LAND DEVELOPMENT STUDY

INTRODUCTION

The Keene Dillant-Hopkins Airport (EEN or the Airport) is classified by the Federal Aviation Administration (FAA) as a "Regional" general aviation (GA) airport. It is a vital transportation hub and economic link for western New Hampshire and the Monadnock Region. Since the Airport was dedicated in 1943, it has grown with the strong leadership of the City of Keene, which has guided development and operations into a robust transportation facility.

Prospective tenants and aircraft owners regularly approach the Airport to base their aircraft at EEN, and the Airport wants to prepare for and protect for future development with this siting study (Study) of available areas. This Technical Memorandum includes the following sections:

1. Airfield Facilities
2. Airport Site Constraints and Considerations
3. Existing Utilities
4. Developable Parcels and Constraints
5. Recommended Best Use for Each Parcel
6. Conceptual Hangar Layouts
7. Cost-Benefit Analysis and Comparison of a 10-Unit T-hangar
8. Recommendations

Information for this Study was gathered from applicable sources, including FAA Advisory Circular (AC) 150/530-13B, *Airport Design*, applicable portions of Title 14, Code of Federal Regulations (CFR) Part 77, *Safe, Efficient Use and Preservation of the Navigable Airspace* (Part 77), among others.

1. AIRFIELD FACILITIES

1.1. Critical Design Aircraft

Airports are typically designed around the critical design aircraft, which is a specific aircraft or group of multiple aircraft with similar attributes such as wingspan or approach speed. The FAA classifies these aircraft based on their operational and physical characteristics, otherwise known as the Aircraft Approach Category (AAC), denoted by the letter A through E, and the Airplane Design Group (ADG), denoted by a Roman numeral I through VI. These factors, along with approach minimums, are together known as the Runway Design Code (RDC). The RDC drives the design for protected zones around the runway, such as the runway safety area (RSA) and runway object free area (ROFA). Taxiway protected areas, such as the taxiway safety area (TSA), and taxiway object free area (TOFA), are based on the ADG and Taxiway Design Groups (TDGs), which range from 1 to 6. EEN has an existing and proposed RDC of B-III-5000, based on the presence of a Bombardier Global 5000 based at the Airport.

1.2. Runways

The Airport has two intersecting runways. Runway 2-20 measures 6,201 feet in length and 100 feet in width and is constructed of asphalt. Runway 2 is the only runway with instrument approaches. It has an instrument landing system (ILS) and as such has precision instrument markings, whereas Runway 20 has basic runway markings. Each runway end has a four-box precision approach path indicator (PAPI) on the left-hand side of the runway from the approaching pilot's perspective.

Runway 14-32 measures 4,001 feet in length and 75 feet wide and is also constructed of asphalt. Both runway ends are marked with basic runway markings as neither runway end has an instrument approach. Runway 32 has a displaced threshold of 1,100 feet.

1.3. Taxiways

Taxiway A is a parallel taxiway for Runway 2-20. South of Runway 14-32, the centerline of Taxiway A is 510 feet from the centerline of Runway 2-20. North of Runway 14-32, Taxiway A is 400 feet from the Runway 2-20 centerline. Taxiways A2 and C are entrance/exit taxiways off of Taxiway A south of Runway 14-32 that provide access to Runway 2-20. Taxiway R connects the Terminal Apron to the approach end of Runway 20, and Taxiway S is an entrance/exit taxiway providing access to Runway 14-32. Finally, Taxilanes T and L provide access to various hangars.

The current ALP proposes a partial parallel Taxiway B along the northeast edge of Runway 14-32 from the Based Aircraft Apron, to the approach end of Runway 14, and Taxiway B1 adjacent to the approach end of Runway 32. The proposed 35-foot-wide taxiway B, with a TDG 2 designation, would have a TOFA width of 171 feet, or 85.5 feet from the taxiway centerline. The ROFAs and TOFAs, as well as environmental constraints can be seen in **Figure 1a,** and **Figure 1b**.

2. AIRPORT SITE CONSTRAINTS AND CONSIDERATIONS

It is important at the outset to identify constraints and limitations that might inhibit development at the Airport. Too often, development occurs that inhibits future development and constrains the growth of an airport. Also, Airport management or potential developers must be fully aware of any constraints, particularly environmental constraints that are inherent in a particular parcel before development planning can begin. The following sections will outlay the several types of constraints that exist at the Airport.

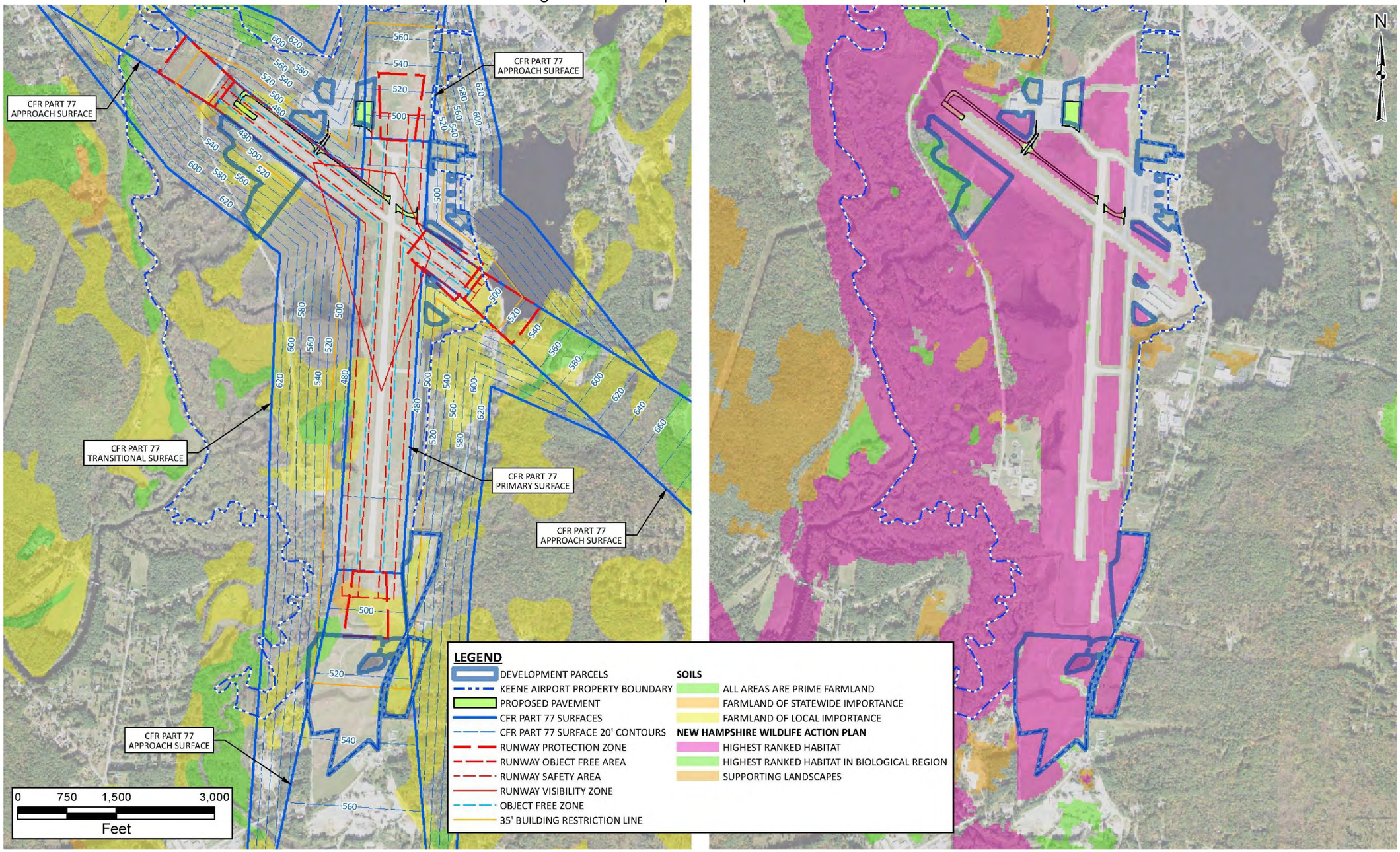
2.1. Key Environmental Constraints

This environmental review is a preliminary evaluation of resources that may be present on airport property, based on mapping from various resource agencies. Environmental constraints evaluated include the National Wetland Inventory mapped wetlands and surface waters, Federal Emergency Management Agency (FEMA) floodplains, drinking water resources, New Hampshire Wildlife Action Plan wildlife habitat, USDA farmland soils using the Web Soil Survey tool, historic resources, and conservation lands. A more detailed resource identification will be required once a parcel is proposed for development.

Parcels that contain mapped resources may require field surveys, further consultation with the appropriate agencies, avoidance and minimization measures, and/or mitigation for impacts to resources that will need to be identified during the permitting process.

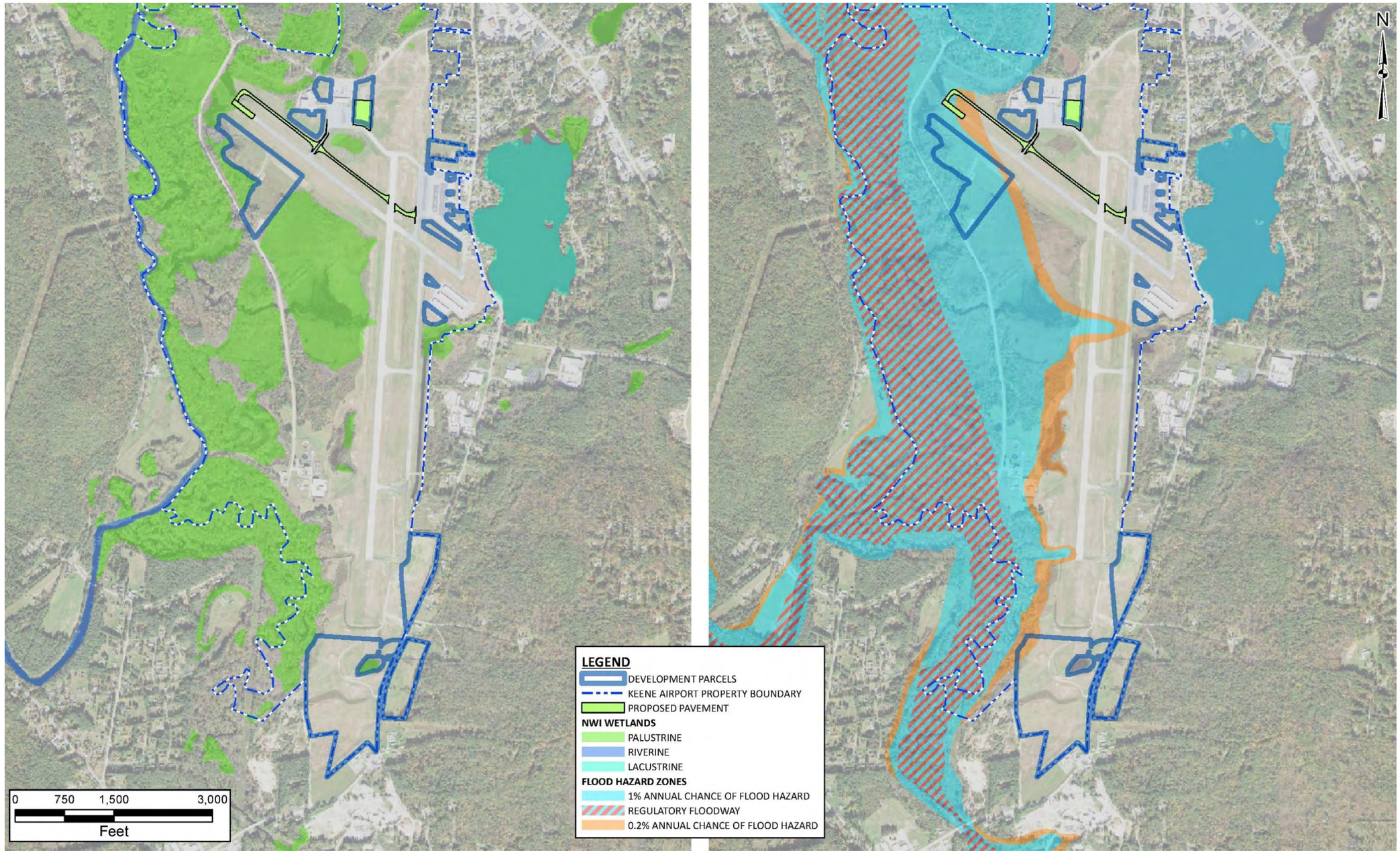
A preliminary resource list was generated for federally threatened and endangered species using the US Fish and Wildlife (USFWS) Information for Planning and Consultation (IPaC) online tool, which listed the Northern long-eared bat (threatened, though will be classified as endangered in 2023), dwarf wedgemussel (endangered), and monarch butterfly (candidate species) as potentially occurring within and/or in the vicinity of the Airport. Additionally, grassland areas at the airport may potentially provide grassland bird nesting habitat. According to the NH Natural Heritage Bureau Datacheck review, issued October 14, 2022, multiple state threatened and endangered species, and one exemplary natural community, were listed as occurring in or near the Airport including:

