3.0 FACILITY REQUIREMENTS

This chapter identifies the facility requirements necessary to meet existing and forecast airport requirements, satisfy FAA design standards, and improve safety. The facility analysis is consistent with the guidelines and standards established in FAA Advisory Circulars.

The analysis includes the following components:

- Airfield Capacity
- Airport Design Standards
- Runway Requirements
- Taxiway Requirements
- Instrument Approach Procedures
- Landside Facilities
- Support Facilities
- Airport Roadways and On-Airport Access
- Airport Staffing

The feasibility and impacts associated with providing the identified facilities is evaluated in subsequent chapters, prior to the development of the recommended plan.

3.1 Airfield Capacity

This section reviews the airfield capacity of OXC, evaluates any capacity surpluses or deficiencies, and identifies airfield improvements that may be required during the 20-year planning period. Airfield capacity is defined as the maximum rate that aircraft can arrive and depart an airfield with an acceptable level of delay. It is a measure of the number of operations that can be accommodated at an airport during a given time period, which is determined based on the available airfield system (runways, taxiways, navaids, etc.) and airport activity characteristics.

The current technique employed by the FAA to evaluate airfield capacity is described in Advisory Circular (AC) 150/5060-5, *Airport Capacity and Delay*. This procedure identifies Hourly Airfield Capacity and Annual Service Volume (ASV).

- Hourly Airfield Capacity: The maximum number of aircraft operations that can take place on the runway system in one hour. As airport activity occurs in certain peaks throughout the day, accommodating the peak hour activity is most critical.

- Annual Service Volume: The annual capacity or the maximum level of annual aircraft operations that can be accommodated on the runway system with an acceptable level of delay. The ASV considers peaking characteristics in its calculation. As such, an airport's ASV would increase without any system or physical airfield improvements if activity became more evenly spread throughout the day, week, and/or year. The opposite would occur if operations became more pronounced into peak periods.

For airports that have multiple runways, air traffic controllers have multiple operating procedures to handle air traffic (e.g., landing on one runway with departures on another). However, as OXC has a simple airfield configuration with a single runway, the airfield capacity does not depend upon various operating configurations. Therefore, the simplified method as provided in FAA AC 150/5060-5 was used to estimate capacity. The AC provides tables of estimated capacity based upon characteristics of the airport. For OXC, the following characteristics and assumptions are applicable:

- The percentage of operations of aircraft over 12,500 pounds is currently 6%, but is forecast to increase to 10% by 2023.
- No operations of aircraft over 300,000 pounds will occur at OXC.
- OXC will remain a general aviation facility with no scheduled commercial service.
- OXC has an ILS, an ATCT, and no airspace limitations.
- Touch and goes (i.e., local operations) will remain under 50% of the total operations.
- Landings generally equal takeoffs during peak periods.
- Monthly peaking is significant (due to summer training activity).
- Hourly peaking is significant (due to touch and go training operations).

Based on the assumptions above, the estimated airfield capacity of OXC is as follows:

- VFR Hourly Capacity: 98 Operations
- IFR Hourly Capacity 59 Operations
- Annual Service Volume 230,000 Operations

Table 3-1 provides a comparison of airfield capacity to airport activity.

TABLE 3-1 – HOURLY CAPACITY ESTIMATE			
		2003	**2023**
a) Peak Hour Operations – VFR		60	75
b) Peak Hour Operations – IFR		5	7
c) Total Annual Operations		66,000	87,000
Source: Activity Forecasts, Chapter 2			
d) Peak Hour Capacity – VFR		98	98
e) Peak Hour Capacity – IFR		59	59
f) Annual Service Volume		230,000	230,000
Source: FAA AC 150/5060-5			
VFR Hourly Capacity Ratio	%(a/d)	61%	77%
IFR Hourly Capacity Ratio	%(b/e)	9%	12%
Annual Capacity Ratio	%(c/f)	29%	38%

As identified in Table 3-1, the airfield currently provides ample capacity to accommodate existing and future operations, with the VFR hourly capacity reaching only 77% during the 2023 peak hour.

