, impact on electronic aids, or adverse effect on controller view of aircraft approaches and ground movement areas, which could adversely affect the safety, efficiency, or utility of the airport. When airport construction, alteration, or deactivation is undertaken, such action requires FAA notification and review in accordance with the provisions of Part 77 and Part 157 of the Federal Aviation Regulations.
2. All proposed airport development identified on the ALP requires environmental processing and shall not be undertaken with or without Federal funds prior to written environmental approval by the FAA.
3. The sponsor has a continuing responsibility to keep the ALP current at all times. All revisions must be submitted to this office for prior approval. The sponsor must also maintain an up-to-date Exhibit "A" Property Map for the airport at all times.
4. The approval of this ALP does not in any way constitute an approval of a release, modification, reformation or amendment to the Airport Property.

2

5. The sponsor is responsible for insuring compatible use of land adjacent to or in the vicinity of the airport and agrees to maintain positive control over existing and future runway protections zones.
6. Airport development not depicted on the approved ALP should not be initiated until a revision to the drawing is approved by the FAA. This office should be contacted to discuss the appropriate process for revising the ALP.

Forwarded with this letter are two copies of the approved ALP for your files.
If you have any questions or require additional information, please contact me at (304)252-6216.

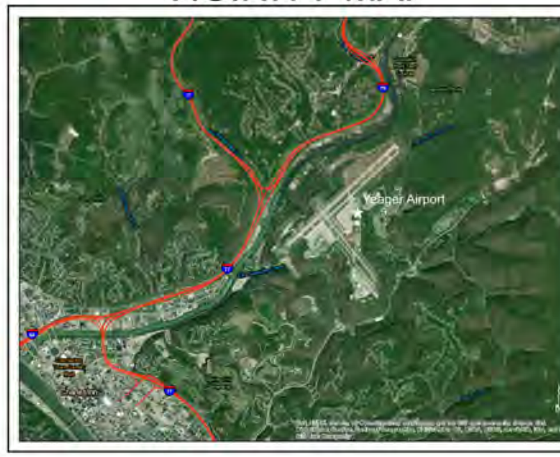
Sincerely,

MATTHEW DIGIULIAN Digitally signed by MATTHEW DIGIULIAN Date: 2020.07.08 10:12:35 -04'00'

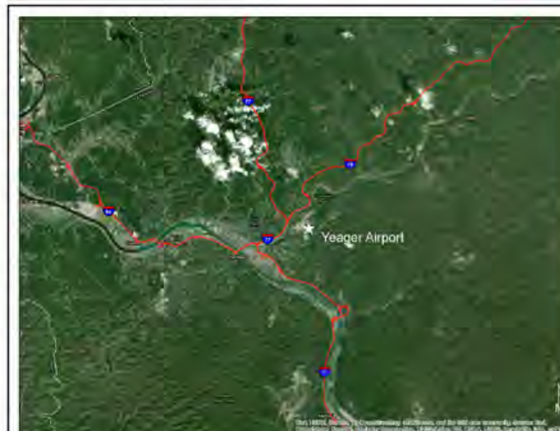
Matthew Di Giulian
Manager

Enclosures

VICINITY MAP



LOCATION MAP



INDEX OF SHEETS

SHEET	SHEET TITLE	REVISION DATE
1	TITLE SHEET	February 2020
2	FUTURE AIRPORT LAYOUT PLAN	February 2020
2a	FUTURE AIRPORT LAYOUT PLAN - INTERIM	February 2020
3	AIRPORT DATA SHEET	February 2020
4	FUTURE PART 77 AIRSPACE PLAN	February 2020
5	INNER PORTION OF THE APPROACH SURFACE - RUNWAY 05	February 2020
6	INNER PORTION OF THE APPROACH SURFACE - RUNWAY 23	February 2020
7	OUTER PORTION OF THE APPROACH SURFACE - RUNWAY 05	February 2020
8	OUTER PORTION OF THE APPROACH SURFACE - RUNWAY 23	February 2020
9	40:1 DEPARTURE SURFACE - RUNWAY 05	February 2020
10	40:1 DEPARTURE SURFACE - RUNWAY 23	February 2020
11	FUTURE ON-AIRPORT LAND USE	February 2020

REV. NO.	ITEM	DATE	SPONSOR APPROVAL	FAA APPROVAL
1	Interim Runway Safety Area Study, Final - February 2018	08/11/17	08/11/17	08/23/17
2	Runway Safety Area Study, Draft - March 2019			
3	Airfield Master Plan, Draft - February 2020			

YEAGER AIRPORT

YEAGER AIRPORT			
CHARLESTON		WEST VIRGINIA	
Title Sheet			
AIP NO: 3-54-0003-058-2017	DATE: February 2020	DRAWING NO. 1	
L&B PROJECT NO: X086.950	DRAWN BY: ARB		
CAD FILE:	CHECKED BY: MLG		

Source: Landrum & Brown analysis.

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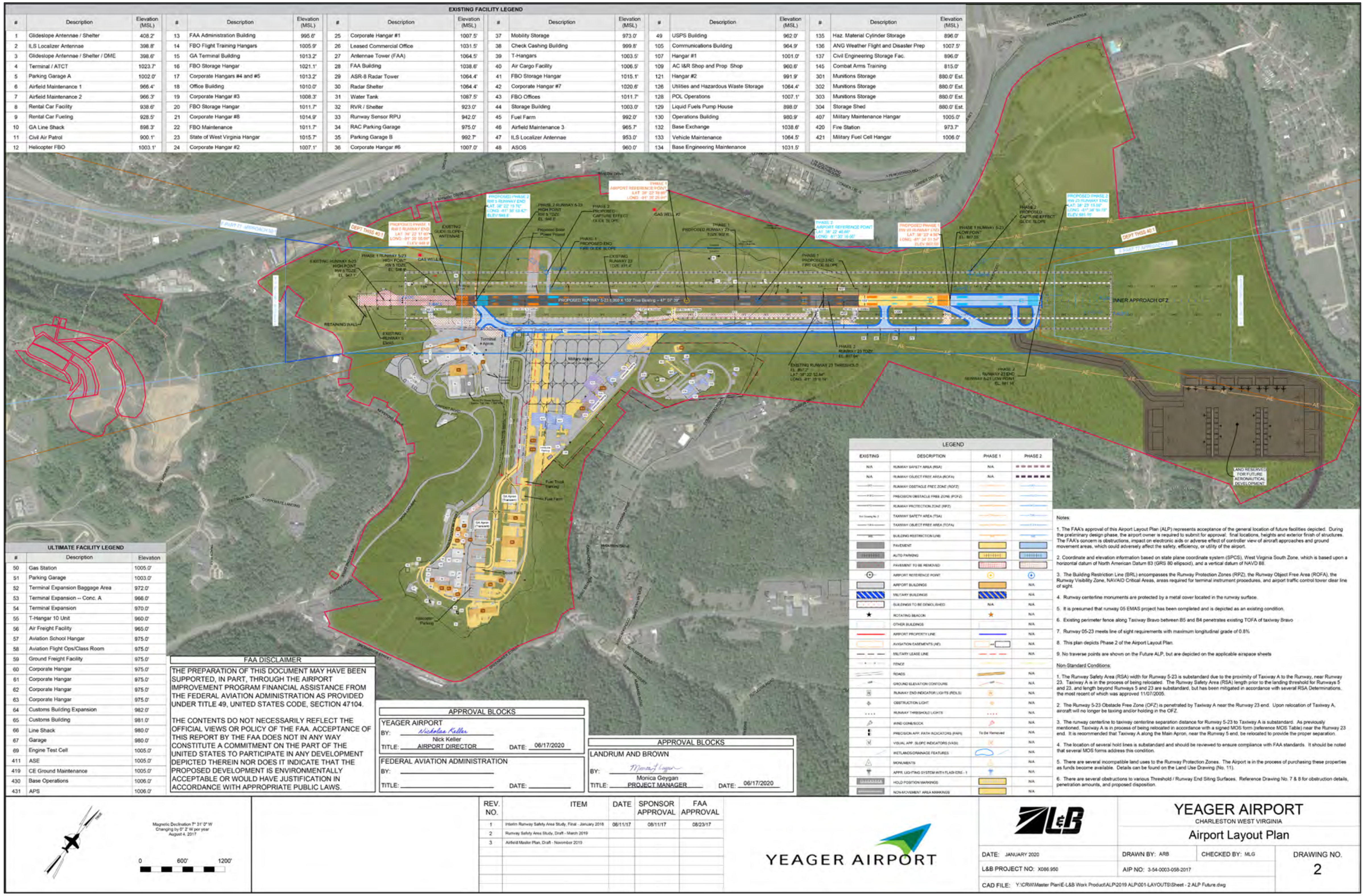
EXHIBIT 6-4 ALP SHEET 2 – FUTURE AIRPORT LAYOUT PLAN – ULTIMATE



EXISTING FACILITY LEGEND

#	Description	Elevation (MSL)
1	Glideslope Antennae / Shelter	408.2'
2	ILS Localizer Antennae	398.8'
3	Glideslope Antennae / Shelter / DME	398.6'
4	Terminal / ATCT	1023.7'
5	Parking Garage A	1002.0'
6	Airfield Maintenance 1	966.4'
7	Airfield Maintenance 2	966.3'
8	Rental Car Facility	938.6'
9	Rental Car Fueling	928.5'
10	GA Line Shack	898.3'
11	Civil Air Patrol	900.1'
12	Helicopter FBO	1003.1'
13	FAA Administration Building	995.6'
14	FBO Flight Training Hangars	1005.9'
15	GA Terminal Building	1013.2'
16	FBO Storage Hangar	1021.1'
17	Corporate Hangars #4 and #5	1013.2'
18	Office Building	1010.0'
19	Corporate Hangar #3	1008.3'
20	FBO Storage Hangar	1011.7'
21	Corporate Hangar #8	1014.9'
22	FBO Maintenance	1011.7'
23	State of West Virginia Hangar	1015.7'
24	Corporate Hangar #2	1007.1'
25	Corporate Hangar #1	1007.5'
26	Leased Commercial Office	1031.5'
27	Antennae Tower (FAA)	1064.5'
28	FAA Building	1038.6'
29	ASR-8 Radar Tower	1064.4'
30	Radar Shelter	1064.4'
31	Water Tank	1087.5'
32	RVR / Shelter	923.0'
33	Runway Sensor RPU	942.0'
34	RAC Parking Garage	975.0'
35	Parking Garage B	992.7'
36	Corporate Hangar #6	1007.0'
37	Mobility Storage	973.0'
38	Check Cashing Building	999.8'
39	T-Hangars	1003.5'
40	Air Cargo Facility	1006.5'
41	FBO Storage Hangar	1015.1'
42	Corporate Hangar #7	1020.6'
43	FBO Offices	1011.7'
44	Storage Building	1003.0'
45	Fuel Farm	992.0'
46	Airfield Maintenance 3	965.7'
47	ILS Localizer Antennae	953.0'
48	ASOS	960.0'
49	USPS Building	962.0'
105	Communications Building	964.9'
107	Hangar #1	1001.0'
109	AC I&R Shop and Prop Shop	960.6'
121	Hangar #2	991.9'
126	Utilities and Hazardous Waste Storage	1064.4'
128	POL Operations	1007.1'
129	Liquid Fuels Pump House	898.0'
130	Operations Building	980.9'
132	Base Exchange	1038.6'
133	Vehicle Maintenance	1064.5'
134	Base Engineering Maintenance	1031.5'
135	Haz. Material Cylinder Storage	896.0'
136	ANG Weather Flight and Disaster Prep	1007.5'
137	Civil Engineering Storage Fac.	896.0'
145	Combat Arms Training	815.0'
301	Munitions Storage	880.0' Est.
302	Munitions Storage	880.0' Est.
303	Munitions Storage	880.0' Est.
304	Storage Shed	880.0' Est.
407	Military Maintenance Hangar	1005.0'
420	Fire Station	973.7'
421	Military Fuel Cell Hangar	1006.0'

ULTIMATE FACILITY LEGEND

#	Description	Elevation
50	Gas Station	1005.0'
51	Parking Garage	1003.0'
52	Terminal Expansion Baggage Area	972.0'
53	Terminal Expansion -- Conc. A	966.0'
54	Terminal Expansion	970.0'
55	T-Hangar 10 Unit	960.0'
56	Air Freight Facility	965.0'
57	Aviation School Hangar	975.0'
58	Aviation Flight Ops/Class Room	975.0'
59	Ground Freight Facility	975.0'
60	Corporate Hangar	975.0'
61	Corporate Hangar	975.0'
62	Corporate Hangar	975.0'
63	Corporate Hangar	975.0'
64	Customs Building Expansion	982.0'
65	Customs Building	981.0'
66	Line Shack	980.0'
67	Garage	980.0'
69	Engine Test Cell	1005.0'
411	ASE	1005.0'
419	CE Ground Maintenance	1005.0'
430	Base Operations	1006.0'
431	APS	1006.0'

Source: Landrum & Brown analysis.