Figure 1a: Keene Airport Development Constraints



Source: US Fish and Wildlife, McFarland Jonson analysis, 2022.

Figure 1b: Keene Airport Development Constraints



Source: McFarland Johnson, 2022.

- Silver Maple – False Nettle – Sensitive Fern Floodplain Forest
- Eastern Meadowlark (*Sturnella magna*)
- Grasshopper Sparrow (*Ammodramus savannarum*)
- Horned Lark (*Eremophila alpestris*)
- Marsh Wren (*Cistothorus palustris*)
- Northern Leopard Frog (*Lithobates pipiens*)
- Sora (*Porzana Carolina*)
- Vesper Sparrow (*Pooecetes gramineus*)
- Wood Turtle (*Glyptemys insculpta*)

While the potential presence of threatened and endangered species does not preclude development, it may require special permitting, avoidance and minimization measures, mitigation, or other development considerations. Also, development in areas that are listed as wetlands, floodplains, surface waters, or farmland soils will require special considerations and likely additional permitting.

2.2. CFR Part 77 Imaginary Airspace Surfaces

The CFR Part 77 imaginary airspace surfaces protect the airspace around airports. If development is to occur within the airspace, developers and airport operators must notify the FAA about the proposed construction, or alteration of existing structures. The FAA then is able to modify flight paths, and approaches, or to notify pilots if an obstruction to air navigation exists.

Key Part 77 surfaces to consider for this Study include the primary surface, which sits longitudinally centered on a runway. The primary surface for Runway 2-20 is 1,000 feet wide, and 500 feet wide for Runway 14-32. Also, off of the edges of the primary surface, rising up at a right angle from the runway centerlines at a slope of 7 to 1 is the transitional surface. In other words, for every one foot out, the slope rises seven feet. Lastly, the Part 77 approach surfaces will need to be taken into consideration for some parcels off of the ends of Runway 2-20.

2.3. Technical Airport Planning Considerations Contained in FAA AC 150/5300-13B

FAA AC 150/5300-13B describes airport design considerations that are used in the planning and layout of airports to ensure safe and smooth aircraft operations. The following sections detail important considerations in airport planning and development from this AC.

FAA Airport Design Approach Surfaces

FAA AC 150-5300-13B lists seven approach and departure surfaces that need to be considered in the planning of any airport development. These trapezoidal surfaces have varying sizes and slopes for the protection of aircraft and are intended to ensure a clear approach and departure path for aircraft using an airport. The airport design approach surfaces that will need to be considered for this Study include those listed in **Table 1**.

35-Foot Building Restriction Line

The Building Restriction Line (BRL) surrounds the runways and taxiways at an airport and limits how close construction should occur to aircraft movement areas. A BRL typically has a building height limitation of 35 feet; however, the BRL could depict alternate distances that an airport needs to be cognizant of to preclude penetrations to critical surfaces. The building height limitation is intended to ensure structures do not penetrate sloped airspace surfaces designed to preclude obstructions.

Table 1: Applicable Airport Design Approach Surfaces

Surface	Runway End
Surface #2	32
Surface #3	20
Surface #5	2
Surface #6	2
Surface #7	20

Source: FAA AC 150/5300-13B.

Runway Safety Area

FAA AC 130/5300-13B defines the runway safety area (RSA) as an area surrounding a runway that is intended to enhance the safety of aircraft that might undershoot, overrun, or veer off the runway. The RSA must be level, graded, and cleared, with no ruts, humps, depressions, or other surface variations. Most importantly for this Study, objects must not be placed within the RSA unless they are essential to air navigation.

The Runway 2-20 RSA at Keene is 300 feet wide and extends 600 feet beyond each runway end. The RSA for Runway 14-32 is 150 feet wide and extends 300 feet beyond each runway end.

Runway Object Free Area

FAA AC 130/5300-13B defines the runway object free area (ROFA) as a cleared area that is limited to essential equipment for air and ground navigation. It also provides for wingtip clearance in the event of an aircraft excursion from the runway.

The ROFA for Runway 2-20 at the Airport is 800 feet wide and extends 600 feet beyond each runway end, and the ROFA for Runway 14-32 is 500 feet wide and extends 300 feet beyond each runway end.

Runway Visibility Zone

The runway visibility zone (RVZ) is formed by intersecting runways like those at EEN. The RVZ is an area of clear visibility or line of sight (LOS) for pilots on opposite runways. A clear RVZ enhances a pilot's situational awareness by helping to ensure situational awareness of aircraft operating on opposing runways. It is not anticipated any development within the RVZ will be considered or planned as a part of this Study.

Runway Protection Zone

The runway protection zone (RPZ) is a trapezoidal-shaped area off of the ends of the runways that are intended for the protection of people and property on the ground in the event of an aircraft undershoot or overshoot. The intent is to keep the RPZ clear of incompatible land uses. Some parcels fall within the RPZ, and consideration will have to be made as to what acceptable uses can be made for those parcels given FAA requirements.

Taxiway/Taxilane Object Free Area

The taxiway object free area (TOFA) and taxilane object free area (TLOFA) are areas adjacent to the taxiway/taxilane that should be clear of objects, except for those fixed by function, to provide vertical and horizontal wingtip clearance. TOFA and TLOFA design standards based on airplane design group (ADG) can be seen in **Table 2**.

Table 2: Taxiway Requirements – Airplane Design Group

Design Standard	ADG I	ADG II	ADG III
TOFA	89’ (44.5’ from Taxiway Centerline)	124’ (62’ from Taxiway Centerline)	171’ (85.5’ from Taxiway Centerline
TLOFA	79’ (39.5’ from Taxilane Centerline)	110’ (65’ from Taxilane Centerline)	158’ (77’ from Taxilane Centerline)

Source: FAA AC 150/5300-13B.

2.4. Fire Protection

The National Fire Protection Association (NFPA) provides standards to help in minimizing the negative effects of fire-related incidents. The New Hampshire State Fire Marshal’s Office uses NFPA 409 *Standard on Aircraft Hangars* (2011 edition) to regulate aircraft hangar construction. For the types and sizes of hangars discussed herein, NFPA 409 prescribes a 50-foot separation between structures. Hangars can be built with separations less than 50 feet if the hangar walls have a higher (specified) fire resistance rating. However, in discussing the cost with a hangar architect, the cost of doing so is upwards of hundreds of thousands of dollars in additional construction costs per hangar. Additionally, if hangar sizing or spacing exceeds certain prescribed NFPA thresholds, fire suppression systems must be installed.

For the fire suppression systems that may need to be installed, it is recommended the Airport avoid allowing fire suppression systems that use Aqueous Film-Forming Foam (AFFF). Given the recent difficulties surrounding the use of AFFF, and the ecological implications of water contamination caused by per- and polyfluoroalkyl substances (PFAS) contained in AFFF, it is recommended no fire suppression systems be allowed to be installed at the Airport that could introduce PFAS into the groundwater.

2.5. Snow and Ice

Where possible in this Study, recommendations are made that take into consideration the potential problems of snow and Ice buildup. Ideally, hangars should be sited to provide for southern exposure so solar radiation can minimize and remediate snow and ice buildup in front of hangar doors in the winter months.

3. EXISTING UTILITIES

The existing utilities that are provided to some or all of the Airport are an important consideration factor as either the Airport or private developers consider development locations.

3.1. Electricity

Electrical power is provided to all existing buildings at the Airport and the airfield by Eversource. It is anticipated that any new hangars or facilities along Airport Road could be supplied via existing transmission lines. Similarly, it is anticipated that new construction along Route 32 and Aviation Drive would be supplied by existing transmission lines.

3.2. Sanitary Sewer

The City of Keene Wastewater Treatment Plant (WWTP) is located on Airport Road, just outside of Airport property. Despite the proximity of the WWTP, there is no sanitary sewer available at the terminal building or along Airport Road. There is a high-pressure sewer supply line along Airport Road, but due to the high pressure, it is not possible to tap into it to provide sanitary sewer collection services at the terminal building or for any new development along Airport Road.

If sanitary sewer were provided along Airport Road, it would greatly increase the marketability of the parcels surrounding the terminal building. It would also greatly increase the efficiency of the terminal building and its tenants. Sanitary sewer is available and provided along Route 32 to the west of the Airport and Aviation Drive.

3.3. Liquid Natural Gas/Tank Propane

Liquid Natural Gas (LNG) is not available at or near the Airport. However, bottled propane is an option utilized locally for heating and other energy needs. Also, many homes around the Airport use home heating oil as a source of heat.

3.4. Stormwater

Considerations will have to be made for the sizing and placement of stormwater discharge elements capable of handling runoff produced by the structures, pavements, and landscaped areas that will be constructed. Roof drains and downspouts will need to either surface discharge or tie into underground detention systems with sufficient stormwater handling capacity that meets the New Hampshire stormwater laws. The Airport is classified as an industrial facility, and as such, is required to manage and keep an updated Stormwater Pollution Prevention Plan (SWPPP), which is intended to prevent groundwater contamination.

3.5. Broadband Internet

Internet service is provided to the Airport by Consolidated Communications. Airport Management has reported they believe an optical fiber communications line has been installed in the surrounding area.

4. DEVELOPABLE PARCELS, CONSTRAINTS, AND RECOMMENDED BEST USE

The parcels identified in this Study are described in the following sections and shown graphically in figures on the following pages. The overall Airport layout with the developable parcels can be seen in **Figure 2**.