Note that the above capacity analysis assumes that full parallel taxiways are provided to prevent unnecessary runway crossing. Currently, a runway crossing is required each time an aircraft based on the east side of the Airport taxis to Runway 36 for takeoff. The lack of an east side full parallel taxiway requires these departing aircraft to cross the runway and utilize Taxiway “A” to access the departure end of Runway 36. Additionally, aircraft making full stop landings on Runway 18 that are headed to east side facilities often need to back-taxi on the runway or conduct a runway crossing after exiting the runway onto Taxiway “A.” This situation will be exacerbated as additional development occurs on the east side of the Airport. These runway crossings may reduce the VFR hourly capacity by as much as 20 percent. Thus, peak hour operations may approach capacity by 2023, resulting in delays to aircraft operations.

In summary, OXC generally provides adequate airfield capacity for existing and future activity; however, runway crossings are currently needed for some operations and will increase in the future. Airfield hourly capacity would be enhanced by the provision of a full parallel taxiway on the east side of the runway. Annual capacity at OXC will continue to be adequate throughout the planning period.

3.2 Airport Design Standards

As discussed in the previous chapter, the Airport's design aircraft is currently a Gulfstream IV (Model G450), which falls within Airport Reference Code (ARC) D-II. Several G450 aircraft are currently based at OXC, and the FAA has recorded over 500 annual itinerant operations of these aircraft since 2001. However, as more Gulfstream V (Model G550) and Bombardier Global Express aircraft continue to be based and operate at OXC, these aircraft are anticipated to become the future design aircraft for OXC. These newer aircraft fall within ARC D-III due to their larger wingspans (i.e., 94 feet). Table 1-7 provides the characteristics that define an airport's ARC.

The projected change in the ARC for OXC has the potential to create new airport facility requirements, as the larger wingspans of the newer aircraft determine the required offsets and dimensions for the Airport. Table 3-2 lists several of the required offsets and FAA design standard changes that occur when the ARC increases from D-II to D-III.

Key airfield design standards include the Runway Safety Area (RSA), Runway Object Free Area (OFA), Runway Protection Zones (RPZ), and several runway and taxiway offsets (i.e., separation standards). The three standards defined below consist of two-dimensional ground surfaces established to protect the safety of aircraft operations and/or people on the ground. These standards must be reviewed as part of the Airport Master Plan Update (AMPU).

TABLE 3-2 – AIRPORT DESIGN STANDARDS				
Design Criteria	**FAA Design Standard**		**Current Condition**	**Deficits** (per D-III)
	ARC D-II	**ARC D-III**		
Runway Safety Area (RSA)				
Width	500 feet	500 feet	500 feet	- - -
Length Beyond Runway End	1,000 feet	1,000 feet	720-920 feet[1]	80-280 feet[1]
Object Free Area (OFA)				
Width	800 feet	800 feet	800 feet	- - -
Length Beyond Runway	1,000 feet	1,000 feet	1,000 feet	- - -
Runway Protection Zone (RPZ) [2]				
Inner Width	500 feet	500 feet	500 feet	Contains
Outer Width	1,010 feet	1,010 feet	1,010 feet	homes north
Length	1,700 feet	1,700 feet	1,700 feet	of runway
Runway Width	100 feet	100 feet	100 feet	- - -
Taxiway Width	35 feet	50 feet	40-50 feet	0-10 feet
Runway Centerline To:				
Edge of Aircraft Parking	400 feet	500 feet	475 feet	25 feet
Parallel Taxiway Centerline	300 feet	400 feet	400 feet	- - -
Taxiway Centerline To:				
Fixed or Moveable Object	65.5 feet	93 feet	75 feet	18 feet[3]
Parallel Taxilane Centerline	105 feet	152 feet	130 feet[4]	22 feet

[1]The current RSA dimensions are the result of a 2004 improvement project to extend the RSA to better meet FAA standards. The current RSA dimensions remain non-standard, but have been approved by the FAA.
[2]RPZ dimensions for the existing 1-mile IFR visibility minimum. RPZ dimensions increase with any reduction in the IFR visibility minimums.
[3]Taxiway centerline offset for parked aircraft on the Northeast Ramp, Northwest Ramp, and South Ramp.
[4]Offset dimension for the parallel taxilane located along the T-Hangars parallel to Taxiway "B."
Notes:
FAA Advisory Circular 150/5300-13 (Changes 1-8)
Complete list of airport design standards is found in Appendix B

- Runway Safety Area (RSA) – A defined surface surrounding a runway prepared for reducing the risk of damage to airplanes in the event of an undershoot, overshoot, or excursion from the runway. This area must also support snow removal equipment, aircraft rescue, and fire fighting equipment. The RSA should be free of objects, except for those objects that must be located in the area because of their function.