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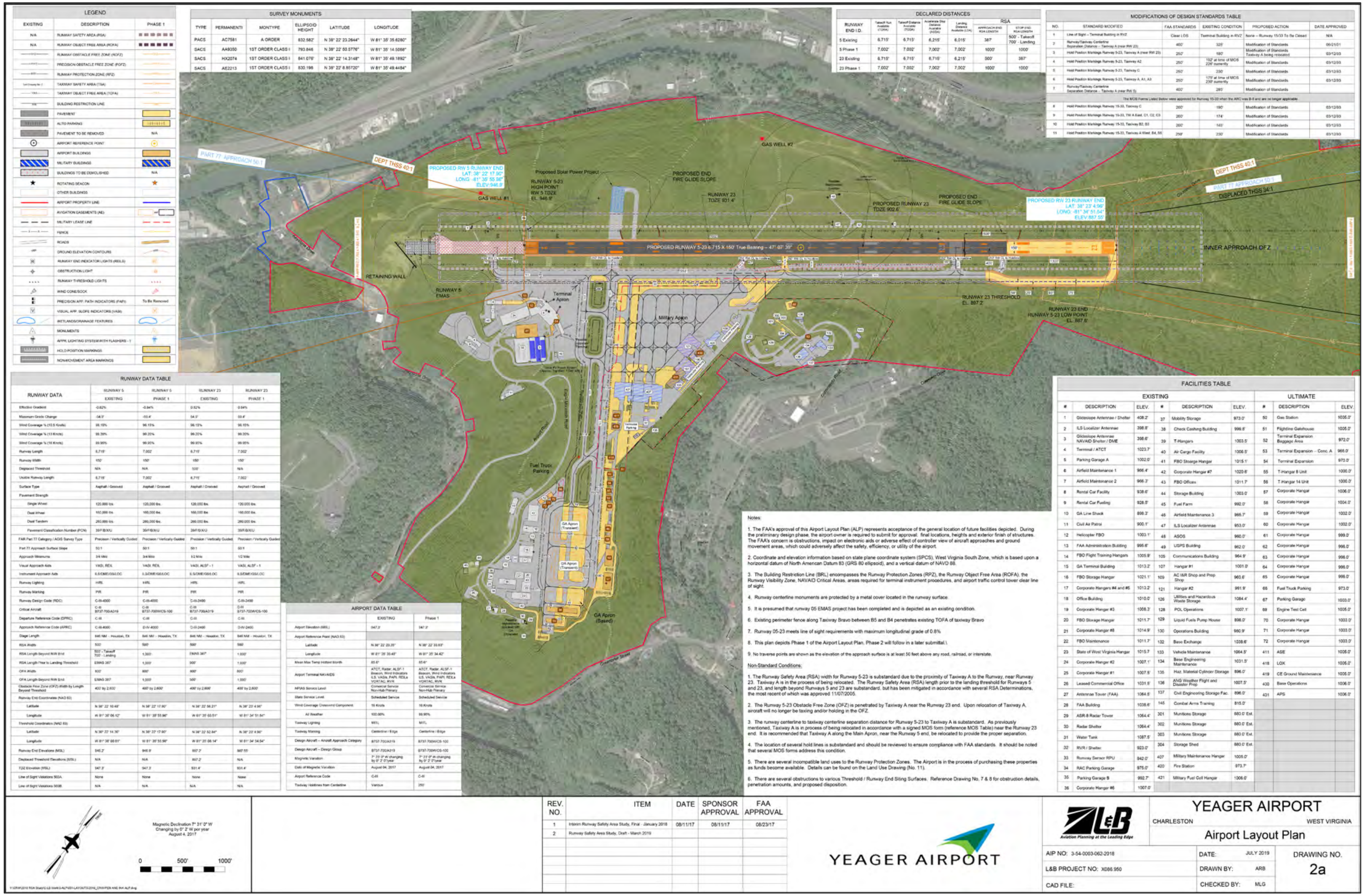
YEAGER AIRPORT

EXHIBIT 6-5 ALP SHEET 2a – FUTURE AIRPORT LAYOUT PLAN – INTERIM



Source: Landrum & Brown analysis.

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YEAGER AIRPORT

EXHIBIT 6-6 ALP SHEET 3 – AIRPORT DATA SHEET

RUNWAY AND APPROACH DATA

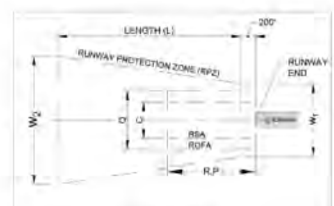
Runway Data	Runway 5 Existing	Runway 5 Phase 1	Runway 5 Phase 2	Runway 23 Existing	Runway 23 Phase 1	Runway 23 Phase 2
Effective Gradient	-0.82%	-0.84%	-0.82%	0.82%	0.84%	0.82%
Maximum Grade Change	-54.9'	-58.4'	-65.5'	54.9'	59.4'	65.5'
Wind Coverage % (10.5 Knots)	71.84%	71.84%	71.84%	89.27%	89.27%	89.27%
Wind Coverage % (13 Knots)	72.60%	72.60%	72.60%	90.72%	90.72%	90.72%
Wind Coverage % (16 Knots)	72.82%	72.82%	72.82%	91.14%	91.14%	91.14%
Wind Coverage % (20 Knots)	72.89%	72.89%	72.89%	91.27%	91.27%	91.27%
Runway Length	6,715'	7,002'	8,000'	6,715'	7,002'	8,000'
Runway Width	150'	150'	150'	150'	150'	150'
Displaced Threshold	N/A	N/A	N/A	500'	N/A	N/A
Usable Runway Length	6,715'	7,002'	8,000'	6,715'	7,002'	8,000'
Surface Type	Asphalt / Grooved	Asphalt / Grooved	Asphalt / Grooved	Asphalt / Grooved	Asphalt / Grooved	Asphalt / Grooved
Pavement Strength						
Single Wheel	120,000 lbs.	120,000 lbs.	120,000 lbs.	120,000 lbs.	120,000 lbs.	120,000 lbs.
Dual Wheel	160,000 lbs.	160,000 lbs.	160,000 lbs.	160,000 lbs.	160,000 lbs.	160,000 lbs.
Dual Tandem	260,000 lbs.	260,000 lbs.	260,000 lbs.	260,000 lbs.	260,000 lbs.	260,000 lbs.
Pavement Classification Number (PCN)	39/F/B/X/U	39/F/B/X/U	39/F/B/X/U	39/F/B/X/U	39/F/B/X/U	39/F/B/X/U
FAR Part 77 Category / AOIS Survey Type	Precision / Vertically Guided	Precision / Vertically Guided	Precision / Vertically Guided	Precision / Vertically Guided	Precision / Vertically Guided	Precision / Vertically Guided
Part 77 Approach Surface Slope	50:1	50:1	50:1	50:1	50:1	50:1
Approach Minimums	3/4 Mile	3/4 Mile	1/2 Mile	3/4 Mile	1/2 Mile	1/2 Mile
Visual Approach Aids	PAPI, REIL	PAPI, REIL	PAPI, MALS	VASI, ALSF - 1	PAPI, ALSF - 1	PAPI, ALSF - 2
Instrument Approach Aids	ILS/DME/GS/LOC	ILS/DME/GS/LOC	ILS/DME/GS/LOC	ILS/DME/GS/LOC	ILS/DME/GS/LOC	ILS/DME/GS/LOC
Runway Lighting	HIRL	HIRL	HIRL	HIRL	HIRL	HIRL
Runway Marking	PIR	PIR	PIR	PIR	PIR	PIR
Runway Design Code (RDC)	C-III-4000	C-III-4000	C-III-2400	C-III-4000	C-III-2400	C-III-2400
Critical Aircraft	C-III B737-700/A319	C-III B737-700W/CS-100	C-III B737-700W/CS-100	C-III B737-700/A319	C-III B737-700W/CS-100	C-III B737-700W/CS-100
Threshold Siting Surface	20:1	20:1	34:1	34:1	34:1	34:1
Departure Surface	40:1	40:1	40:1	40:1	40:1	40:1
Departure Reference Code (DPRC)	C-III	C-III	C-III	C-III	C-III	C-III
Approach Reference Code (APRC)	C-III-4000	C-III-4000	C-III-2400	C-III-4000	C-III-2400	C-III-2400
Stage Length	846 NM – Houston, TX	846 NM – Houston, TX	846 NM – Houston, TX	846 NM – Houston, TX	846 NM – Houston, TX	846 NM – Houston, TX
C - RSA Width	500'	500'	500'	500'	500'	500'
L - Length of RPZ	1,700'	1,700'	2,500'	2,500'	2,500'	2,500'
P - OFA Length Beyond R/W End	EMAS 387'	1,000'	1,000'	500'	1,000'	1,000'
R - RSA Length Beyond R/W End	500' - Takeoff 700' - Landing	1,000'	1,000'	EMAS 387'	1,000'	1,000'
W_1 - Inner Width of RPZ	1,000'	1,000'	1,000'	1,000'	1,000'	1,000'
W_2 - Outer Width of RPZ	1,510'	1,510'	1,750'	1,750'	1,750'	1,750'
RSA Length Prior to Landing Threshold	EMAS 387'	1,000'	1,000'	500'	1,000'	1,000'
OFA Width	800'	800'	800'	800'	800'	800'
Obstacle Free Zone (OFZ) Width by Length Beyond Threshold	400' by 2,600'	400' by 2,600'	400' by 2,600'	400' by 2,600'	400' by 2,600'	400' by 2,600'
Runway End Coordinates (NAD 83)						
Latitude	N 38° 22' 10.48"	N 38° 22' 17.90"	N 38° 22' 18.78"	N 38° 22' 56.21"	N 38° 23' 4.96"	N 38° 23' 13.56"
Longitude	W 81° 36' 06.12"	W 81° 35' 55.98"	W 81° 35' 53.42"	W 81° 35' 03.51"	W 81° 34' 51.54"	W 81° 34' 39.78"
Threshold Coordinates (NAD 83)						
Latitude	N 38° 22' 14.36"	N 38° 22' 17.90"	N 38° 22' 19.76"	N 38° 22' 52.84"	N 38° 23' 4.96"	N 38° 23' 13.56"
Longitude	W 81° 36' 00.81"	W 81° 35' 55.98"	W 81° 35' 53.42"	W 81° 35' 08.14"	W 81° 34' 54.54"	W 81° 34' 39.78"
Runway End Elevations (MSL)	946.2'	946.9'	946.6'	897.2	887.55'	881.16'
Displaced Threshold Elevations (MSL)	N/A	N/A	N/A	897.2'	N/A	N/A
TDZ Elevation (MSL)	947.3'	946.9'	946.6'	931.4'	902.8'	897.04"
Line of Sight Violations 5/23A	None	None	None	None	None	None
Line of Sight Violations 5/23B	N/A	N/A	N/A	N/A	N/A	N/A

AIRPORT DATA TABLE

	Existing	Phase 1	Phase 2
Airport Elevation (MSL)	947.3'	946.9'	946.6'
Airport Reference Point (NAD 83)			
Latitude	N 38° 22' 23.35"	N 38° 22' 33.63"	N 38° 22' 46.66"
Longitude	W 81° 35' 35.48"	W 81° 35' 34.42"	W 81° 35' 16.60"
Mean Max Temp Hottest Month	85.6°	85.6°	85.6°
Airport Terminal NAVAIDS	ATCT, Radar, ALSF-1 Beacon, Wind Indicators ILS, VASIs, PAPI, REILs VORTAC, RVR, AWOS	ATCT, Radar, ALSF-1 Beacon, Wind Indicators ILS, VASIs, PAPI, REILs VORTAC, RVR, AWOS	ATCT, Radar, ALSF-2 Beacon, Wind Indicators ILS, PAPI, REILs VORTAC, RVR, MALS, AWOS
NPIAS Service Level	Comercial Service Non-Hub Primary	Comercial Service Non-Hub Primary	Comercial Service Non-Hub Primary
State Service Level	Scheduled Service	Scheduled Service	Scheduled Service
Wind Coverage Crosswind Component	16 Knots	16 Knots	16 Knots
All Weather	100.00%	99.95%	99.95%
Taxiway Lighting	MITL	MITL	MITL
Taxiway Marking	Centerline / Edge	Centerline / Edge	Centerline / Edge
Design Aircraft – Aircraft Approach Category	B737-700/A319	B737-700W/CS-100	B737-700W/CS-100
Design Aircraft – Design Group	B737-700/A319	B737-700W/CS-100	B737-700W/CS-100
Magnetic Variation	7° 23' 0" W changing by 0° 2' 0"/year	7° 23' 0" W changing by 0° 2' 0"/year	7° 47' W ± 0° 21' changing by 0° 1' W per year
Date of Magnetic Variation	August 04, 2017	August 04, 2017	October, 31, 2019
Airport Reference Code	C-III	C-III	C-III
Taxiway Holdlines from Centerline	Various	250'	250'

DECLARED DISTANCES

Runway End	Takeoff Run Available (TORA)	Takeoff Distance Available (TODA)	Accelerate Stop Distance Available (ASDA)	Landing Distance Available (LDA)	RSA: Approach End RSA Length	RSA: Stop End RSA Length
5 Existing	6,715'	6,715'	6,215'	6,215'	387'	500' - Takeoff 500' - Landing
5 Phase 1	7,002'	7,002'	7,002'	7,002'	1000'	1000'
5 Phase 2	8,000	8,000	8,000	8,000	1,000	1,000
23 Existing	6,715'	6,715'	6,715'	6,215'	500'	387'
23 Phase 1	7,002'	7,002'	7,002'	7,002'	1000'	1000'
23 Phase 2	8,000	8,000	8,000	8,000	1000'	1000'



RPZ KEY MAP
N.T.S.