4.1. Parcel 1

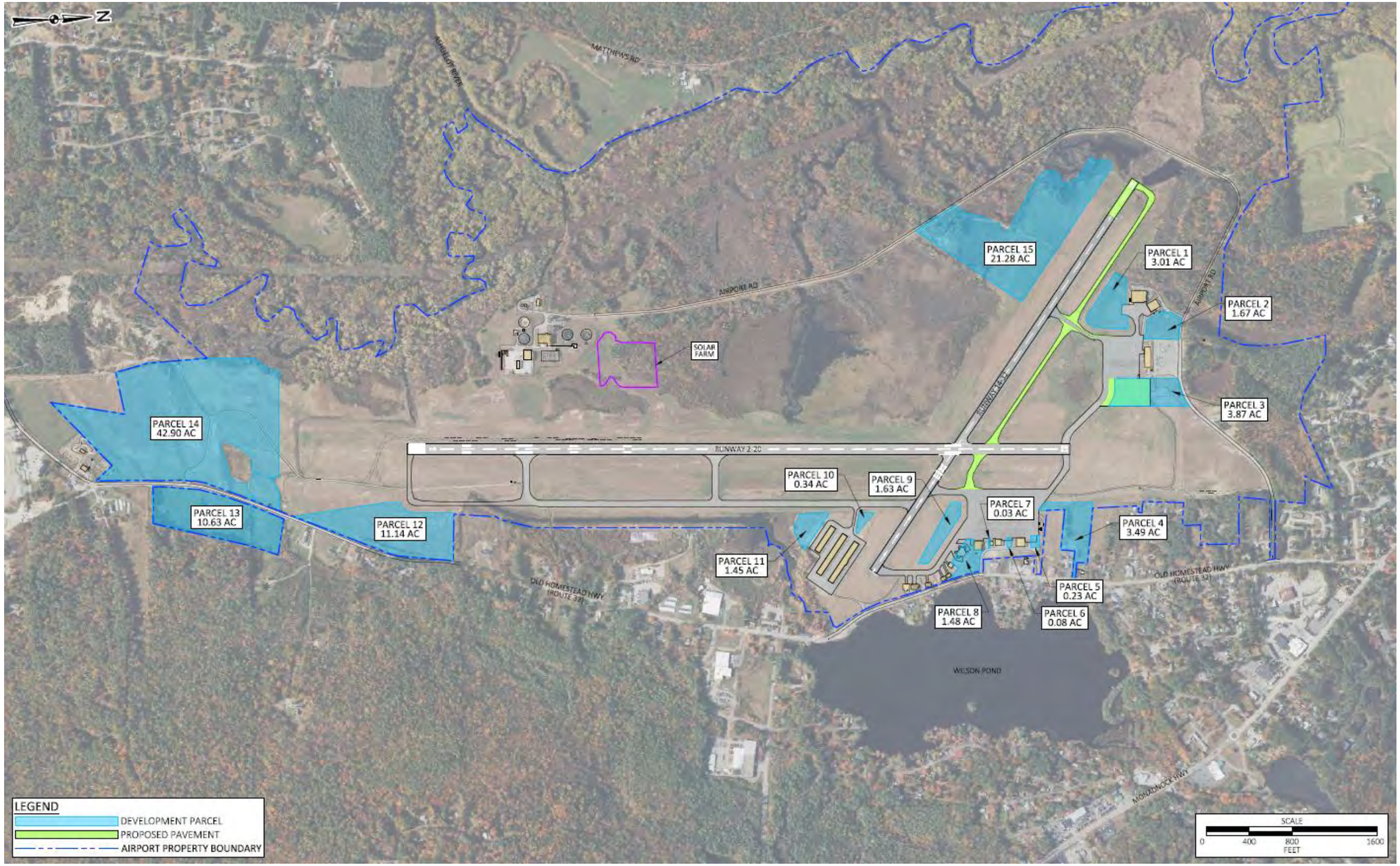
Parcel 1 can be seen in **Figure 3** and is located adjacent to the existing C&S Wholesale Grocers hangar, southwest of the terminal building and northeast of Runway 14-32. It is 3.01 acres, and a potential developer would need to expand the existing apron. Airport management has reported C&S Wholesale Grocers has a right of first refusal on this parcel.

The parcel is cleared and level, and if the parcel is developed for aviation or hangar use, aircraft could access the Airport via Taxiway S and/or future Taxiway B. Access could be provided via the drive behind the Airport maintenance building that also serves C&S. However, if that drive exclusively serves C&S and is constructed at their expense for their sole use, negotiations may need to take place for another tenant to use that infrastructure.

The parcel is constrained to the east by the Taxiway S TOFA and the proposed parallel taxiway to the southwest. Also, a 35-foot BRL is depicted which represents the location of the Part 77 transitional surface at 35 feet AGL. The height of a proposed structure will dictate how close it can be to avoid penetrating this surface. There is no sanitary sewer available, so a septic system would have to be considered in the design, and stormwater handling requires space, which will impact the available building footprint.

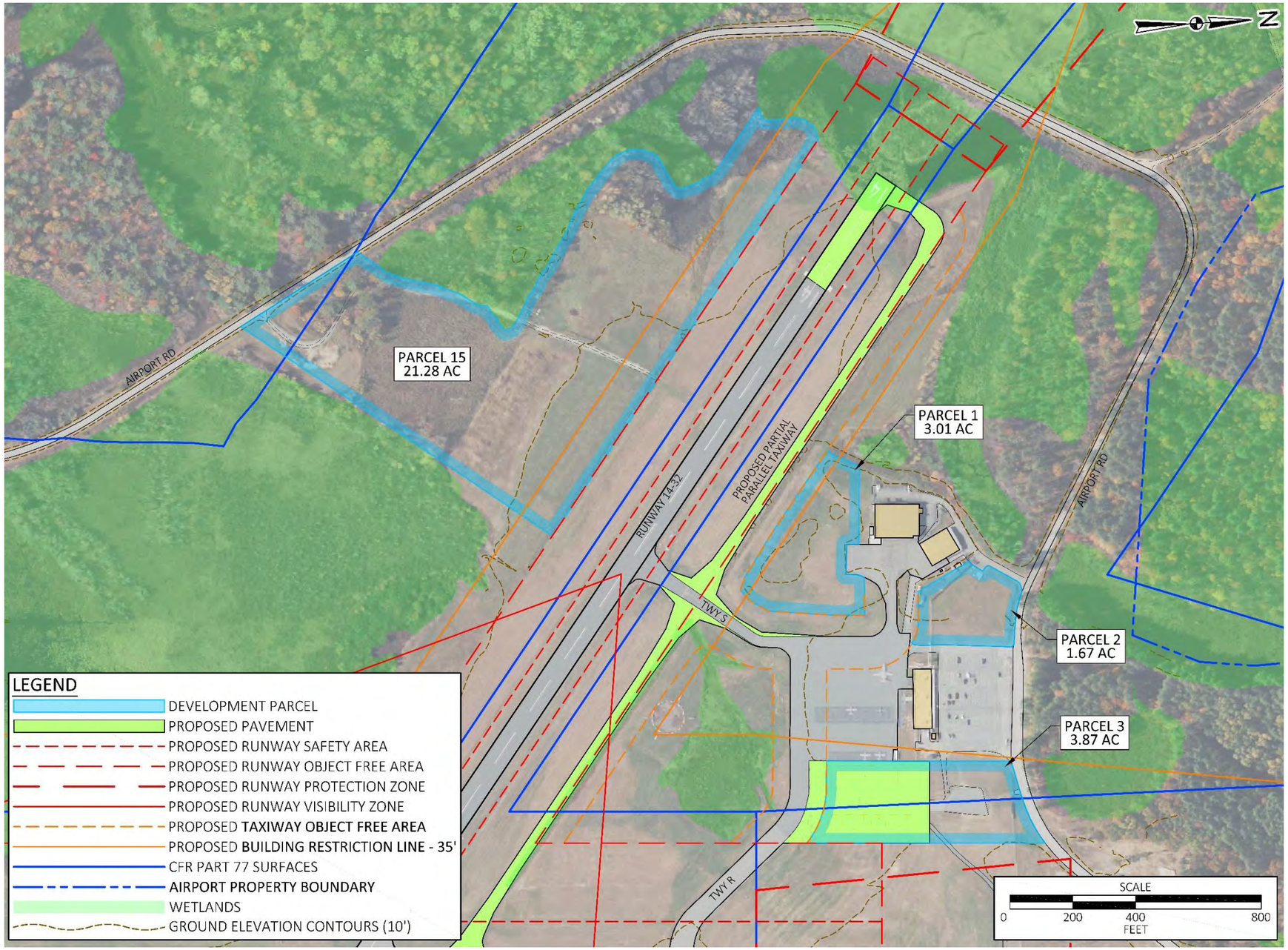
Parcel 1 would be ideally suited for one or more conventional hangars, situated similarly to the existing C&S hangar, with an apron that allows for southern exposure to minimize snow and ice buildup on the apron. The first of the hangars would be positioned south of the existing C&S hangar with the apron and vehicle access expanded. It is conceivable that a hangar of up to 18,000 SF could be accommodated in this location while respecting the 50-foot separation between hangars and remaining outside of the 35-foot BRL. Care would need to be taken to ensure no portions of the C&S apron are shaded during the short wintertime daylight

Figure 2: Airport Development Parcels



Source: McFarland Johnson, 2022.

Figure 3: Airport Development Parcels – Northwest



Source: McFarland Johnson, 2022.

hours, which could contribute to snow and ice buildup in front of their hangar doors.

A second hangar of up to 16,000 SF or more depending on the width could be constructed across from these two hangars in a campus style, with all three hangars taking advantage of southern solar radiation during the day. Vehicular, utility, and water access to this easternmost hangar would be slightly more challenging, but attainable.

4.2. Parcel 2

Parcel 2 is located between the terminal parking lot and the Airport maintenance/SRE building and can also be seen in **Figure 3**. It is 1.67 acres. It is cleared and graded. Access would easily be provided directly from Airport Road. Also, an apron and taxilane would need to be constructed providing access to Taxiway S or future Taxiway B2 if this parcel will be developed for aviation use.

It is constrained by the Airport Maintenance/SRE facility to the southwest, the terminal parking lot to the east, and Airport Road to the north. Again, without sanitary sewer, a septic system would need to be designed, and stormwater handling capacity needs to be included in the design.

With the location of Parcel 2 between Airport Road and the existing C&S Hangar taxilane, it is an ideal location for an additional conventional hangar. It is conceivable a hangar of up to 20,000 SF could be constructed in this location, possibly even larger. An additional corporate hangar in this location would contribute nicely to a conventional hangar campus in this portion of the Airport.

An alternative to a conventional hangar could be a row of standard or nested T-hangars. The orientation of Parcel 2 is very well set up for a single row of T-hangars. Potentially a 10- or 11-unit T-hangar could be sited in a north-south orientation that would see both sides of the T-hangar receiving solar radiation during the winter months, thereby minimizing the chances of snow and ice buildup in front of hangar doors.

4.3. Parcel 3

Parcel 3 is east of the existing terminal building and vehicle parking lot and is 3.87 acres. The parcel can be seen in **Figure 3**. The 2017 AMPU proposed a majority of Parcel 3 (approximately 75 percent) be developed as a tie-down apron, and this Study will still consider that apron as required for future aircraft parking needs.

Parcel 3 is constrained to the north by Airport Road, to the west by the terminal parking lot, and to the south by a proposed future tie-down apron. Parcel 3 is bisected by the edge of the Part 77 approach surface, with half of the Part 77 approach surface atop of it toward the east, and half of the Part 77 transitional surface atop of it to the west. This places the entire parcel within the 35' BRL. While it is typically not advisable for development within the 35-foot BRL and beneath the Part 77 approach surface, in this case, the Part 77 approach surface is sited based on the presence of an instrument approach to the opposite runway end (Runway 2). Having only visual approaches, the Runway 20 Part 77 approach surface and associated transitional surface would not typically have an impact on Parcel 3.