MODIFICATION OF STANDARDS

#	Standard Modified	FAA Standards	Existing Condition	Proposed Action	Date Approved
1	Line of Sight – Terminal Building in RVZ	Clear LOS	Terminal Building in RVZ	None – Runway 15/33 To Be Closed	N/A
2	Runway/Taxiway Centerline Separation Distance -- Taxiway A (near RW 23)	400'	325'	Modification of Standards	06/21/01
3	Hold Position Markings Runway 5-23, Taxiway A (near RW 23)	250'	160'	Modification of Standards - Taxiway A being relocated.	03/12/93
4	Hold Position Markings Runway 5-23, Taxiway A2	250'	192' at time of MOS 228' currently	Modification of Standards	03/12/93
5	Hold Position Markings Runway 5-23, Taxiway C	250'	230'	Modification of Standards	03/12/93
6	Hold Position Markings Runway 5-23, Taxiway A, A1, A3	250'	175' at time of MOS 230' currently	Modification of Standards	03/12/93
7	Runway/Taxiway Centerline Separation Distance -- Taxiway A (near RW 5)	400'	285'	Modification of Standards	
8	Hold Position Markings Runway 15-33, Taxiway C	200'	190'	Modification of Standards	03/12/93
9	Hold Position Markings Runway 15-33, TW A East, C1, C2, C3	200'	174'	Modification of Standards	03/12/93
10	Hold Position Markings Runway 15-33, Taxiway B2, B3	200'	145'	Modification of Standards	03/12/93
11	Hold Position Markings Runway 15-33, Taxiway A West, B4, B5	250'	230'	Modification of Standards	03/12/93

SURVEY MONUMENTS

Type	Permanent	Monument Type	Ellipsoid Height	Latitude	Longitude
PACS	AC7581	A ORDER	832.582'	N 38° 22' 23.2844"	W 81° 35' 35.6280"
SACS	AA9350	1ST ORDER CLASS I	793.848	N 38° 22' 50.5776"	W 81° 35' 14.5068"
SACS	HX2074	1ST ORDER CLASS I	841.076'	N 38° 22' 14.3148"	W 81° 35' 49.1892"
SACS	AE2213	1ST ORDER CLASS I	830.108	N 38° 22' 8.85720"	W 81° 35' 49.4484"

TAXIWAY DATA

Taxiway/Taxilane Designation	Width	TSA	TOFA	Taxiway Lighting
A	75'	118'	186'	MITL
A1	100'	118'	186'	MITL
A2	50'	118'	186'	MITL
B	40'	118'	186'	MITL
B1	50'	118'	186'	MITL
B2	50'	118'	186'	MITL
B3	50'	118'	186'	MITL
B4	75'	118'	186'	MITL
B5	75'	118'	186'	MITL
B6	75'	118'	186'	MITL
C	75'	118'	186'	MITL
C2	75'	118'	186'	MITL
C3	75'	118'	186'	MITL
D	50'	118'	186'	MITL

ULTIMATE FACILITY LEGEND

#	Description	Elevation
50	Gas Station	1005.0'
51	Parking Garage	1003.0'
52	Terminal Expansion Baggage Area	972.0'
53	Terminal Expansion – Conc. A	966.0'
54	Terminal Expansion	970.0'
55	T-Hangar 10 Unit	960.0'
56	Air Freight Facility	965.0'
57	Aviation School Hangar	975.0'
58	Aviation Flight Ops/Class Room	975.0'
59	Ground Freight Facility	975.0'
60	Corporate Hangar	975.0'
61	Corporate Hangar	975.0'
62	Corporate Hangar	975.0'
63	Corporate Hangar	975.0'
64	Customs Building Expansion	982.0'
65	Customs Building	981.0'
66	Line Shack	980.0'
67	Garage	980.0'
68	Engine Test Cell	1005.0'
411	ASE	1006.0'
419	CE Ground Maintenance	1005.0'
430	Base Operations	1006.0'
431	APS	1006.0'

EXISTING FACILITY LEGEND

#	Description	Elevation	#	Description	Elevation
1	Glideslope Antennae / Shelter	408.2'	37	Mobility Storage	973.0'
2	ILS Localizer Antennae	398.8'	38	Check Cashing Building	999.8'
3	Glideslope Antennae NAVAID Shelter/DME	398.8'	39	T-Hangers	1003.5'
4	Terminal / ATCT	1023.7'	40	Air Cargo Facility	1006.5'
5	Parking Garage A	1002.0'	41	FBO Storage Hangar	1015.1'
6	Airfield Maintenance 1	966.4'	42	Corporate Hangar #7	1020.6'
7	Airfield Maintenance 2	966.3'	43	FBO Offices	1011.7'
8	Rental Car Facility	938.6'	44	Storage Building	1003.0'
9	Rental Car Fueling	928.5'	45	Fuel Farm	992.0'
10	GA Line Shack	898.3'	46	Airfield Maintenance 3	965.7'
11	Civil Air Patrol	900.1'	47	ILS Localizer Antennae	953.0'
12	Helicopter FBO	1003.1'	48	ASOS	960.0'
13	FAA Administration Building	995.6'	49	USPS Building	962.0'
14	FBO Flight Training Hangars	1005.9'	105	Communications Building	964.9'
15	GA Terminal Building	1013.2'	107	Hangar #1	1001.0'
16	FBO Storage Hangar	1021.1'	109	AC I&R Shop and Prop. Shop	960.8'
17	Corporate Hangars #4 and #5	1013.2'	121	Hangar #2	991.9'
18	Office Building	1010.0'	126	Utilities and Hazardous Waste Storage	1064.4'
19	Corporate Hangar #3	1008.3'	128	POL Operations	1007.1'
20	FBO Storage Hangar	1011.7'	129	Liquid Fuels Pump House	898.0'
21	Corporate Hangar #8	1014.9'	130	Operations Building	980.9'
22	FBO Maintenance	1011.7'	132	Base Exchange	1038.6'
23	State of West Virginia Hangar	1015.7'	133	Vehicle Maintenance	1064.5'
24	Corporate Hangar #2	1007.1'	134	Base Engineering Maintenance	1031.5'
25	Corporate Hangar #1	1007.5'	135	Haz. Material Cylinder Storage	896.0'
26	Leased Commercial Office	1031.5'	136	ANG Weather Flight and Disaster Prep	1007.5'
27	Antennae Tower (FAA)	1064.5'	137	Civil Engineering Storage Fac.	896.0'
28	FAA Building	1038.6'	145	Combat Arms Training	815.0'
29	ASR-8 Radar Tower	1064.4'	301	Munitions Storage	880.0' Est.
30	Radar Shelter	1064.4'	302	Munitions Storage	880.0' Est.
31	Water Tank	1087.5'	303	Munitions Storage	880.0' Est.
32	RVR / Shelter	923.0'	304	Storage Shed	880.0' Est.
33	Runway Sensor RPU	942.0'	407	Military Maintenance Hangar	1005.0'
34	RAC Parking Garage	976.0'	420	Fire Station	973.7'
35	Parking Garage B	992.7'	421	Military Fuel Cell Hangar	1006.0'
36	Corporate Hangar #6	1007.0'			

WIND ROSES

ALL WEATHER IMC VMC

NOTES:
1. ELEVATIONS SHOWN ARE BASED ON VERTICAL DATUM NAVD88
2. COORDINATES SHOWN ARE BASED ON HORIZONTAL DATUM NAD83
3. WEATHER DATA SOURCE: NATIONAL CLIMATIC DATA CENTER (NCDC) STATION WBAN 13866, DATA RECORDED AT YEAGER AIRPORT FOR THE PERIOD
4. RUNWAY DATA OBTAINED FROM THE FAA NATIONAL FLIGHT DATA CENTER WEBSITE
5. APPROACH VISIBILITY MINIMUMS OBTAINED FROM FAA DIGITAL - TERMINAL PROCEDURES PUBLICATION WEBSITE
6. FRZ, ROFA, AND RSA PROPERTIES ARE DEPICTED IN RPZ KEY MAP

Magnetic Declination 7° 31' 0" W
Changing by 0° 2' W per year
August 4, 2017

REV. NO.	ITEM	DATE	SPONSOR APPROVAL	FAA APPROVAL
1	Interim Runway Safety Area Study, Final - January 2018	08/11/17	08/11/17	08/23/17
2	Runway Safety Area Study, Draft - March 2019			
3	Airfield Master Plan, Draft - November 2019			

YEAGER AIRPORT

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YEAGER AIRPORT
CHARLESTON WEST VIRGINIA
Airport Data Sheet

DATE: JANUARY 2020 | DRAWN BY: ARS | CHECKED BY: MLG | DRAWING NO. 3
L&B PROJECT NO: X086.850 | AIP NO: 3-54-0003-058-2017
CAD FILE: Y:\CRW\Master Plan\E-L&B Work Product\ALP\2019 ALP\01-LAYOUTS\Sheet - 3 Data Sheet.dwg

Source: Landrum & Brown analysis.

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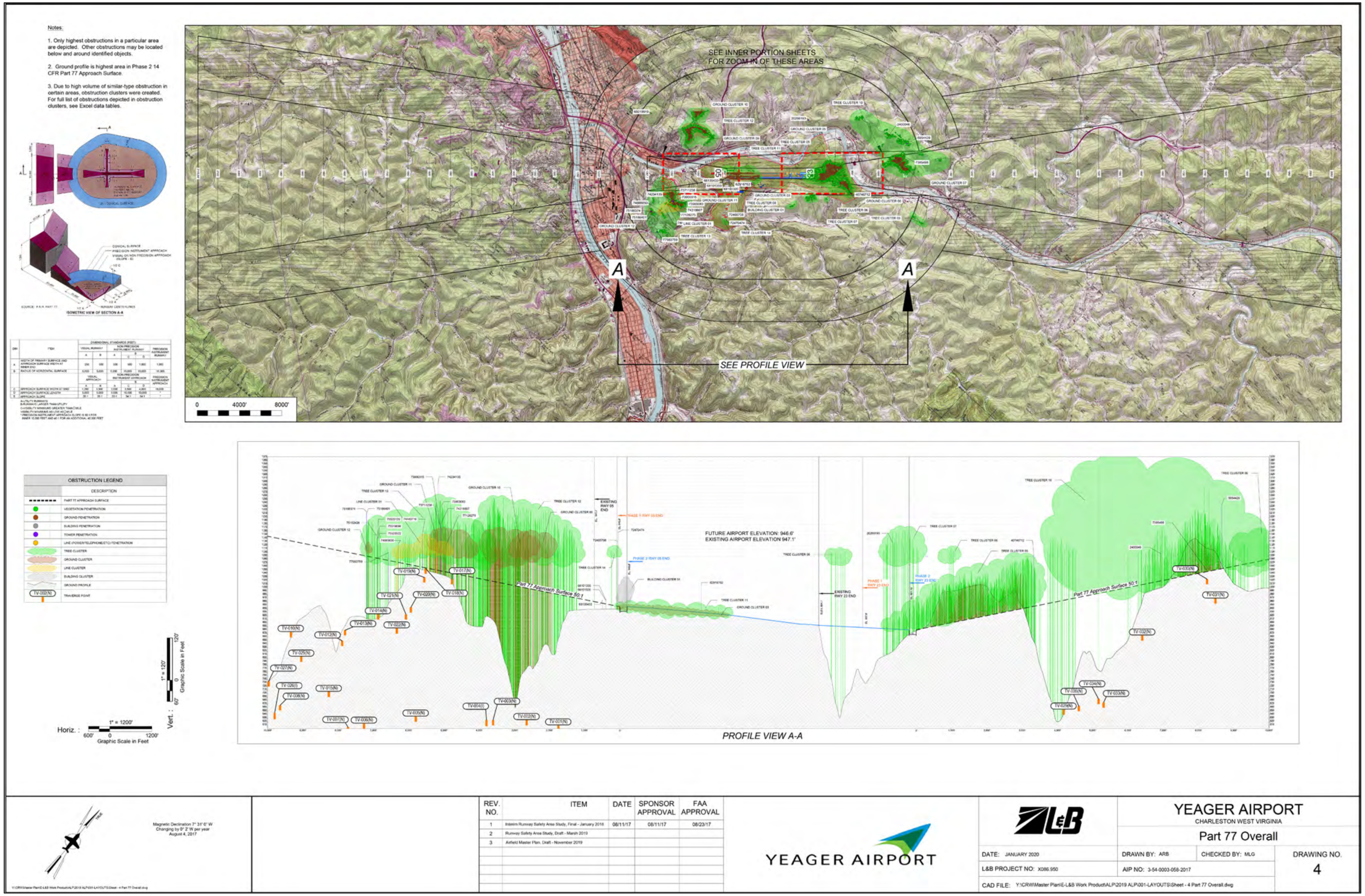
EXHIBIT 6-7 ALP SHEET 4 – FUTURE PART 77 AIRSPACE PLAN



Source: Landrum & Brown analysis.