The entirety of Parcel 3 is within the 35-foot BRL, and half of the parcel is beneath the Part 77 approach surface. While Runway 20 has only visual approaches, the width of the Part 77 approach surface is based on the width of the Part 77 primary surface, which is driven by the presence of the instrument approach to Runway 2. Regardless of the driving factors, it does not change the fact that any structural development within this area would penetrate the Part 77 surfaces.

This Study examined the potential impact of a future instrument approach to Runway 20 with ¾ SM visibility. The Surface #5 ≥ ¾ Mile can be seen in **Figure 4**. As shown, Parcel 3 would remain outside of Surface #5, and would not detract from the potential of a future approach to Runway 20.

4.4. Parcel 4

Parcel 4 is toward the northeast of the Airport adjacent to Wilson Pond, and portions have been recently acquired. It is 3.49 acres and can be seen in **Figure 5**. Roadway access could be via Old Homestead Way, and, if this parcel will be developed for aviation or hangar use, a taxilane would need to be constructed to connect to Taxiway A or the adjacent apron.

Constraints include the Airport property line on the north and south sides, the Part 77 primary surface to the west, and Route 32 (Old Homestead Highway) to the east. A portion of Airport property does extend to Route 32, which would allow for existing sanitary sewer and water to be brought to the site. The parcel is uneven and descends toward the runway from the street as much as 25 feet.

Parcel 4 was originally depicted on the 2017 ALP with opposite-facing T-hangars along the north and south edges of the parcel.

Parcel 4 could be used for a corporate hangar of up to 27,000 SF or larger without penetrating the 35-foot BRL. However, doing so would mean setting the hangar further to the east, thereby increasing the amount of taxilane necessary to access the airport movement areas. Further, rising terrain toward the west will make hangar development in this parcel challenging.

There is a peninsula of land that is not owned by the Airport to the south of Parcel 4, and it would be worthwhile exploring a land swap for this parcel in exchange for Parcel 4 which might be better suited for non-airport development.

4.5. Parcel 5

Parcel 5 is 0.23 acres and located at the northeasternmost portion of the based aircraft apron and can be seen in **Figure 5**. It is constrained by the existing large green hangar to the south, the based aircraft apron to the east, Aviation Drive to the west, and the fuel farm access road to the north. The fuel farm access road is at a substantially higher elevation than Parcel 5 (approximately seven feet), which would need to be accounted for in the design of any hangar in Parcel 5. Either the road would need to be lowered, or a retaining wall would need to be constructed. The wall would need to be capable of supporting the road and fully laden delivery semi-tractor-trailer trucks that deliver fuel to the fuel farm. Parcel 5 has access to power, municipal water, and sanitary sewer along Old Homestead highway and Aviation Drive.

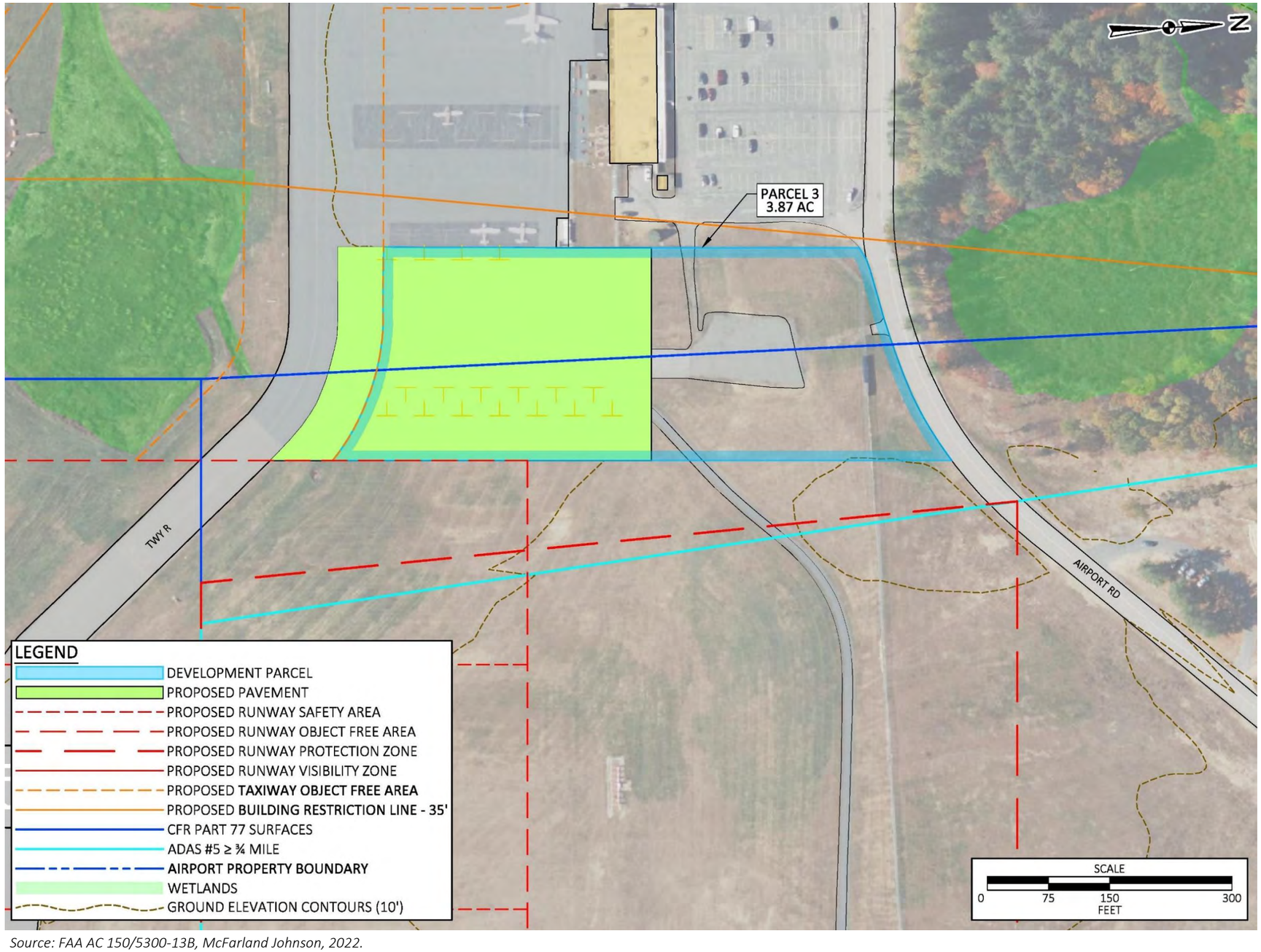
Although less than a quarter acre in area, Parcel 5 could be used for hangar development. It may be possible to construct a smaller conventional hangar with up to a 60-foot-wide door opening and a 60-foot hangar depth or perhaps even deeper. As previously mentioned, the fuel farm access lane runs just to the north of this parcel and is significantly higher than Parcel 5 which will need to be addressed if Parcel 5 is to be developed.

4.6. Parcel 6

Parcel 6 is inset along Aviation Drive adjacent to other conventional hangars and is 0.08 acre. It can be seen in **Figure 5**.

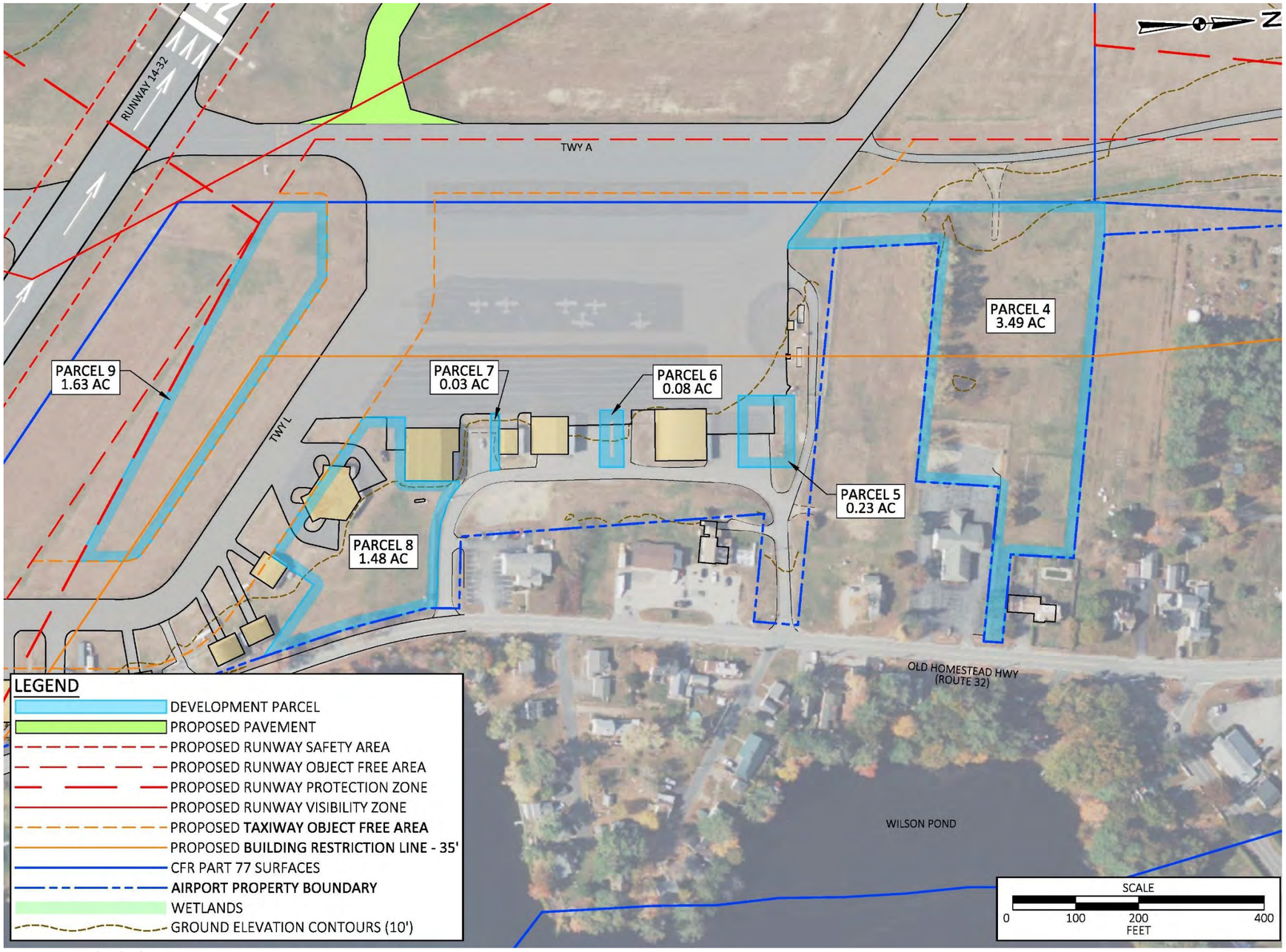
Parcel 6 is constrained by the large green hangar and the new Whip City Hangar that was recently constructed. Conversations with the Airport Manager revealed it was hoped parcel 5 could be used for hangar

Figure 4: Parcel 3 with Airport Design Approach Surface (ADAS) #5 ≥ ¾ Mile



Source: FAA AC 150/5300-13B, McFarland Johnson, 2022.

Figure 5: Airport Development Parcels – Northeast



Source: McFarland Johnson, 2022.

However, given the 50-foot separation standard between hangars imposed by NFPA 409, there is no opportunity for a hangar in this location. If the green hangar reaches the end of its useful life and is demolished, this opens up Parcel 6 for a large corporate hangar. Until then, constructing a hangar on Parcel 6 is not foreseeable.

Given the 50-foot hangar separation requirements of NFPA 409 and the siting of the newest hangar, there are only approximately 26 feet of space available between the large green hangar and the newest hangar on the Airport. As such, Parcel 6 is not viable for any sort of hangar development and should be abandoned for any future hangar development considerations. If the large green hangar reaches the end of its useful life and is demolished, this area opens up for additional hangar development.

4.7. Parcel 7

Parcel 7 is located along Aviation Drive and is the site of the former aircraft rescue and firefighting (ARFF) building, which is currently being used by the Airport for storage. It is assumed development on this parcel would involve the demolition of this structure. Parcel 6 is 0.03 acres and can be seen in **Figure 5**.

Similarly, to the plan for Parcel 6, there was the intent to demolish the old ARFF building and use Parcel 7 for hangar development. However, the siting of the most recently constructed hangar in this location has eliminated the possibility of any new hangar development in this location.

If a developer wanted to construct hangars in Parcel 6 or 7, a hangar could be constructed with fire-rated walls that meet the standards prescribed in NFPA 409. However limited research suggests that for a hangar of the magnitude of around 100 feet by 100 feet, this increases the cost of construction by hundreds of thousands of dollars. Cost increases of this magnitude for relatively small hangars might not be feasible. Further, it is unclear whether the existing hangar would need to be retrofitted with fire-rated walls as well. If there was any serious interest in developing hangars in this area, further research with a qualified architect and consultation with the New Hampshire State Fire Marshal's Office would be warranted.

Moreso than Parcel 6, Parcel 7 is not viable for hangar development due to the spacing restrictions of NFPA 409 and should be abandoned for any future hangar development considerations.

4.8. Parcel 8

Parcel 8 is located at the intersection of Route 32 (Old Homestead Way) and Aviation Drive and is approximately 1.48 acres. It can be seen in **Figure 5**. To fully realize this parcel for aeronautical use, the hexagonal hangar would likely need to be demolished to make the parcel fully accessible, which would potentially open up this space for a larger conventional hangar with an associated apron. Vehicular access and parking could easily be accomplished via Aviation Drive. Parcel 8 has access to power, municipal water, and sanitary sewer along Old Homestead Highway and Aviation Drive.

Parcel 8 is constrained by Aviation Drive to the north, Route 32 to the east, the Taxiway L TLOFA to the southwest, and an existing hangar to the northwest. Given the proximity of Wilson Pond to Parcel 8, it is likely any development must be permitted through a Shoreland Impact Permit Application

If the hexagon hangar has reached the end of its useful life, it should be demolished to make better use of the available land in Parcel 8. With the demolition of the hexagon hangar, Parcel 8 opens up to the full development potential of 1.48± acres. With southern exposure and road access, it is ideally situated for a conventional hangar. Conceptually, a hangar of up to 15,000 SF could be constructed in this location.

There is a terrain drop from Route 32/Aviation Drive to Taxiway L that will need to be considered in the planning of any facility in Parcel 8. Potentially, a retaining wall will need to be constructed to maximize buildable space in this parcel.

4.9. Parcel 9

Parcel 9 is located between Taxiway L and the approach end of Runway 32 and is 1.63 acres. It can be seen in **Figure 5**. Parcel 9 is constrained by the Taxiway L TLOFA to the north, northeast, and east, and Runway 14-32 ROFA to the southwest, as well as a small portion of the Runway 2-20 Part 77 primary surface to the west. Parcel 9 has access to power, municipal water, and sanitary sewer along Old Homestead Highway and Aviation Drive.

This location would be suitable for standard or nested T-hangars. However, with this double-sided hangar configuration, the northern side will be prone to snow and ice buildup.

Another alternative would be a 12-unit clear-span hangar system with the door openings and an apron toward the south only. It is estimated the dimensions of a 12-unit structure would be 528 feet long by 40 feet deep. Each unit would be 40 feet deep and have a door/stall width of 44 feet and a 14-foot door height which would accommodate 95 percent of ADG A and B aircraft, including all single-engine aircraft and most light and medium twin-engine aircraft. The entire structure would be within the 35-foot BRL. However, based on information from Fulfab, a hangar manufacturer, the total height of such a hangar would be 18 feet, 6 inches at the peak, which appears to be below the Part 77 transitional surface. As the roof slopes down and away from the peak to a height of 16 feet, 10 inches, it appears the entire structure will be entirely below the transitional surface.

A third and final option might be to install the clear-span hangar facing north as there is already a taxiway on that side (Taxiway L)

4.10. Parcel 10

Parcel 10 is a small parcel adjacent to the existing northeasternmost 20-unit T-hangar and is 0.34 acre. It can be seen in **Figure 6**. On the 2017 ALP, an extension to the existing 20-unit T-hangar was depicted. However, construction would encroach into the Runway 32 approach RPZ. As such, Parcel 10 has been reduced to only those areas outside of the RPZ.

Parcel 10 is constrained to the northeast by the Runway 32 approach RPZ, to the south by the Taxilane T TLOFA, and to the west by the Taxiway A TOFA. Further, Parcel 10 is entirely within the 35-foot BRL. While the 2017 ALP showed development within the Runway 32 approach RPZ, for the purposes of this Study, Parcel 10 has been limited only to areas outside of safety zones, and as such, is extremely limited for development.

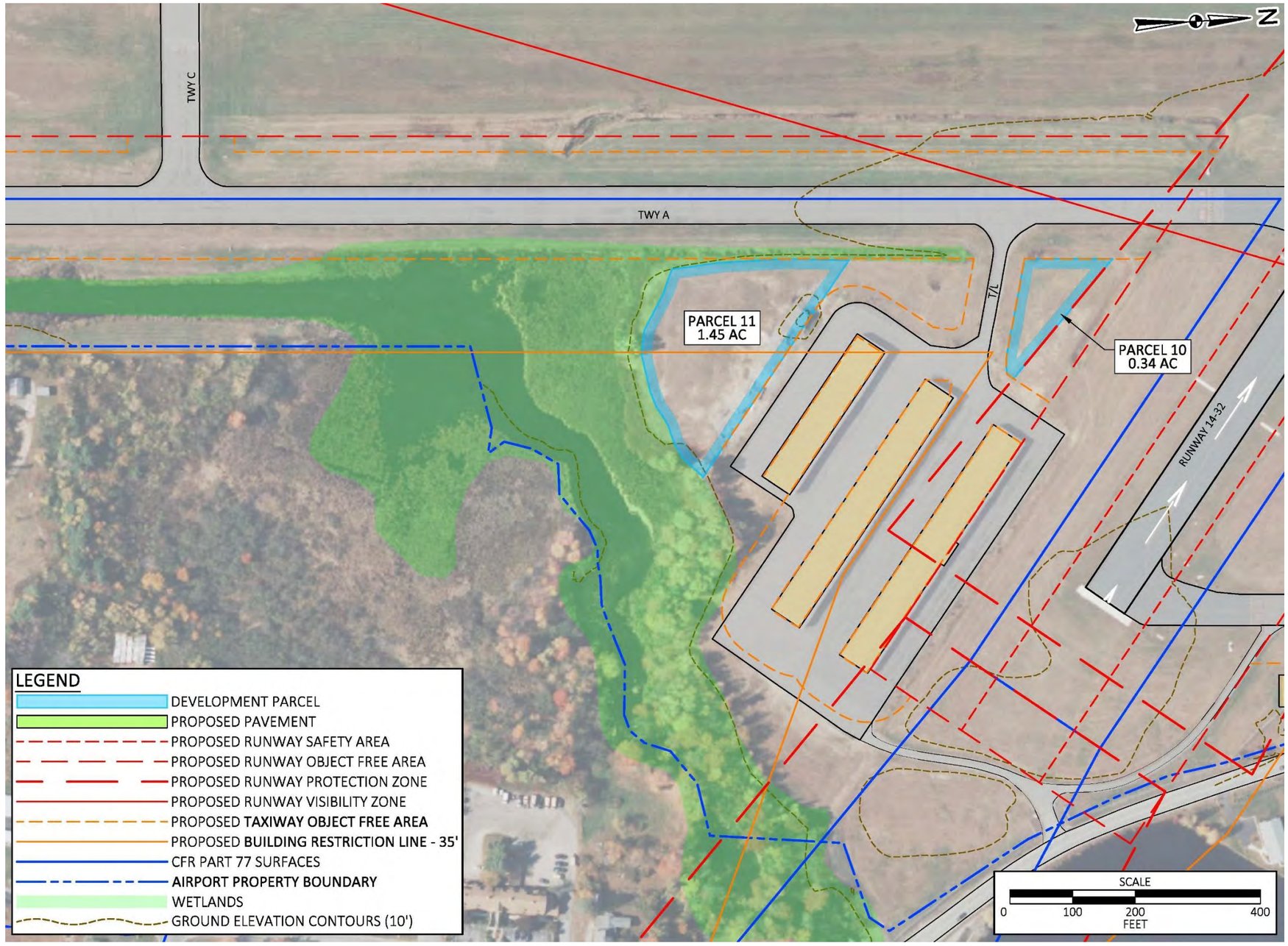
Given that Parcel 10 is entirely within the 35-foot BRL and limited to less than half an acre, there is no conceivable development potential, and it is recommended it be abandoned as a development site.

4.11. Parcel 11

Parcel 11 is 1.45 acres and is southwest of the existing T-hangars and west of Taxiway A. It can be seen in **Figure 6**. It is constrained by the T-hangars to the northeast, wetlands to the southeast, south, and west, and by the Taxiway A TOFA to the west. Parcel 11 also has relatively easy access to power, either from Old Homestead Highway, or by tapping into airfield electricity.

Given the proximity to the existing T-hangars, the ideal use for Parcel 11 would be an additional 10-unit T-

Figure 6: Airport Development Parcels – East



Source: McFarland Johnson, 2022.

hangar (or smaller as space allows). The 2017 ALP also depicted an additional T-hangar in this location.

An alternative to an additional T-hangar might be a small conventional hangar. Conceivably, a conventional hangar of up to 12,000 SF might be feasible in this location, with a direct access taxilane to Taxiway A.

Lastly, Parcel 11 could be utilized for a row of box hangars. Conceivably, a row of seven connected box hangars, each 44 feet wide by 40 feet deep would fit on this lot, with enough space for a suitable apron to accommodate aircraft operations.

4.12. Parcel 12

Parcel 12 as seen in **Figure 7** is along the southeast portion of the Airport adjacent to the new Taxiway A extension and is 11.14 acres. It is a wedge-shaped parcel along the Airport property line and a portion of Route 32.

Parcel 12 is constrained to the north, east, and southeast by the Airport property line, to the east and southeast by Route 32, and to the southwest and west by the Part 77 approach and primary surfaces, and the new Taxiway A TOFA. The Parcel is also constrained by terrain rising by approximately 40 feet from east to west, which could make structural development difficult.

The terrain slopes negatively from Route 32 down toward the approach end of Runway 2, which would make structural development difficult. Substantial amounts of fill would need to be removed and potentially a retaining wall would need to be constructed to make Parcel 12 viable for any hangar development.