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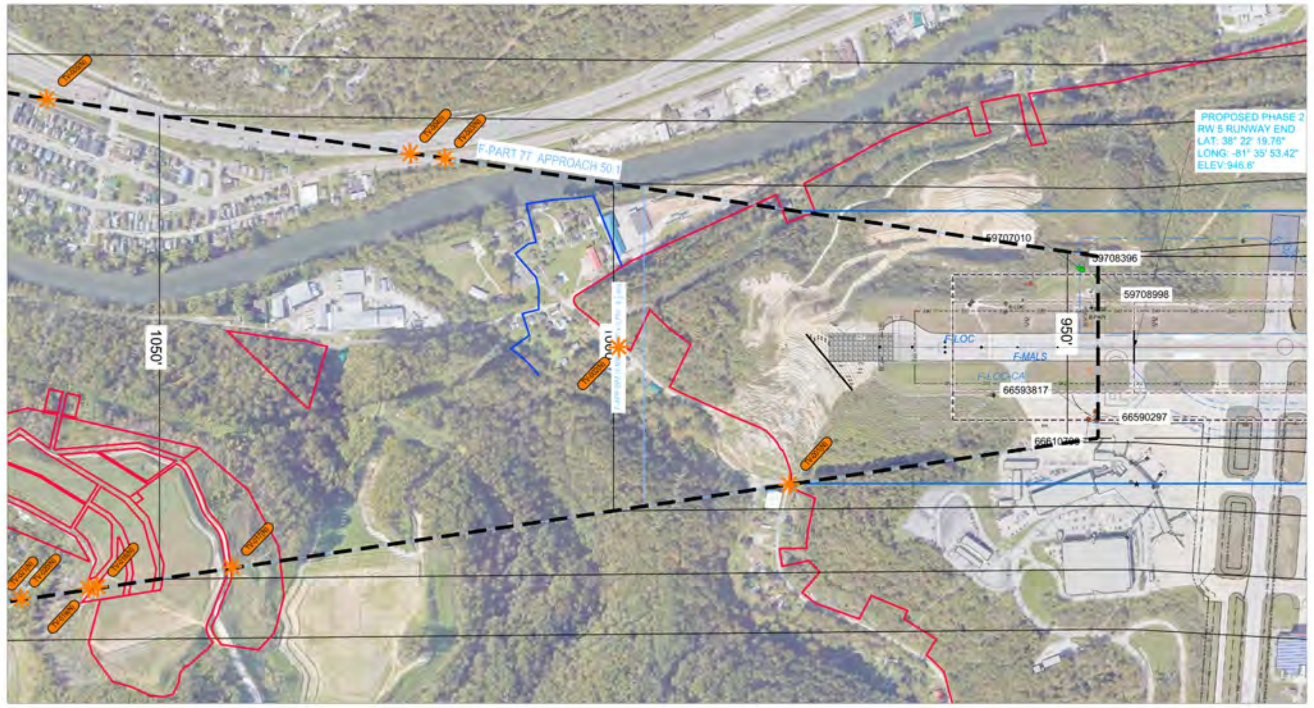
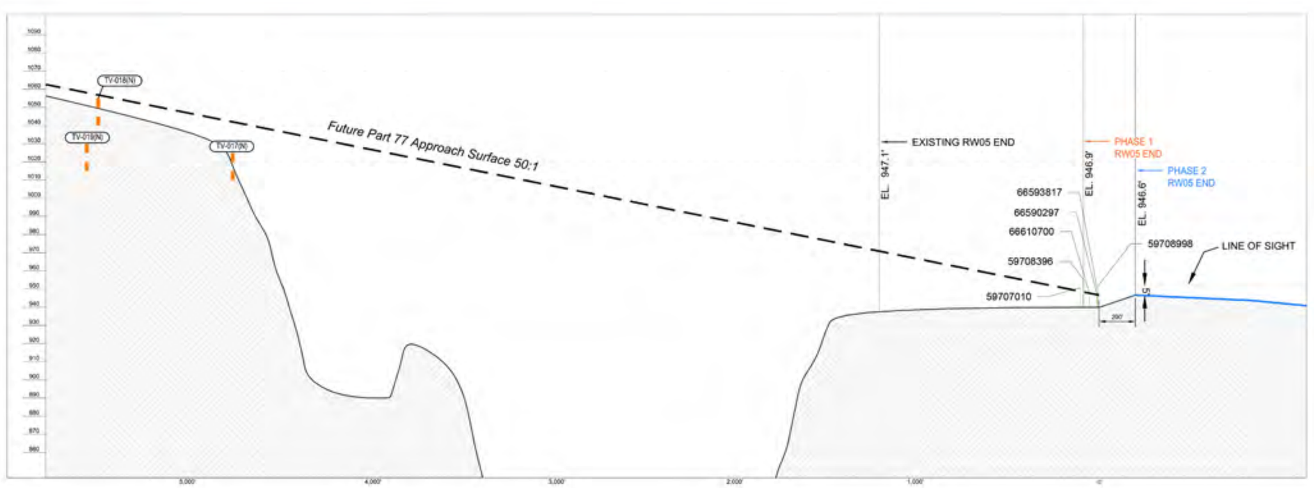
YEAGER AIRPORT

EXHIBIT 6-8 ALP SHEET 5 – INNER PORTION OF THE APPROACH SURFACE – RUNWAY 05





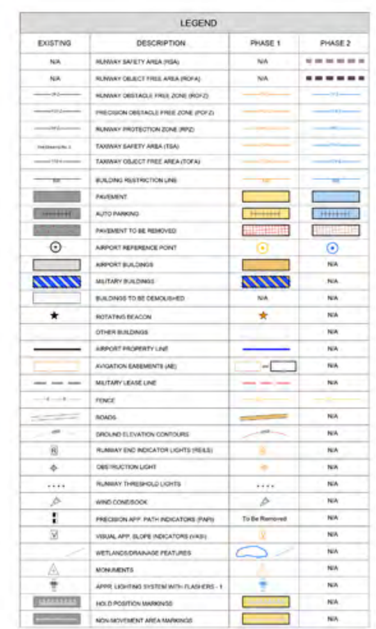
Notes:

1. Only highest obstructions in a particular area are depicted. Other obstructions may be located below and around identified objects.

2. Ground profile is highest area in Phase 2 14 CFR Part 77 Approach Surface.

3. Due to high volume of similar-type obstruction in certain areas, obstruction clusters were created. For full list of obstructions depicted in obstruction clusters, see Excel data tables.

CLUSTER	ID #	OBJECT TYPE	EASTING	NORTHING	ELEVATION (ft. MSL)	HEIGHT ABOVE SURFACE (ft.)	SURFACE NAME	DISPOSITION
GC-08	66590297	Ground	1797099.31	499800.70	947.34	0.45	AIRS--PT77--INNER_APCH--RW05	To Be Mitigated As Funds Allow
GC-08	66593817	Ground	1797134.85	499769.95	948.39	1.61	AIRS--PT77--INNER_APCH--RW05	To Be Mitigated As Funds Allow
GC-08	66610700	Ground	1797097.76	499743.00	947.79	0.10	AIRS--PT77--INNER_APCH--RW05	To Be Mitigated As Funds Allow
TC-11	59707010	Vegetation	1796498.82	500322.72	950.62	1.93	AIRS--PT77--INNER_APCH--RW05	To Be Mitigated As Funds Allow
TC-11	59708396	Vegetation	1796518.18	500327.31	955.18	6.84	AIRS--PT77--INNER_APCH--RW05	To Be Mitigated As Funds Allow
TC-11	59708998	Vegetation	1796601.47	500356.69	951.83	5.11	AIRS--PT77--INNER_APCH--RW05	To Be Mitigated As Funds Allow



Vert. : 1" = 40' Graphic Scale in Feet

Horiz. : 1" = 400' 200' 0 400' Graphic Scale in Feet

Magnetic Declination 7° 31' 0" W Changing by 0° 2' W per year August 4, 2017

REV. NO.	ITEM	DATE	SPONSOR APPROVAL	FAA APPROVAL
1	Interim Runway Safety Area Study, Final - January 2018	08/11/17	08/11/17	08/23/17
2	Runway Safety Area Study, Draft - March 2019			
3	Airfield Master Plan, Draft - November 2019			

YEAGER AIRPORT

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YEAGER AIRPORT
CHARLESTON WEST VIRGINIA
Inner Portion of Approach Surface Drawing - Runway 05

DATE: JANUARY 2020
DRAWN BY: ARB
CHECKED BY: MLG
DRAWING NO. 5
L&B PROJECT NO: X086.950
AIP NO: 3-54-0003-058-2017
CAD FILE: Y:\CRW\Master Plan\E-L&B Work Product\ALP\2019 ALP\001-LAYOUTS\Sheet - 5-6 - Inner Apch 05-23.dwg

Source: Landrum & Brown analysis.

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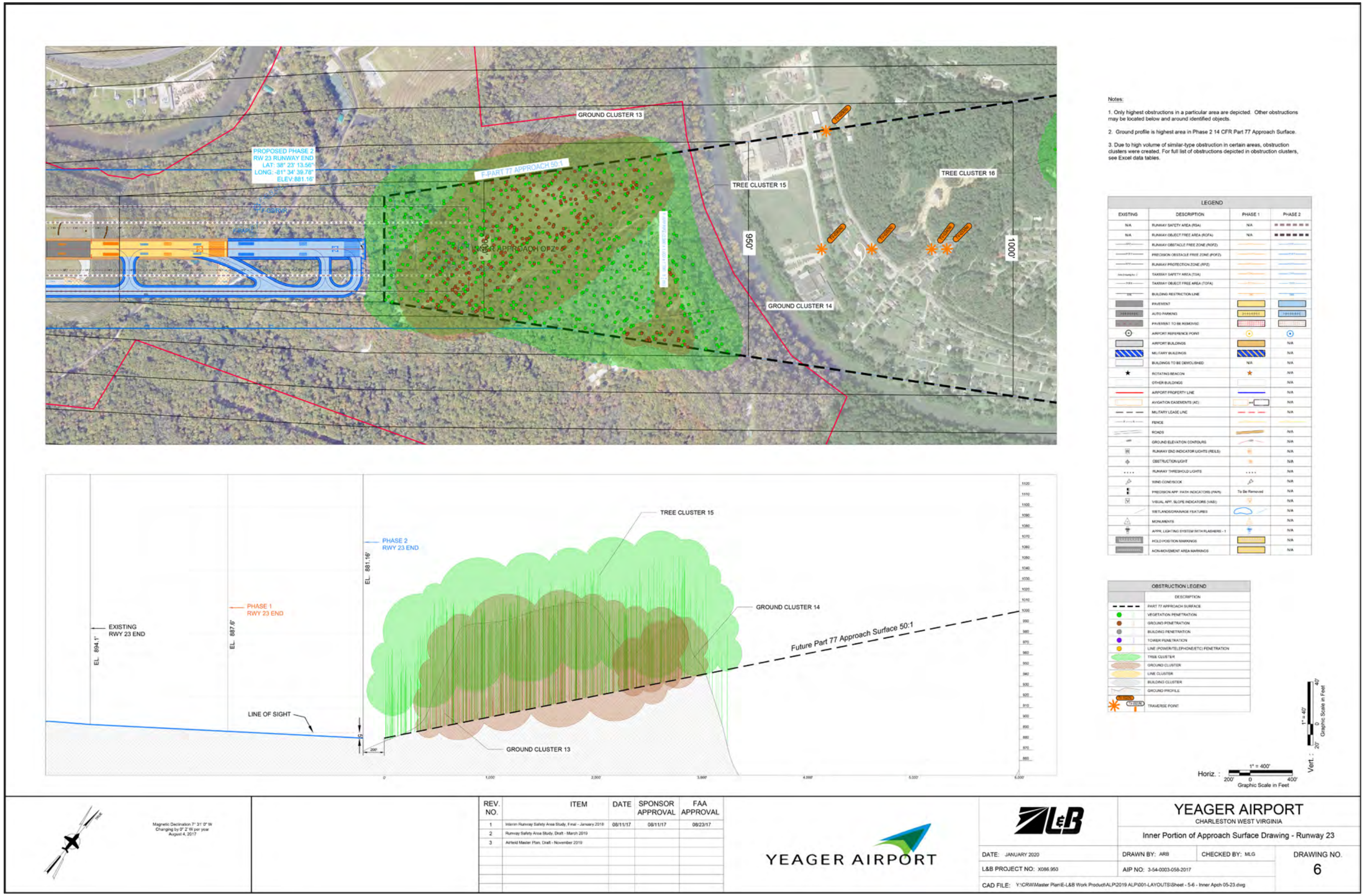
YEAGER AIRPORT

EXHIBIT 6-9 ALP SHEET 6 – INNER PORTION OF THE APPROACH SURFACE – RUNWAY 23



Source: Landrum & Brown analysis.

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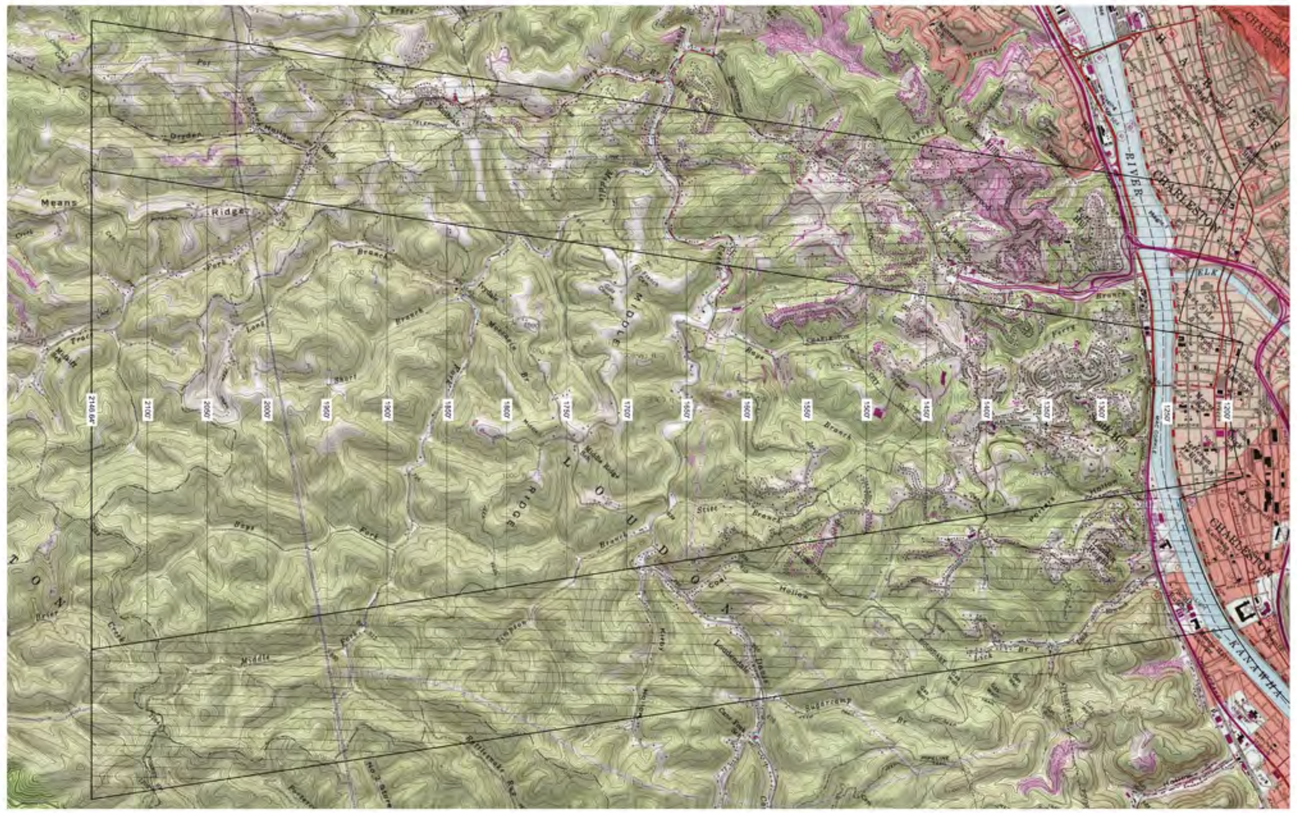
EXHIBIT 6-10 ALP SHEET 7 – OUTER PORTION OF THE APPROACH SURFACE – RUNWAY 05



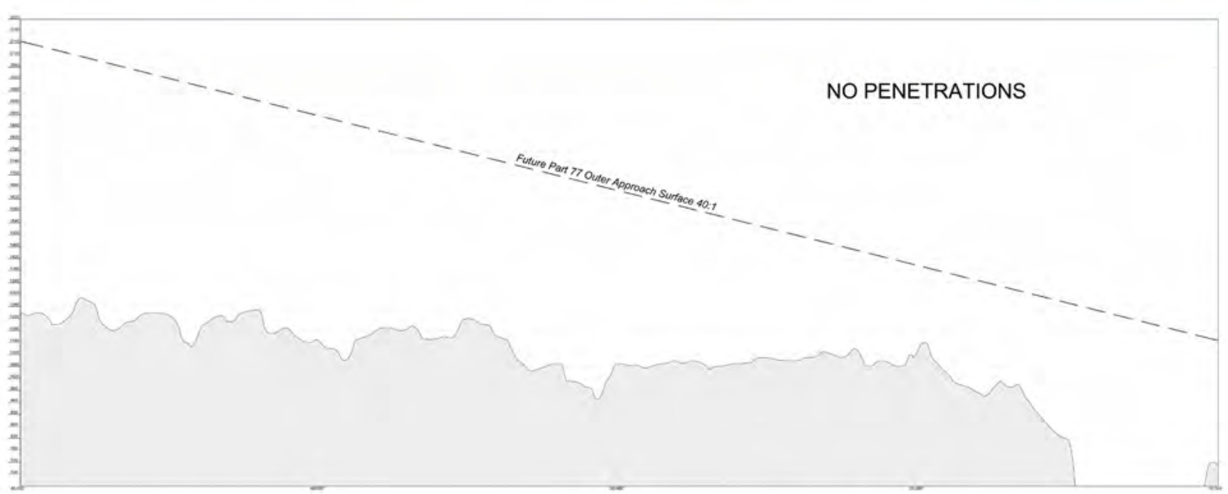
Notes:

1. Only highest obstructions in a particular area are depicted. Other obstructions may be located below and around identified objects.

2. Ground profile is highest area in Phase 2 14 CFR Part 77 Approach Surface.

3. Due to high volume of similar-type obstruction in certain areas, obstruction clusters were created. For full list of obstructions depicted in obstruction clusters, see Excel data tables.

4. No traverse points are shown as the elevation of the approach surface is at least 50 feet above any road, railroad, or interstate.



OBSTRUCTION LEGEND	
	DESCRIPTION
(dashed line)	PART 77 APPROACH SURFACE
(green dot)	VEGETATION PENETRATION
(brown dot)	GROUND PENETRATION
(grey dot)	BUILDING PENETRATION
(purple dot)	TOWER PENETRATION
(orange dot)	LINE (POWER/TELEPHONE/ETC) PENETRATION
(green area)	TREE CLUSTER
(tan area)	GROUND CLUSTER
(yellow area)	LINE CLUSTER
(line)	GROUND PROFILE

Horiz. : 1" = 2500' — 1250' 0 2500' Graphic Scale in Feet

Vert. : 1" = 250' — 125' 0 250' Graphic Scale in Feet

Magnetic Declination 7° 31' 0" W
Changing by 0° 2' W per year
August 4, 2017

REV. NO.	ITEM	DATE	SPONSOR APPROVAL	FAA APPROVAL
1	Interim Runway Safety Area Study, Final - January 2018	08/11/17	08/11/17	08/23/17
2	Runway Safety Area Study, Draft - March 2019			
3	Airfield Master Plan, Draft - November 2019			

YEAGER AIRPORT

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YEAGER AIRPORT
CHARLESTON WEST VIRGINIA

Outer Portion of Approach Surface Drawing - Runway 05

DATE: JANUARY 2020 | DRAWN BY: ARB | CHECKED BY: MLG | DRAWING NO. 7

L&B PROJECT NO: X086.950 | AIP NO: 3-54-0003-058-2017

CAD FILE: Y:\CRW\Master Plan\E-L&B Work Product\ALP\2019 ALP\001-LAYOUTS\Sheet - 7 Part77 Outer Apch RW05.dwg

Source: Landrum & Brown analysis.

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EXHIBIT 6-11 ALP SHEET 8 – OUTER PORTION OF THE APPROACH SURFACE – RUNWAY 23

Notes:

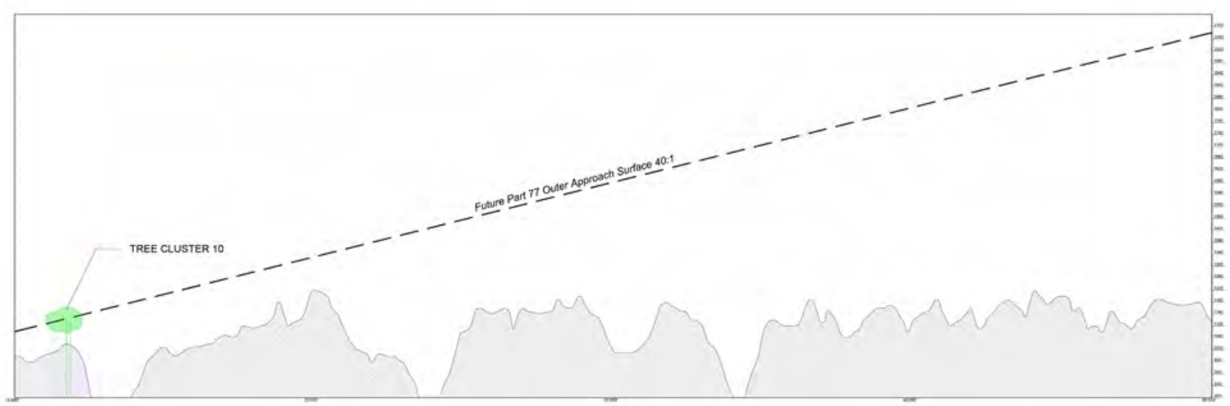
1. Only highest obstructions in a particular area are depicted. Other obstructions may be located below and around identified objects.

2. Ground profile is highest area in Phase 2 14 CFR Part 77 Approach Surface.

3. Due to high volume of similar-type obstruction in certain areas, obstruction clusters were created. For full list of obstructions depicted in obstruction clusters, see Excel data tables.

4. No traverse points are shown as the elevation of the approach surface is at least 50 feet above any road, railroad, or interstate.

CLUSTER	ID #	OBJECT TYPE	EASTING	NORTHING	ELEVATION (ft. MSL)	HEIGHT ABOVE SURFACE (ft.)	SURFACE NAME	DISPOSITION
TC-10	7735395	Vegetation	1810939.34	514733.45	1128.70	0.54	PT77-OUTER APCH-RW23	To Be Mitigated As Funds Allow
TC-10	7812172	Vegetation	1810827.73	514631.77	1135.03	10.64	PT77-OUTER APCH-RW23	To Be Mitigated As Funds Allow
TC-10	7850645	Vegetation	1810965.37	514649.04	1130.96	3.74	PT77-OUTER APCH-RW23	To Be Mitigated As Funds Allow
TC-10	7903709	Vegetation	1810780.08	514572.53	1130.24	7.73	PT77-OUTER APCH-RW23	To Be Mitigated As Funds Allow
TC-10	7938024	Vegetation	1810867.18	514589.93	1132.28	7.87	PT77-OUTER APCH-RW23	To Be Mitigated As Funds Allow
TC-10	8064071	Vegetation	1810926.61	514535.26	1126.90	2.32	PT77-OUTER APCH-RW23	To Be Mitigated As Funds Allow
TC-10	8155597	Vegetation	1810515.47	514367.90	1114.95	0.77	PT77-OUTER APCH-RW23	To Be Mitigated As Funds Allow



OBSTRUCTION LEGEND	
	DESCRIPTION
	PART 77 APPROACH SURFACE
	VEGETATION PENETRATION
	GROUND PENETRATION
	BUILDING PENETRATION
	TOWER PENETRATION
	LINE (POWER/TELEPHONE/ETC) PENETRATION
	TREE CLUSTER
	GROUND CLUSTER
	LINE CLUSTER
	GROUND PROFILE

Vert. : 1" = 250' 125' 0 250' Graphic Scale in Feet

Horiz. : 1" = 2500' 1250' 0 2500' Graphic Scale in Feet

Magnetic Declination 7° 37' 0" W
Changing by 0° 2' W per year
August 4, 2017

REV. NO.	ITEM	DATE	SPONSOR APPROVAL	FAA APPROVAL
1	Interim Runway Safety Area Study, Final - January 2018	08/11/17	08/11/17	08/23/17
2	Runway Safety Area Study, Draft - March 2019			
3	Airfield Master Plan, Draft - November 2019			

YEAGER AIRPORT

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YEAGER AIRPORT
CHARLESTON WEST VIRGINIA
Outer Portion of Approach Surface Drawing - Runway 23

DATE: JANUARY 2020 | DRAWN BY: ARB | CHECKED BY: MLG | DRAWING NO. 8
L&B PROJECT NO: X086.950 | AIP NO: 3-54-0003-058-2017
CAD FILE: Y:\CRW\Master Plan\E-L&B Work Product\ALP\2019 ALP\001-LAYOUTS\Sheet - 8 Part 77 Outer Apch RW23.dwg

Source: Landrum & Brown analysis.