An alternative to hangar development in Parcel 12 might be to lease the area for solar development. This would be in keeping with the City of Keene's sustainability goals and might be the only viable use for this parcel.

4.13. Parcel 13

Parcel 13 can be seen in **Figure 7** and is across Route 32 from the Airport. It is 10.63 acres.

It is not contiguous with the Airport, so aeronautical development is not possible without relocating Route 32, however, it could be developed for non-aeronautical use. A majority of the parcel is within the 35-foot BRL and beneath the Part 77 approach surface, but 2.26 acres to the south are unconstrained.

Parcel 13 is disconnected from the Airport and should be considered for non-aeronautical development. However, the majority of Parcel 13 is beneath the Part 77 50:1 approach surface. There are approximately three acres in the northeast corner of Parcel 13 that are outside of the Part 77 approach surface that could be considered for commercial development such as a multi-tenant retail facility. The Airport could charge a land lease for a developer to construct a commercial facility on this portion of the site. A majority of the remainder of the 10.63-acre has allowable structure heights of 15 to 25 feet, which is likely not enough clearance for any sort of structure. One possible consideration for the remainder of the parcel could be a solar farm, which does not require tall structures. Figure 8 depicts the allowable structure heights that could be considered within Parcel 13.

4.14. Parcel 14

Parcel 14 is aligned with the extended centerline of Runway 2-20 and is approximately 42.90 acres. It can be seen in **Figure 7**.

It is constrained to the north by the Runway 2 RPZ, to the east by Route 32, and to the south and west by the Airport property line.

Parcel 14 lies within the extended centerline of Runway 2 and only the 42.90 acres south of the RPZ are considered viable for any sort of development. A substantial portion of Parcel 14 has road frontage. The precision instrument approach to Runway 2 provides for a 50:1 slope for the Part 77 approach surface, which is the most restrictive slope, and this would only allow structure heights of 15 to 30 feet, which is likely not tall enough for any sort of retail facility. Also, Parcel 14 is separated enough from the runway and taxiway system that it is not viable for any sort of hangar development.

Like Parcel 13, portions of Parcel 14 could be ideal for a solar farm to help the Airport and the City of Keene come closer to attaining their sustainability goals. The allowable heights for development can be seen in **Figure 8**.

4.15. Parcel 15

Finally, Parcel 15 can be seen in **Figure 3**. It is adjacent to the approach end of Runway 14 and is 21.28 acres.

It is constrained to the northeast by the Runway 14-32 ROFA, to the southeast by wetlands, to the southwest by Airport Road and more wetlands, and to the west and northwest and west by still more wetlands. A taxiway providing access to Runway 14-32 would need to be constructed if Parcel 14 were to be developed for aeronautical use.

Parcel 15 is suitable for T-hangar or conventional hangar development. It is conceivable to site two 20-unit nested T-hangars, or box hangars in a northeast-southwest alignment with aprons along all sides, as well as two 10-unit nested T-hangars or box hangars in a northwest-southeast alignment with requisite aprons along all sides.

Alternatively, the parcel is large enough to support just about any size conventional hangar that might be appropriate for the types of aircraft that will utilize EEN. the parcel would require extensive development, including new pavement and a taxiway to connect to the approach end of Runway 14, as well as a vehicular access road from Airport Road. The extension of sanitary sewer along Airport Road will greatly enhance the development potential of this parcel.

5. CONCEPTUAL HANGAR LAYOUTS

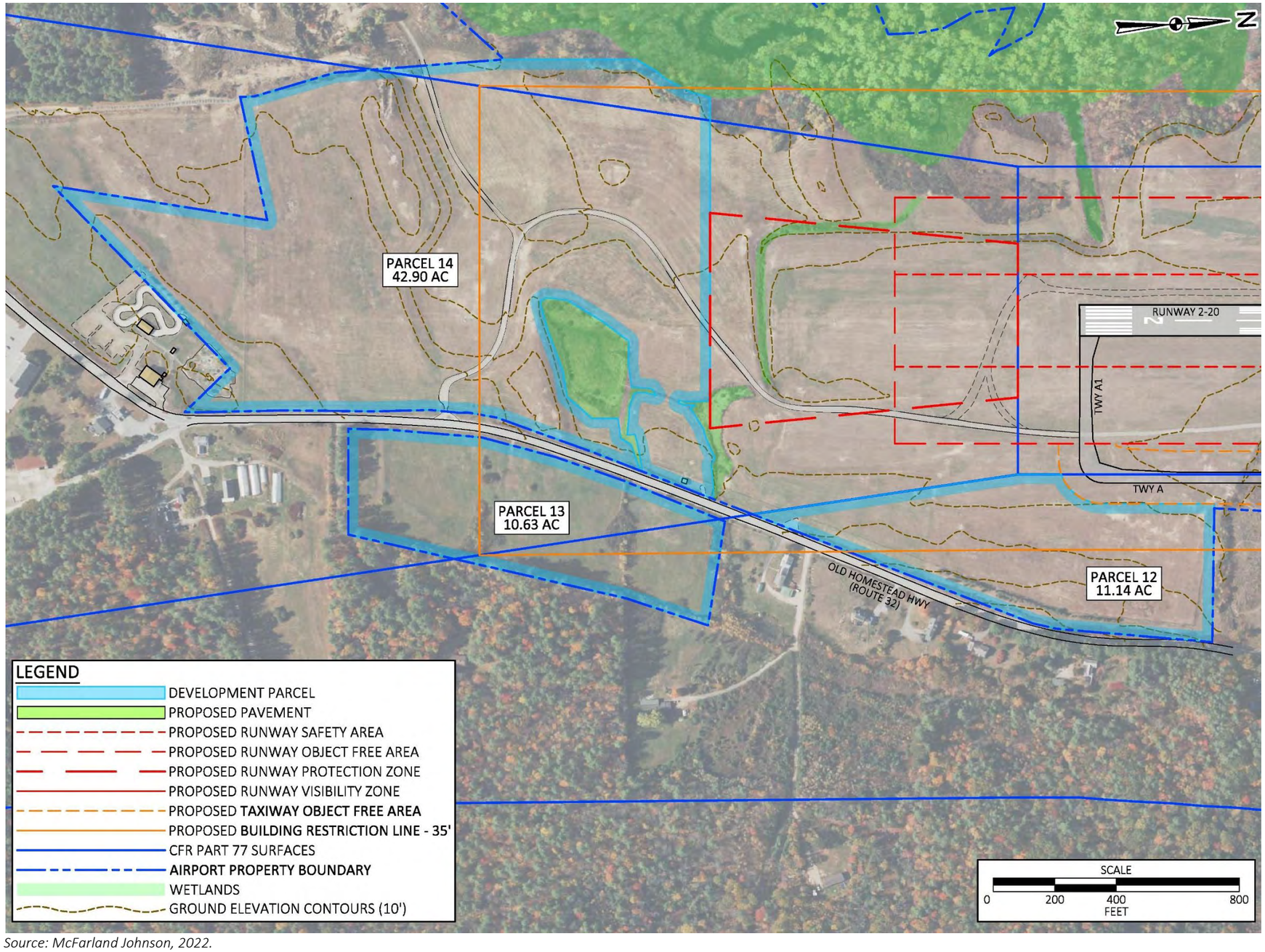
Figure 9 depicts three conceptual hangar layouts, including a 10-unit T-hangar, a 75-foot by 75-foot conventional hangar, and a 100-foot by 100-foot conventional hangar. It includes depictions of aprons outside of the hangars, and connections to taxiways/taxilanes for access to the Airport. Dimensions are provided to give a sense of the scale of these facilities for planning purposes, and potential lease development.

5.1. ADG I 10-Unit T-hangar

The first of the conceptual hangar layouts in **Figure 9** is the 10-unit T-hangar. A nested T-hangar design is depicted, which allows for a shorter overall building length as opposed to a standard or "stacked" T-hangar, wherein the aircraft are essentially parked in stalls adjacent to each other. The nested T-hangar design also allows for less taxilane pavement, which can be a cost saving.

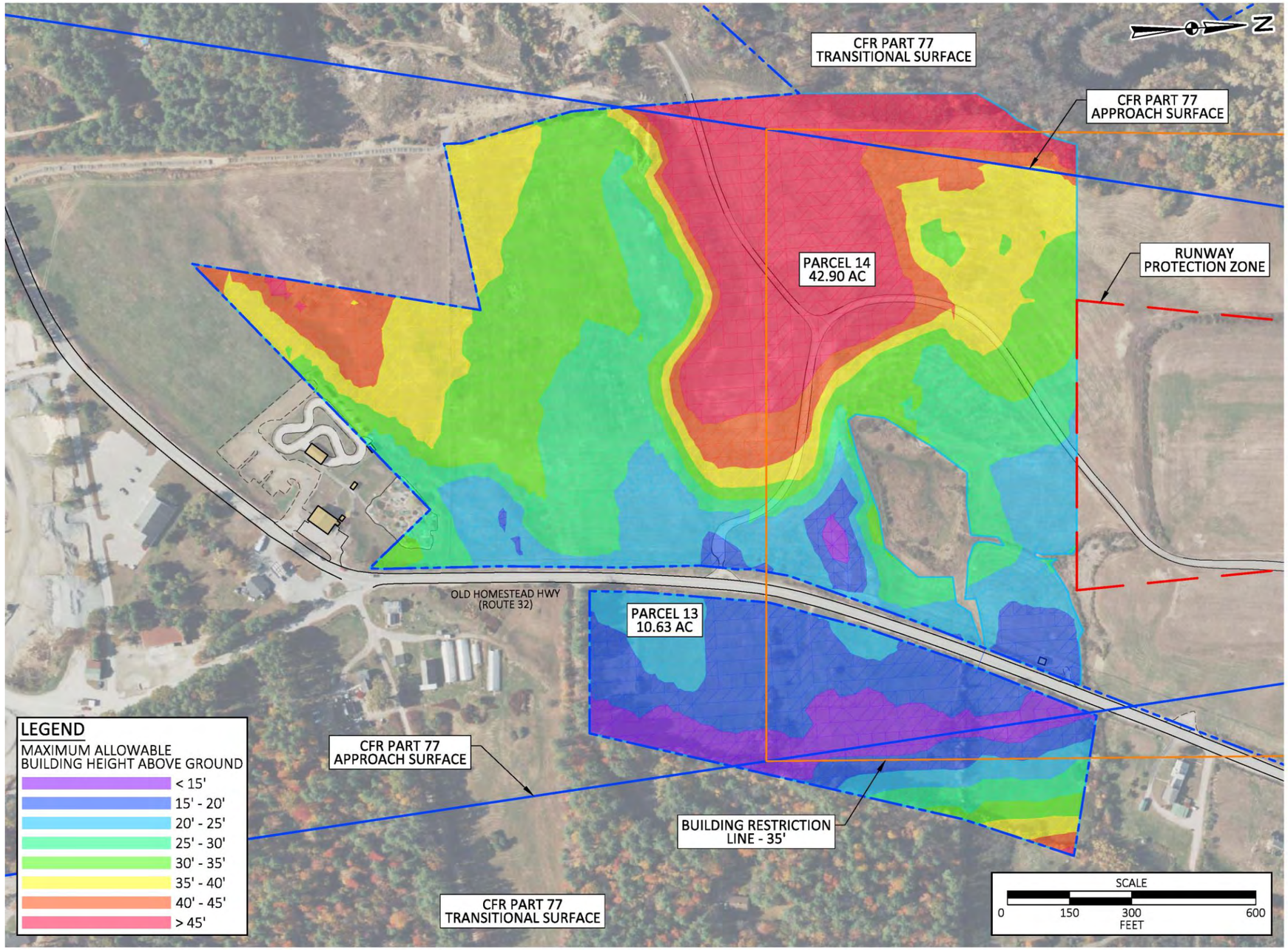
T-hangars typically accommodate ADG I aircraft such as a Cessna 172 or light twine engine aircraft but can be constructed to accommodate a range of aircraft sizes, with overall structure heights ranging from approximately 20 feet to up to 35 feet tall.