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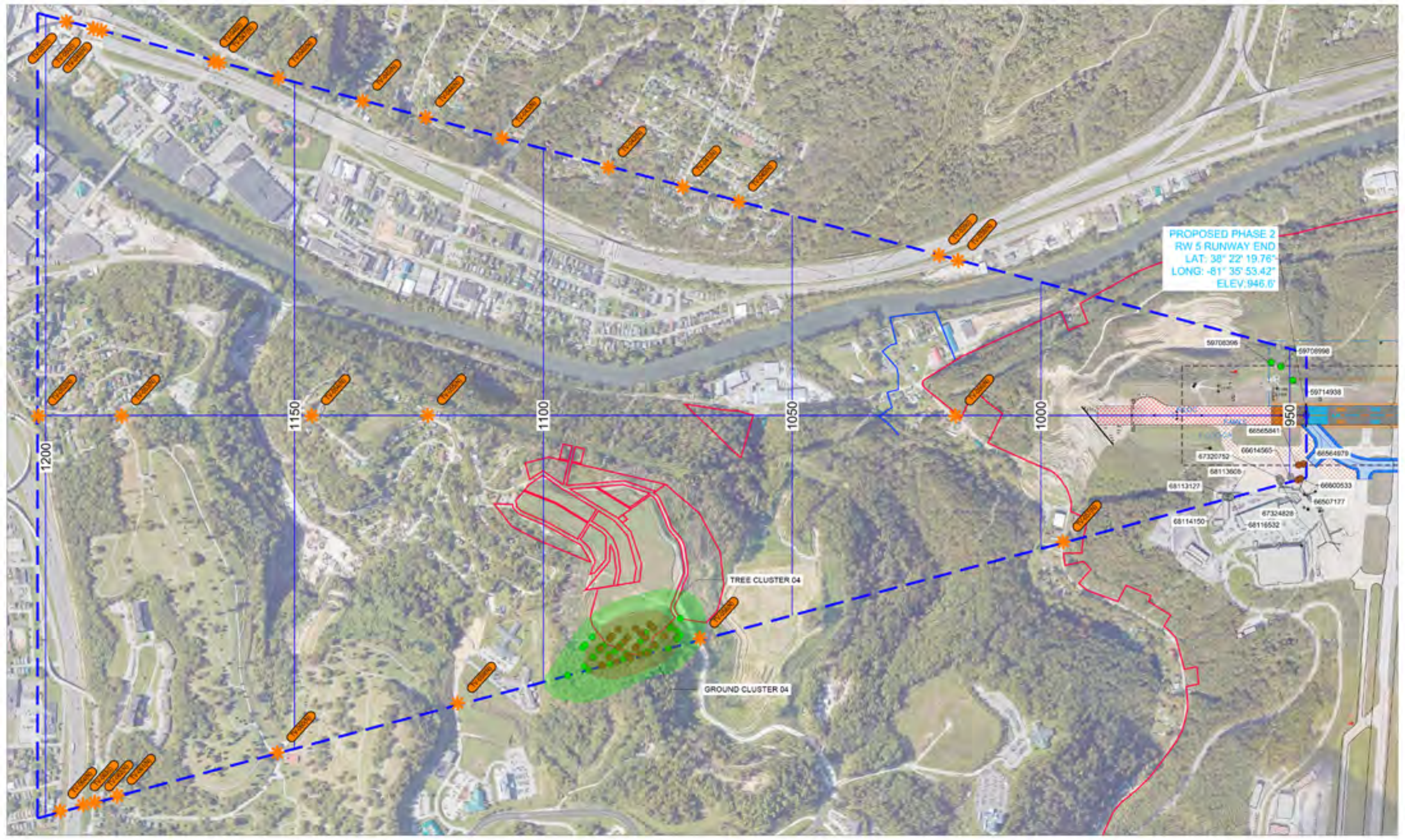
EXHIBIT 6-12 ALP SHEET 9 – 40:1 DEPARTURE SURFACE – RUNWAY 05



Notes:

1. Only highest obstructions in a particular area are depicted. Other obstructions may be located below and around identified objects.
2. Ground profile is highest area in Phase 2 14 CFR Part 77 Approach Surface.
3. Due to high volume of similar-type obstruction in certain areas, obstruction clusters were created. For full list of obstructions depicted in obstruction clusters, see Excel data tables.

CLUSTER	ID #	OBJECT TYPE	EASTING	NORTHING	ELEVATION (ft. MSL)	HEIGHT ABOVE SURFACE (ft.)	SURFACE NAME	DISPOSITION
N/A	59708396	Vegetation	1796518.18	500327.31	955.18	1.41	AIRS--TSS--DEPT--RW23	To Be Mitigated As Funds Allow
N/A	59708998	Vegetation	1796601.47	500356.69	951.83	0.10	AIRS--TSS--DEPT--RW23	To Be Mitigated As Funds Allow
N/A	59714938	Vegetation	1796745.54	500338.97	951.80	2.42	AIRS--TSS--DEPT--RW23	To Be Mitigated As Funds Allow
N/A	66507177	Ground	1797315.05	499777.40	948.45	0.08	AIRS--TSS--DEPT--RW23	To Be Mitigated As Funds Allow
N/A	66564979	Ground	1797262.67	499901.88	947.76	0.53	AIRS--TSS--DEPT--RW23	To Be Mitigated As Funds Allow
N/A	66565841	Ground	1797239.54	499868.80	948.22	0.01	AIRS--TSS--DEPT--RW23	To Be Mitigated As Funds Allow
N/A	66600533	Ground	1797324.54	499800.25	948.35	0.54	AIRS--TSS--DEPT--RW23	To Be Mitigated As Funds Allow
N/A	66614565	Building	1797255.55	499755.97	968.04	18.22	AIRS--TSS--DEPT--RW23	To Be Mitigated As Funds Allow
N/A	67320752	Building	1797198.22	499685.71	961.34	9.27	AIRS--TSS--DEPT--RW23	To Be Mitigated As Funds Allow
N/A	67324828	Building	1797220.57	499674.71	966.53	14.69	AIRS--TSS--DEPT--RW23	To Be Mitigated As Funds Allow
N/A	68113127	Building	1797003.92	499291.33	966.99	4.68	AIRS--TSS--DEPT--RW23	To Be Mitigated As Funds Allow
N/A	68113608	Building	1796996.30	499300.32	967.18	4.88	AIRS--TSS--DEPT--RW23	To Be Mitigated As Funds Allow
N/A	68114150	Building	1796979.63	499285.32	967.61	4.75	AIRS--TSS--DEPT--RW23	To Be Mitigated As Funds Allow
N/A	68116532	Building	1797011.33	499310.59	968.17	6.32	AIRS--TSS--DEPT--RW23	To Be Mitigated As Funds Allow

REV. NO.	ITEM	DATE	SPONSOR APPROVAL	FAA APPROVAL
1	Interim Runway Safety Area Study, Final - January 2018	08/11/17	08/11/17	08/23/17
2	Runway Safety Area Study, Draft - March 2019			
3	Airfield Master Plan, Draft - November 2019			

YEAGER AIRPORT
CHARLESTON WEST VIRGINIA
Departure Surface Drawing - Runway 05

DATE: JANUARY 2020
DRAWN BY: ARB
CHECKED BY: MLG
DRAWING NO. 9

Source: Landrum & Brown analysis.

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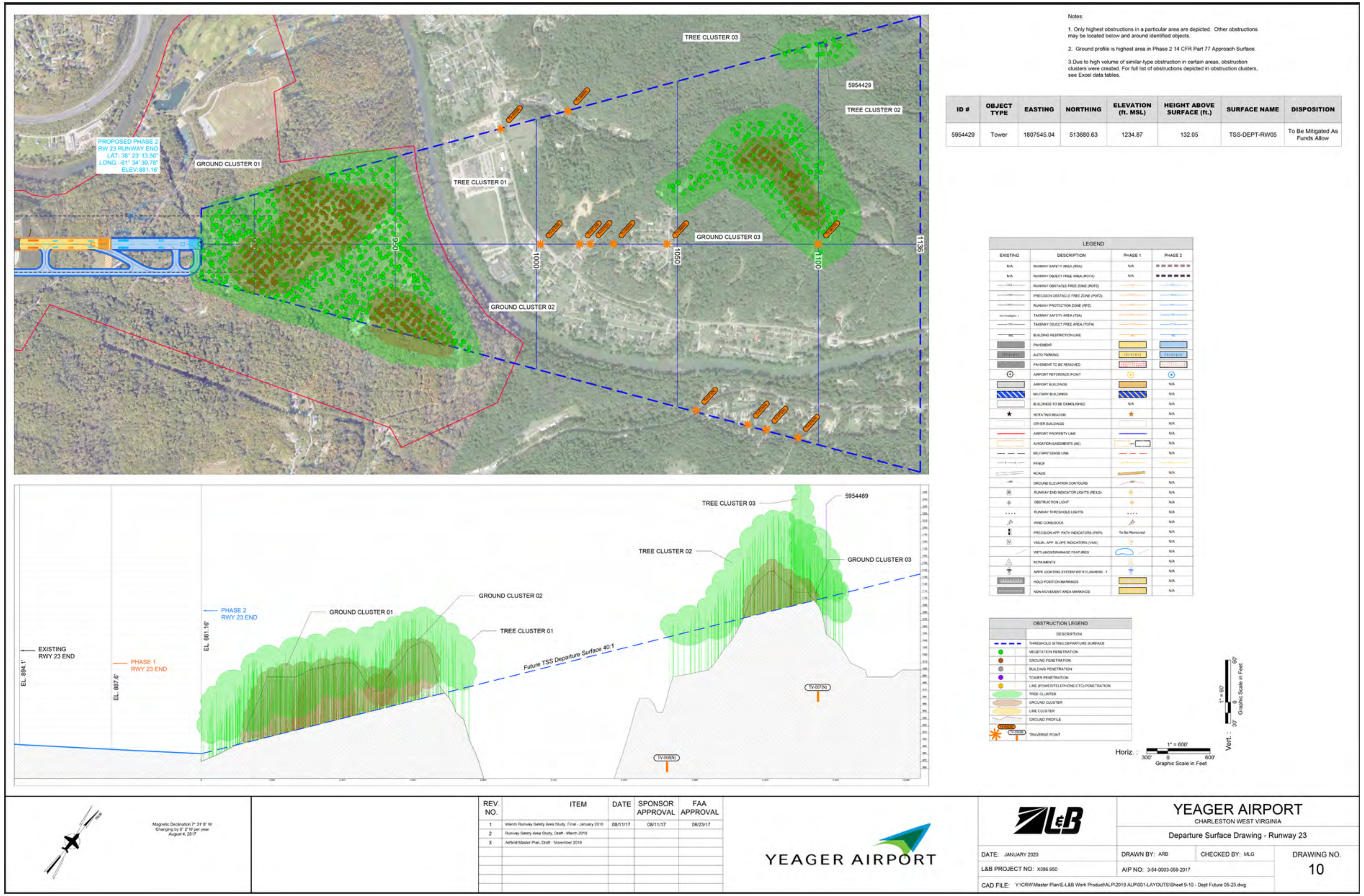
EXHIBIT 6-13 ALP SHEET 10 – 40:1 DEPARTURE SURFACE – RUNWAY 23



ID #	OBJECT TYPE	EASTING	NORTHING	ELEVATION (ft. MSL)	HEIGHT ABOVE SURFACE (ft.)	SURFACE NAME	DISPOSITION
5954429	Tower	1807545.04	513680.63	1234.87	132.05	TSS-DEPT-RW05	To Be Mitigated As Funds Allow

Source: Landrum & Brown analysis.

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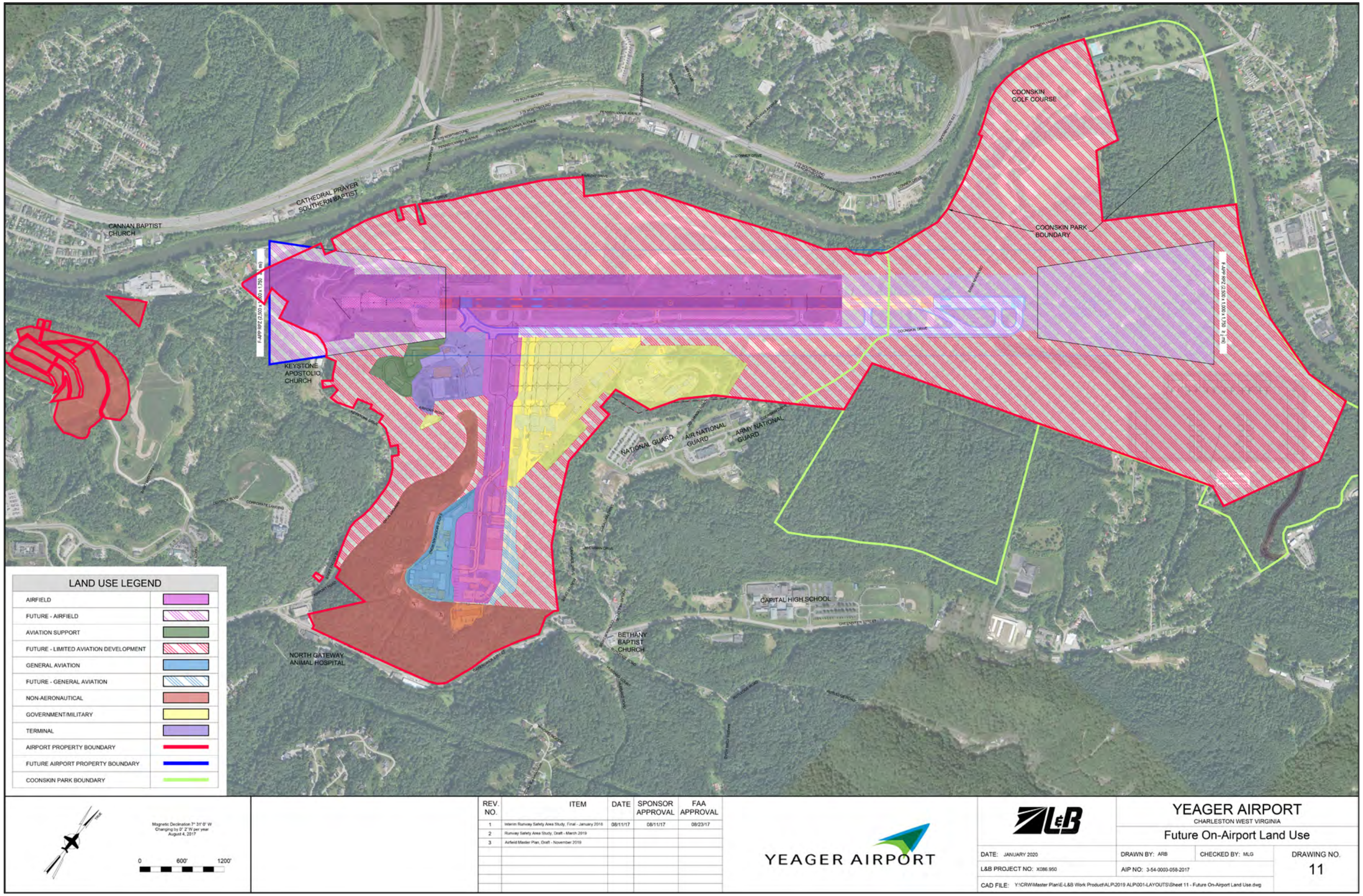
EXHIBIT 6-14 ALP SHEET 11 – FUTURE ON-AIRPORT LAND USE



Source: Landrum & Brown analysis.

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A Letter from American Airlines

American Airlines

November 20, 2017

Mr. Matthew DiGiulian
Manager
FAA Beckley Airports Field Office
176 Airport Circle
Beaver, West Virginia 25813

Subject: American Airlines Supports Yeager Airport Runway Extension

Dear Mr. DiGiulian:

In May 2015 American Airlines discontinued nonstop service from Yeager Airport, Charleston, WV (CRW) to Dallas/Fort Worth (DFW.) At that time, American moved CRJ-200 aircraft out of the DFW hub and the runway at CRW was too short to accommodate the appropriately sized alternative aircraft. Demand for the service did not warrant larger aircraft.

American currently serves CRW from our hubs in Charlotte, Philadelphia and Washington, DC and we value its presence in our network. This year American has converted to all-jet service resulting in additional seats at the CRW airport. In the spring of 2018 we plan to upgauge one of our flights to Charlotte to a CRJ-700 which includes first-class and main cabin extra seating.

While American is not planning to add service to CRW from DFW in the near term, the appropriate aircraft to introduce DFW service would be the Embraer-145 aircraft. Unfortunately, the current runway length would result in significant weight restrictions on this aircraft making the service untenable. If service was initiated, we would value the flexibility to fly larger aircraft, the CRJ-900 for example, as the market matured. The DFW route would provide direct access to one of the most popular destinations for Charleston passengers as well as one-stop access to our extensive DFW network for passengers who originate or terminate in Charleston. American Airlines supports a runway extension to allow for the potential reinstatement of nonstop service to DFW.

Sincerely,

Jason Reisinger
Managing Director
Global Network Planning
American Airlines, Inc.

P.O. Box 619616, MD 5544
DFW Airport, TX 75261-6916

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B Runway Length Analysis – Methodology Exceptions

B.1 Introduction

The runway length analysis conducted for the Yeager Airport (CRW) Airfield Master Plan used the aircraft manufacturer's airport planning manuals and followed the guidance specified in Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5325-4B, *Runway Length Requirements for Airport Design*. In some cases, however, the aircraft manufacturer's airport planning manuals do not contain enough information in the payload/range charts to determine takeoff weights for specific destinations as required by the AC. This appendix describes the alternative methodologies used to determine takeoff weights for those cases. Four aircraft types were analyzed using alternative methodologies:

- Airbus A319
- Airbus A320
- Bombardier CS100
- Bombardier CRJ-900

B.2 Payload/Range Methodology

The CRW Master Plan forecast identified potential destinations for future flights from CRW and determined the types of aircraft that could be used to serve these destinations. Most of the forecast destinations do not require an aircraft to have a full fuel load so are likely to depart at less than their Maximum Takeoff Weight (MTOW). As a result, a payload/range analysis was conducted to determine the reduced takeoff weights for each aircraft.

B.3 Insufficient Charts

The payload/range charts for the A319, A320, CS100, and CRJ-900 only provide enough information to determine the maximum range of an aircraft with a given payload. They do not provide enough information to determine the takeoff weight of an aircraft for aircraft flying shorter distances. Thus, it is not possible to use the airport planning manuals to calculate takeoff weights in conformance with the requirements of FAA AC 150/5325-4B.

B.4 Airbus A319 and A320

The furthest destination for the A319 is Orlando (MCO) in 2027 and Atlanta (ATL) in 2037 in the base and high case forecasts. The furthest destination for the A320 in 2037 is MCO in the base case and Las Vegas (LAS) in the high case. The A320 is not projected to operate in 2027.

The following three-step methodology was used to compute the take-off weight for the A320 and the A319:

- Calculate the fuel load of each aircraft traveling to the furthest forecast destination using the ICAO Engine Exhaust Emissions Databank for the landing and take-off cycle and flights below 3,000 feet, and data from Flybe airlines for fuel consumption for flight above 3,000. Added standard reserves for taxi, alternate and holding fuel.
- Added the calculated fuel load to the operating empty weight (OEW) of the aircraft and added the maximum payload to determine a reduced takeoff weight.
- Used the reduced takeoff weight with the aircraft manufacturers hot day takeoff runway length charts in order to determine a proper takeoff runway length requirement for each aircraft.

B.4.1 Step 1: Determine Fuel Load

The first step to determine fuel load was to determine the flight distance. **Table B-1, *Summary of Modeled Operations,*** displays the flight plan distance for the A319 to MCO and ATL and the A320 to MCO and LAS. The track distance listed in the table was calculated based on the distance between the origin and destination airports according to a great circle distance formula (haversine formula[1]).

TABLE B-1 SUMMARY OF MODELED OPERATIONS

AIRCRAFT TYPE	ORIGIN	DESTINATION	FLIGHT DISTANCE (NM)
A320	CRW	MCO	596
A320	CRW	LAS	1,606
A319	CRW	MCO	596
A319	CRW	ATL	316

Source: Landrum & Brown analysis.

[1] The haversine formula determines the great-circle distance between two points on a sphere given their longitudes and latitudes.

The second step in determining fuel loads was to determine the fuel burn. Fuel burn varies by what the aircraft is doing (taxiing vs cruising for example). The stages of flight used in this analysis are:

- **Stage 1**: Taxi, Takeoff, and Climb Out (ICAO Airport Air Quality Manual and Taxi Fuel Allowance)
- **Stage 2**: Climb to 3,000 feet (ICAO Airport Air Quality Manual)
- **Stage 3**: Climb from 3,000 to 30,000 feet (Flybe data)
- **Stage 4**: Cruise (Flybe data)
- **Stage 5**: Descend from 30,000 to 3,000 feet (Flybe data)
- **Stage 6**: Descend below 3,000 feet (ICAO Airport Air Quality Manual)
- **Stage 7**: Final Approach, Landing, and Taxi (ICAO Airport Air Quality Manual and Taxi Fuel Allowance)

The resulting fuel loads are provided in **Table B-4, *Fuel Calculation Results***. In addition to the stages of flight, reserve fuel was added. This is a unique calculation for each aircraft type.

TABLE B-4 FUEL CALCULATION RESULTS

Fuel Types	A320 CRW – MCO (lbs)	A320 CRW – LAS (lbs)	A319 CRW-MCO (lbs)	A319 CRW-ATL (lbs)
ICAO LTO Fuel (Stages 1 & 7)	1,597	1,597	1,514	1,514
Taxi and Takeoff/Landing Fuel (Stages 1 & 7)	500	500	500	500
Climb Out Fuel (Stages 2 & 3)	3,600	3,600	3,235	3,235
Cruise Fuel (Stage 4)	3,272	11,749	2,161	540
Descent Fuel (Stages 5 & 6)	311	311	466	466
Subtotal Flight Fuel	**9,280**	**17,757**	**7,876**	**6,255**
Reserves Fuel	8,800	8,800	6,000	6,000
Total Fuel	**18,080**	**26,557**	**13,876**	**12,255**

Source: ICAO Airport Air Quality Manual, Flybe Airlines data and Landrum & Brown analysis.

B.4.2 Step 2: Calculate Reduced Takeoff Weight

Once the total fuel was calculated for each flight, it was combined with the aircraft manufacturer's OEW and maximum payload weight for each aircraft listed in the aircraft's airport planning manual. These three weights make up the calculated takeoff weight by destination as shown in **Table B-5, *Reduced Takeoff Weight Calculations***.

TABLE B-5 REDUCED TAKEOFF WEIGHT CALCULATIONS

AIRCRAFT	DESTINATION	OEW (LBS.)	MAX PAYLOAD (LBS.)	FUEL LOAD (LBS.)	REDUCED TOW (LBS.)
A320	CRW-MCO	99,757	42,000	18,081	159,838
A320	CRW-LAS	99,757	42,000	26,557	168,314
A319	CRW-MCO	93,070	35,900	13,876	142,846
A319	CRW-ATL	93,070	35,900	12,255	141,225

Sources: Airbus Airport Planning Manuals for the A319 and A320 and Landrum & Brown analysis.

B.4.3 Step 3: Calculate Takeoff Runway Length Requirement

Once the decreased takeoff weights were calculated, the Airbus airport planning manuals' hot day takeoff length charts were used to calculate the takeoff lengths for each aircraft. The reduced takeoff weight, calculated in Step 2, and the CRW airport field elevation was applied to the hot day charts to obtain the takeoff length result. The takeoff lengths required for the A319 range from 4,920 feet (CRW-ATL) to 5,020 feet (CRW-MCO). The takeoff lengths required for the A320 range from 6,820 feet (CRW-MCO) to 7,920 feet (CRW-LAS).

B.5 Bombardier CS100

The CS100 is forecast to fly to ATL from CRW on Delta Air Lines in 2027 and 2037 in the base case and high case forecasts. The distance from CRW to ATL is 316 nautical miles. Unlike the A319 and A320, the CS100 is a new aircraft to the industry and there was no suitable source of fuel burn rates by phase of flight. Airlines have placed orders for the CS100; however, the aircraft will not be in service until at least 2018. Since fuel burn rate data is not available for the CS100, the takeoff weight was calculated based on a comparison to other aircraft flying to ATL. The alternative takeoff length analysis involved a two-step process:

- Calculate decreased takeoff weight based on similar aircraft flying to ATL.
- Apply the reduced takeoff weight to the aircraft manufacturers hot day takeoff length charts in order to determine a proper takeoff length requirement for each aircraft.

B.5.1 Step 1: Calculate Reduced Takeoff Weight

The CS100 reduced takeoff weight was based upon similar Delta aircraft flying to ATL from CRW. The aircraft found in **Table B-6, *CS100 Comparable Aircraft***, display aircraft with similar performance characteristics flying the CRW to ATL market. The table identifies their reduced takeoff weight percentages.

TABLE B-6 CS100 COMPARABLE AIRCRAFT

AIRCRAFT	DESTINATION FROM CRW	STUDY ORIGIN	REDUCED TOW (LBS)	MTOW (LBS)	% OF MTOW
B737-700W	ATL	Airfield Master Plan	133,000	154,500	86%
B737-800	ATL	2017 RSA Study	153,000	174,200	88%
CRJ-900	ATL	2017 RSA Study	76,050	84,500	90%

Source: Airbus Airport Planning Manuals for the A319 and A320; Landrum & Brown analysis.

The aircraft in the table are flying at 86% to 90% of their MTOW capability. Thus, 90% of MTOW was applied to the CS100 to determine the reduced takeoff weight. The resulting takeoff weight is 120,600 pounds.

B.5.2 Step 2: Calculate Takeoff Length Requirement

Once the decreased takeoff weight was calculated, the Bombardier CS100 airport planning manual's hot day takeoff length charts were used to calculate the required takeoff length for the CS100. The reduced takeoff weight, calculated in Step 1, and the CRW airport field elevation were then applied to the hot day charts to get a takeoff length of 6,320 feet.