Figure 7: Airport Development Parcels – South



Source: McFarland Johnson, 2022.

Figure 8: Maximum Allowable Building Heights – Parcels 13 and 14



Source: McFarland Johnson, 2022.

5.2. ADG II 75-foot by 75-foot Conceptual Hangar Layout

The second conceptual hangar layout depicts a 75-foot by 75-foot conventional hangar. It is assumed the aircraft being accommodated would be ADG II aircraft with larger wingspans representative of a Beechcraft King Air 350 or similar large twin turboprop or small twin turbine corporate aircraft such as a HondaJet. An apron outside of the hangar for staging the width of the hangar and 65 feet deep (which represents approximately 56 percent of ADG II aircraft) would be used for aircraft staging.

The building height for this size hangar is estimated to accommodate aircraft with up to a 25-foot tail height (which represents approximately 95 percent of ADG II aircraft). There will be a four-foot clearance between

the tail height and the clear opening, a three-foot beam, and a 1:12 slope of the roof with three feet of roof ridge height. The total 75-foot by-75-foot hangar building is estimated to be approximately 35 feet tall. These dimensions are for planning purposes. Ultimately, hangars will be designed based on the needs at the time and will be located based on the current design, geometry, and airspace standards at the time of design (which may be different from current standards).

5.3. ADG II 100-foot by 100-foot Conceptual Hangar Layout

A 100-foot by 100-foot conceptual hangar layout is also shown in **Figure 9**. With even taller structures, these hangars would need to be sited even further still from the runway to remain below CFR Part 77 surfaces. An apron of building width and 90-foot depth (which represents approximately 79 percent of ADG II aircraft) for aircraft staging would be provided.

The building height for this size hangar is also expected to accommodate aircraft with up to a 25-foot tail height. There will be a three-foot clearance between the tail height and the clear opening, a three-foot beam, and a 1:12 slope of the roof, making for four feet of roof height. The total 100-by-100-foot hangar building is estimated to be approximately 35 feet tall. These dimensions are for planning purposes. Ultimately, hangars will be designed based on the needs at the time and will be located based on the current design, geometry, and airspace standards at the time of design (which may be different from current standards).

6. LOT CONFIGURATION

The Conceptual Layouts were taken one step further in **Figure 10**, which depicts the three hangars in their respective lots. The lots for the conventional hangars include a 50-foot buffer between structures to address fire standards. Also, each lot depicts critical elements including stormwater treatment areas, oil/water separator holding tanks, a utility corridor opposite the taxilane for electric, communications lines, water lines, and a septic system. Also shown is a concrete conduit along the taxilane for existing or future taxiway lighting. The lots include a staging apron outside of the hangar doors for startup, loading, and shutdown operations. Note that items such as septic and communications may not be necessary for T-hangars, depending on cost and complexity. The following square footages (SF) in **Table 3** were derived from the lot configurations and could be used to establish lease rates.

Table 3: Lot Configuration Square Footages

	10-Unit T-hangar	75-foot by 75-foot Hangar	100-foot by 100-foot Hangar
Structure	15,312	5,625 SF	10,000 SF
Apron	30,096	5,625 SF	10,000 SF
Total Lot	62,424	20,625 SF	32,250 SF

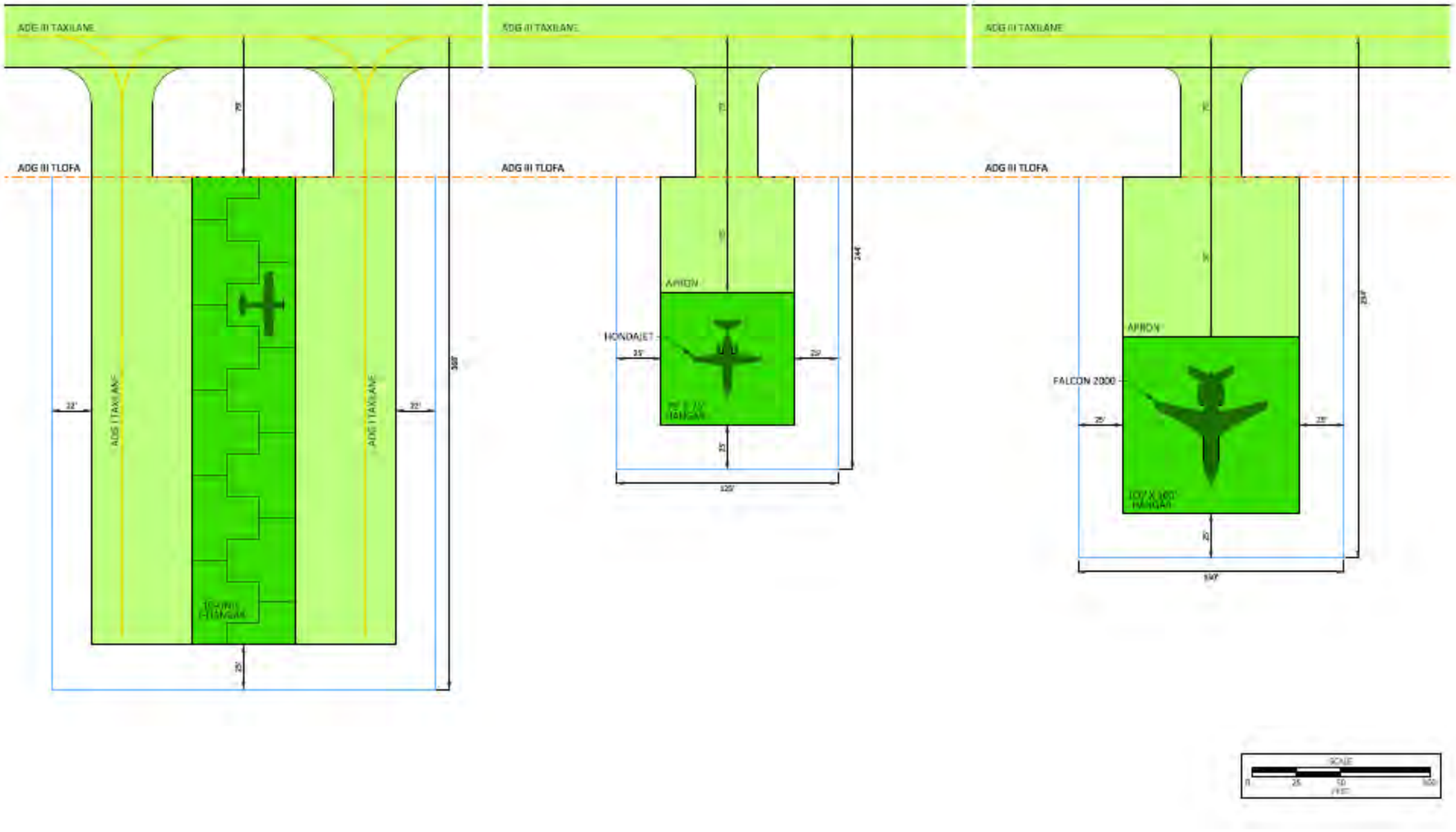
Source: McFarland Johnson analysis, 2022.

7. COST-BENEFIT ANALYSIS AND COMPARISON OF A 10-UNIT T-HANGAR

An important analysis for the Airport is a cost-benefit analysis between the capital cost of the City of Keene constructing a 10-unit T-hangar and leasing the 10 units over 40 years as opposed to providing land for a private developer to construct a 10-unit T-hangar and charging a land lease over the same 40-year period. A comparison between the two models of total costs after expenses will be made at the 20-year and 40-year marks. The following assumptions have been made in this analysis:

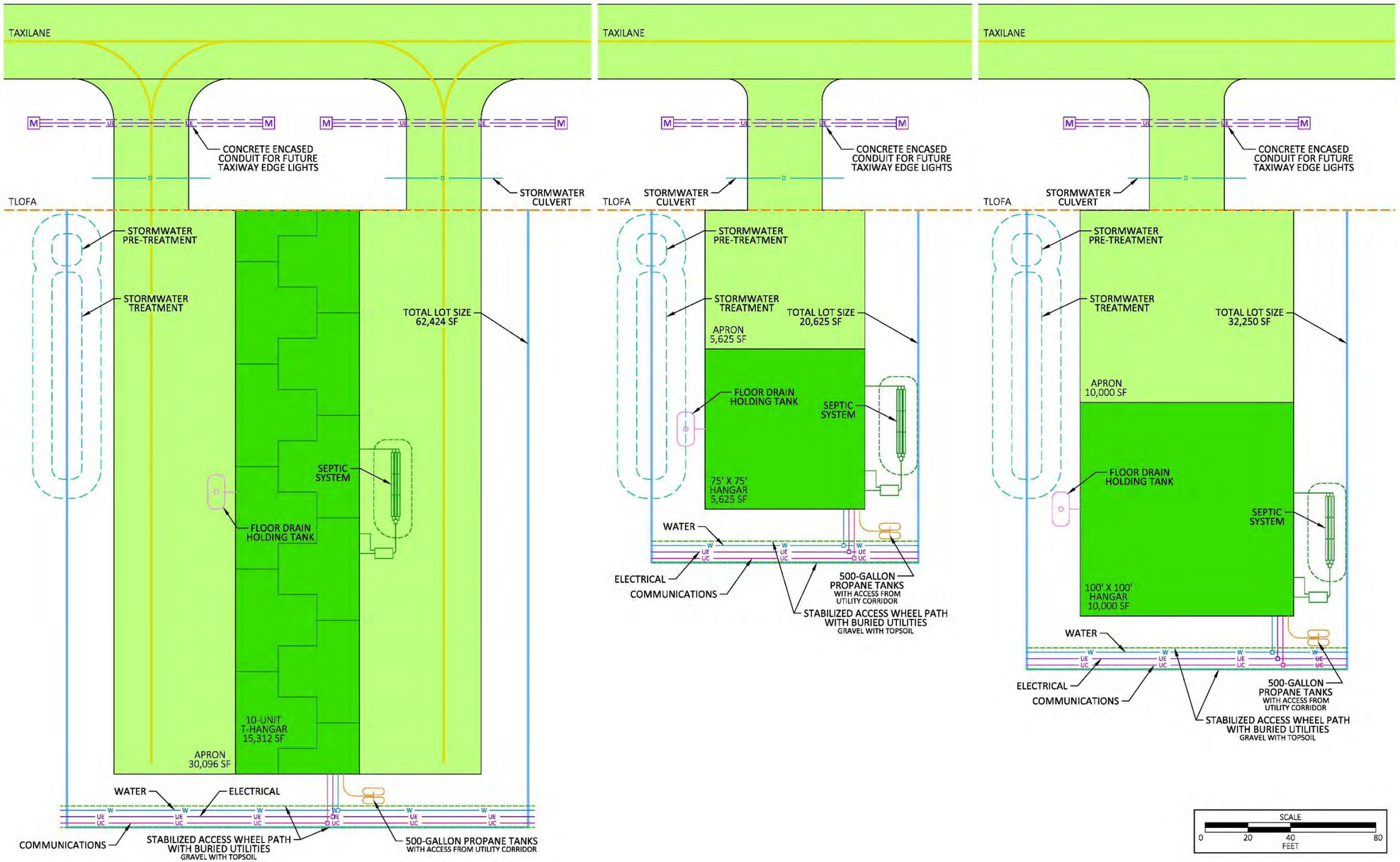
- For the 10-unit T-hangar the Airport would construct
  - Construction costs utilizing 2022 construction costs
    - Costs include taxilanes on both sides of the hangar
  - 100 percent occupancy rate
  - $600.00 per month T-hangar unit rental cost
    - T-hangar rental rates increase 10 percent every six years with no maximum
  - Maintenance costs assume $1,400.00 in year 1 (labor only) increasing at 3 percent per year
    - The cost to replace two hangar doors at the 30-year mark at $15,000.00 each
    - The cost to replace the roof at the 40-year mark at $250,000.00
  - Bond costs assume 5 percent interest and $10,000.00 issuance costs
- For the 10-unit T-hangar a private developer would construct, and the Airport would charge a monthly land lease
  - Land lease rate of $0.30 per SF per the *Airport Land Leasing Policy for the Keene Dillant-Hopkins Airport*
    - Land lease rate increases at an average of 3 percent per year (average Consumer Price Index (CPI))
  - One scenario assumes only the building footprint would be leased (approximately 15,000 SF)

Figure 9: Conceptual Hangar Layouts



Source: McFarland Jonson, 2022.

Figure 10: Hangar Lot Configurations

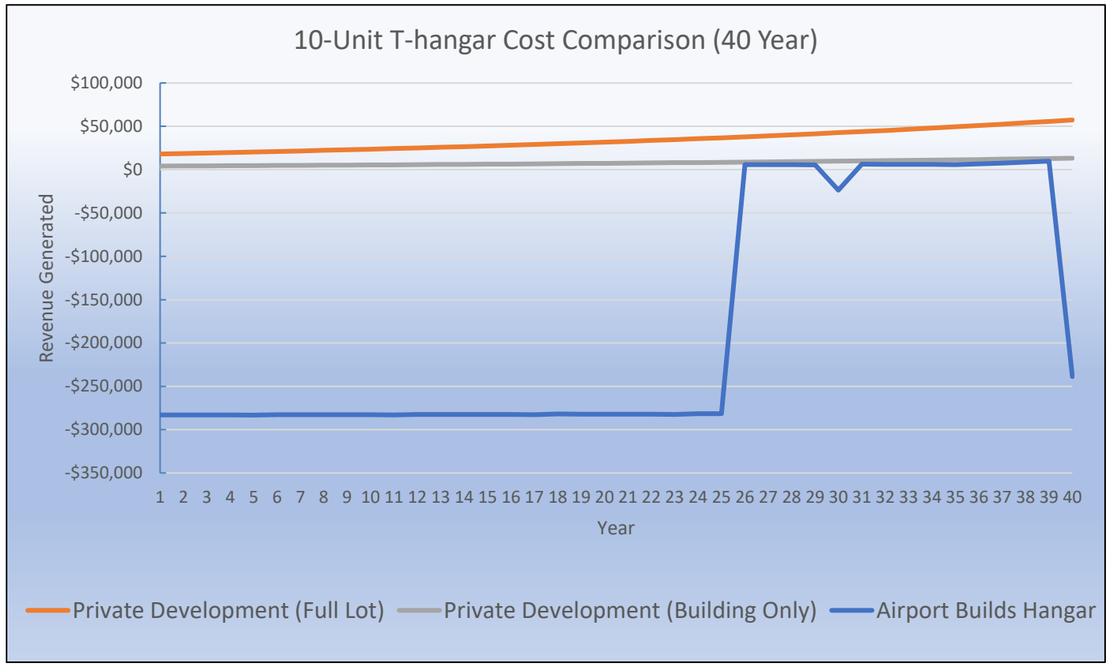


Source: McFarland Johnson, 2022.

- The second scenario assumes the entire lot, including taxilanes on both sides and the taxilane object free area would be leased (approximately 62,000 SF)
- Labor costs include monthly billing and annual CPI lease rate increases

The estimated 40-year costs can be seen graphically in **Chart 1** below.

Chart 1: T-hangar Cost Comparison Chart



Source: McFarland Johnson analysis, 2022.

7.1. Airport Constructed Hangar

The first scenario will consider the cost of the Airport constructing a 10-unit T-hangar and leasing the units. To perform this analysis, some general assumptions and simplifications have been made. Using 2022 construction costs, it is estimated the cost of the T-hangar would be $4.1 million. Additional assumptions are the hangar would be constructed to FAA standards using burdened rates.

The Airport would likely need to bond such a project, and a compounded interest rate of five percent was used for the analysis over a term of 25 years. With these terms, the total interest cost of the bond is estimated to be over $3 million, bringing the total cost of the project over 25 years to approximately $7.2 million.

Also, maintenance costs were estimated to be approximately $1,400.00 per year (two employees at $35 per hour performing 20 hours of maintenance per year). The maintenance costs escalate at three percent per year to cover the costs of annual salary increases. Also, general high-cost items such as the potential replacement of up to two hangar doors at $15,000.00 each, and the eventual necessity of a roof replacement at the end of the 40-year lifespan of the structure have been included as potential considerations.

As can be seen from **Chart 1**, the Airport under this scenario would struggle to recoup costs until year 25, when the bond is fully paid off. Even after that time period, ongoing maintenance and repair costs make profitability in this scenario exceedingly difficult.

7.2. Private Development with a Land Lease

The second scenario considers the 10-Unit T-hangar being constructed with private development and the Airport charges a land lease in accordance with the established land lease policy. Two separate scenarios have been considered. In the first scenario, the land lease only charges for the building footprint (not recommended), and in the second scenario, the entire lot, including taxilanes on both sides of the T-hangar, out to the edges of the taxilane object free area is included in the lease (recommended). The latter is preferred because the extra areas included would otherwise not be available for any future development and revenue generation. It is understood that a negotiation process would likely result in a total amount of square feet somewhere between these two scenarios.

Airport labor costs considered are only administrative and include the monthly cost of billing and calculating the annual CPI rate increases (one employee at $35 per hour conducting 18 hours of admin work per year at one hour per month for billing and six hours per year to calculate the CPI increases and implement them). This rate is increased at 3 percent per year to consider the increasing cost of labor over time.

One important consideration is the responsibility for the construction and maintenance of the taxilanes on both sides of the T-hangar. Private developers typically expect the Airport to carry out this construction, thereby lowering their construction costs and making a project viable. However, if the taxilanes are expected to be solely used by the T-hangar tenants, then it is assumed that construction and maintenance would be the responsibility of the developer. A possible solution might be to have the developer construct the taxilanes, and hand them over to the Airport for ongoing maintenance as part of the Airport's pavement management plan.

8. RECOMMENDATIONS

As the Airport continues to grow and evolve, the future siting of hangars will be a critical component of its success. Airports that do not take this important first step in looking at the big picture of development can end up inadvertently closing off portions of the Airport that could be better developed, or development components can be constructed in areas that limit the utility of the Airport for decades to come.

In all cases, where a maximum buildout of a parcel or a portion of a parcel is recommended, negotiations with potential tenants should begin with the idea the tenant will lease the entirety of that parcel or portion of that parcel. If a potential tenant seeks to construct a smaller hangar on a parcel that would support a larger facility, that tenant is depriving the Airport of valuable potential revenue that might otherwise be entitled to the Airport and is thereby lessening potential revenue the Airport is entitled to.

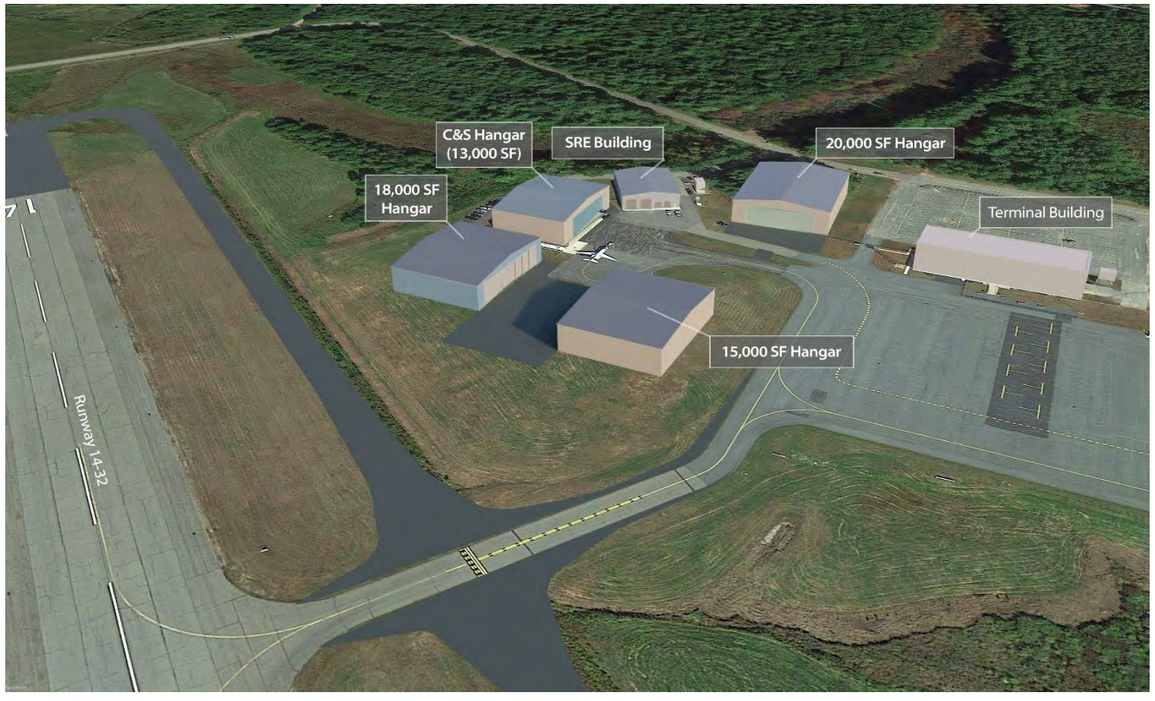
To become obtainable, any proposed hangar development will be dependent on a public-private partnership (P3). Public use infrastructure such as access roads, utility corridors, taxilanes, and holistic stormwater permitting are items that will be benefiting the whole development and should be considered as a public responsibility. There are federal funding sources such as the Northern Borders Regional Commission (NBRC), Economic Development Administration (EDA), and the FAA which can provide funding for a portion of this work. Public funds can be reimbursed through impact fees established uniformly for private developers. The private sector will be responsible for tailoring the hangar facility to fit their specific operational needs. Building projects become costly when conducted with federal funding sources and have longer implementation

periods. By pre-permitting and prepping the access and utilities for the hangar sites, private development can be quickly implemented, and hangar construction can begin to allow for aircraft operations shortly thereafter. This will also improve the marketability of the hangar development in the future.

For T-hangar and box hangar development, it is recommended the Airport solicit developers and showcase Parcels 9 and 15.

For conventional hangar development, it is recommended the Airport solicit developers who are willing to construct today, and Parcels 1 and 2 are ideal locations for large hangar development. **Figure 11** depicts what a corporate conventional hangar campus might look like adjacent to the terminal building.

Figure 11: Conceptual Hangar Development Parcels 1 and 2



Source: McFarland Johnson, 2022