B.6 Bombardier CRJ-900

The Bombardier CRJ-900 is forecast to fly from CRW to Houston (IAH) in 2027 and 2037 in the base and high case forecasts. The distance from CRW to IAH is 848 nautical miles. The charts indicated that the CRJ-900 to IAH would be at close to 100% MTOW. Therefore, the CRJ-900 to IAH was run at MTOW with the airport planning manual's hot day takeoff length charts. The resulting takeoff length requirement is 7,820 feet.

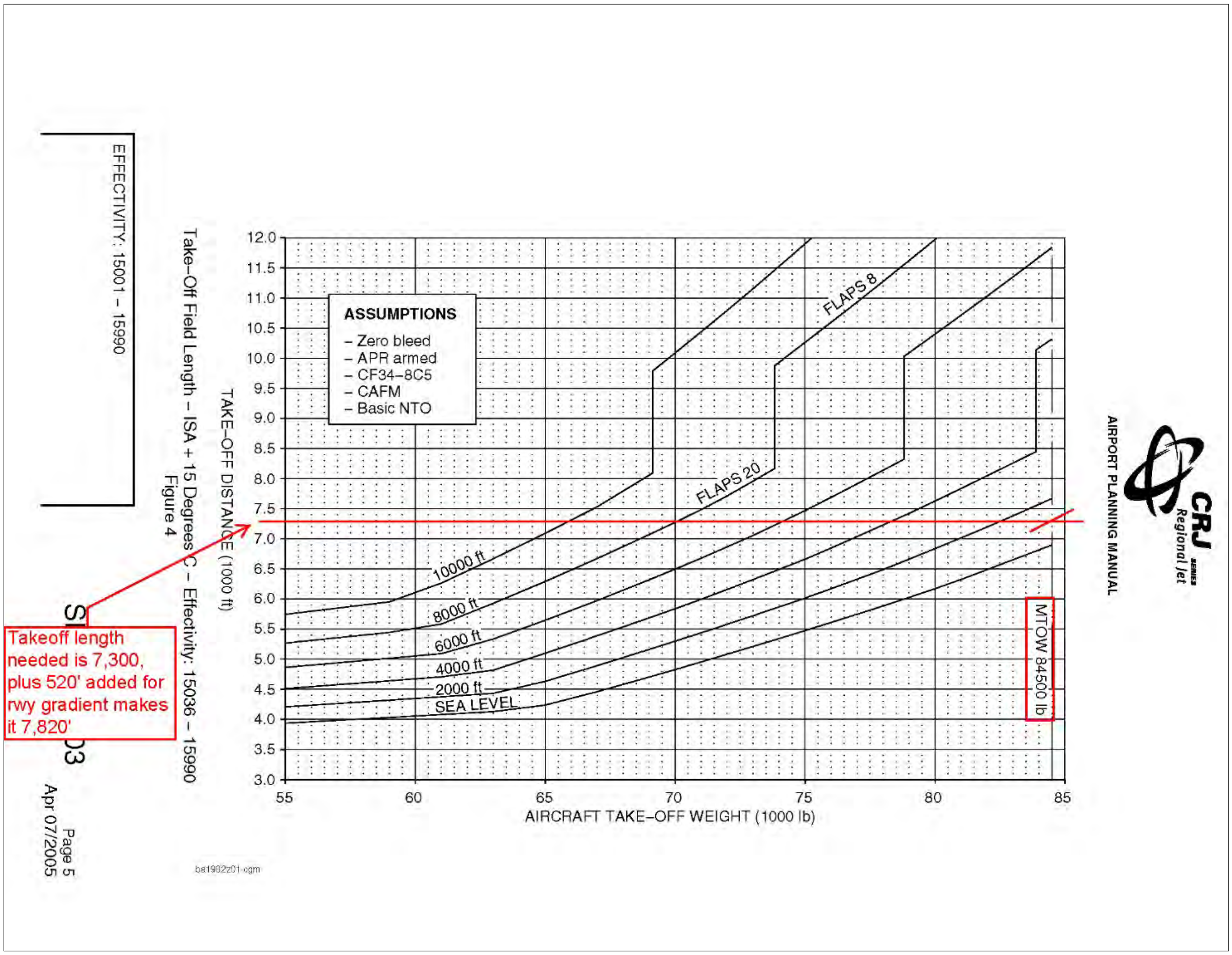
C Runway Length Charts

This appendix presents the runway length charts used for the CRW Airfield Master Plan Update to determine the critical aircraft for runway length. The runway length requirements were developed in accordance with Federal Aviation Administration (FAA) Advisory Circular 150/5325-4B, *Runway Length Requirements for Airport Design,* where possible. Alternative methodologies had to be used for some aircraft and are further explained in the previous appendix, ***Appendix B, Runway Length Analysis – Methodology Exceptions***.

Aircraft charts listed in this appendix include:

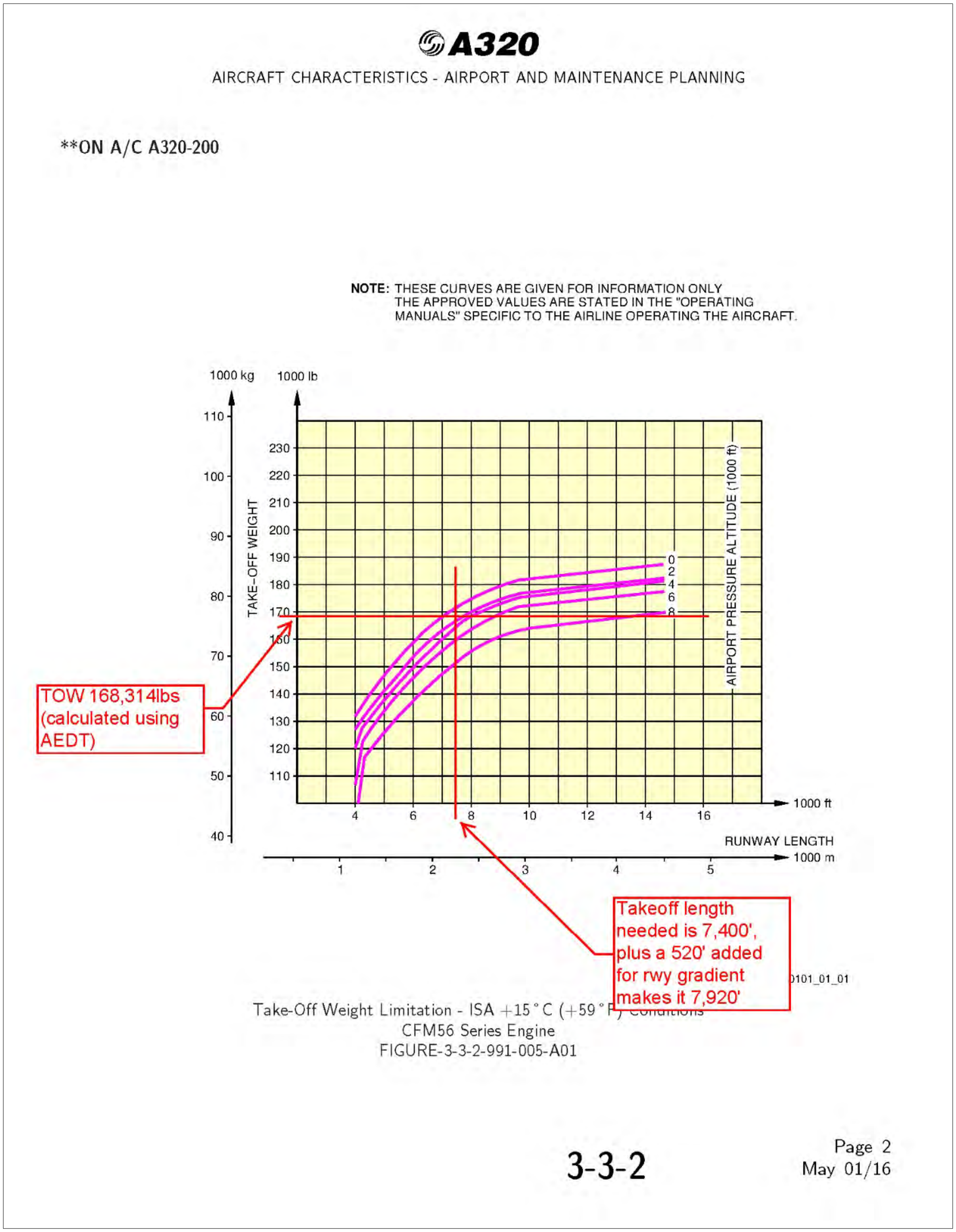
- Takeoff
  - CRJ-900 (10-year base and high case takeoff length requirements, and 20-year base case takeoff length requirement)
  - A320 (20-year high case takeoff length requirement)
- Landing
  - CRJ-900 (both the 10-year and 20-year landing length requirement)

EXHIBIT C-1 CRJ-900 TAKEOFF LENGTH REQUIREMENT



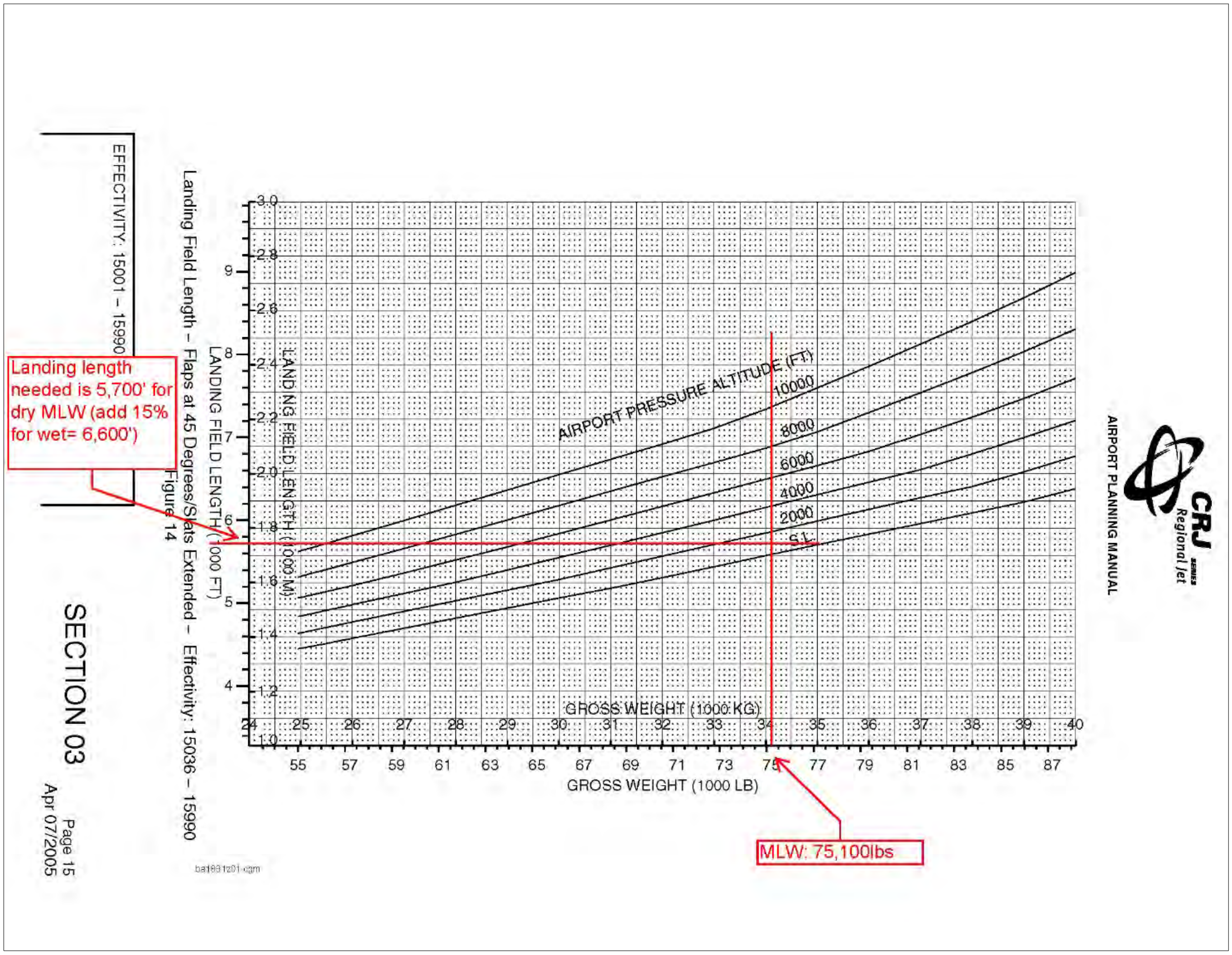
Sources: CRJ Series Airport Planning Manual and Landrum & Brown analysis.

EXHIBIT C-2 A320 TAKEOFF LENGTH REQUIREMENT



Sources: Airbus Airport Planning Manual and Landrum & Brown analysis.

EXHIBIT C-3 CRJ-900 LANDING LENGTH REQUIREMENT



Sources: CRJ Series Airport Planning Manual and Landrum & Brown analysis.

AIRFIELD MASTER PLAN

Final - July 2020

YEAGER AIRPORT