- Runway Object Free Area (OFA) – A ground area surrounding the RSA and runway that should be clear of objects, except for objects that need to be located in the area for aeronautical purposes.

- Runway Protection Zone (RPZ) – Trapezoidal areas located beyond the runway ends that should be controlled by the airport for the protection of people and property on the ground. This is achieved through airport property acquisition, easements, or zoning to control development and land use activities.

As indicated in Table 3-2, several features of the Airport do not meet existing and/or future FAA design standards. As the AMPU is a long-range study, satisfying future requirements is an important consideration. The discussion below addresses each of the deficits identified in Table 3-2.

The standard dimensions of the RSA are the same for the existing and future ARC. However, the actual dimensions will remain nonstandard even in light of the recent 2004 RSA expansion project.

The FAA standard length of 1,000 feet beyond the north end of the runway is not feasible due to the drop-off in topography, the location of Juliano Road, and the high development costs for the final 80 feet of RSA. Beyond the south end of the runway, the Larkin State Park Trail, topography, and private property hinder a full length RSA. Nevertheless, the 2004 RSA improvement project provided additional safety for all aircraft operations, even though it did not provide full FAA standards. The project extended the length of the RSA beyond both runway ends as indicated in Table 3-3. Figure 1.2 in Chapter 1 depicts the 2004 RSA dimensions.

TABLE 3-3 – RSA DIMENSIONS

Runway End	**Length beyond Runway End**		
	Previous RSA	**2004**	**FAA Standard**
Runway 18	300 feet	920 feet	1,000 feet
Runway 36	500 feet	720 feet	1,000 feet

Note: RSA extension project completed in 2004

The RPZ on the southern end of the Airport does not contain any residential or commercial development, and satisfies FAA criteria. However, much of the RPZ property is not owned by the State. Ideally, State control of the RPZ, either through easement or acquisition, is desirable to prevent future development and clear tree obstructions.

Although the RPZ is primarily designated to protect people and property on the ground, the FAA considers the clearing of all objects within the RPZ a safety benefit, particularly objects that obstruct the runway approach surface. On the southern end of the Airport, a major 115 K.V. transmission line traverses the RPZ (see Figure 1.2) and obstructs the approach to Runway 36. The utility company that owns the line, Northeast Utilities, is proposing a new electrical substation within the RPZ. ConnDOT is working with Northeast Utilities on this issue in an effort to potentially lower or bury the power line in the area of the RPZ and improve land use compatibility. This issue is further discussed in later chapters of the AMPU.

The RPZ on the north end of the Airport contains 32 homes. The FAA classifies residential development as a non-compatible land use within an RPZ. The homes were developed during the same time as the Airport. The State does not own any interest in the properties containing the homes, and thus does not control the land use in the RPZ. Nevertheless, later chapters of the AMPU and the separate FAR Part 150 Noise Study address alternatives for improved land use compatibility in the RPZs.

The remaining design standard deficiencies at OXC are associated with the anticipated change in the ARC from D-II to D-III. This change affects the required taxiway width, as well as the separation standards for taxiways, taxilanes, aircraft parking, and other objects. The current width of Taxiway "A," while Taxiway "B" and all exit taxiways are 50 feet wide. As such, widening of Taxiway "A" or another alternative may be necessary.

The ARC change would also increase the required distance between the following:

- Runway centerline and the aircraft parking aprons (i.e., tiedowns located on the Northeast Ramp, and potentially on the Northwest Ramp and South Ramp) from 400 to 500 feet.

- Taxiway centerline and the aircraft parking aprons (i.e., tiedowns located on the Northeast Ramp, and potentially on the Northwest Ramp and South Ramp) from 65.5 to 93 feet.

- Parallel Taxiway "B" centerline and the parallel taxilane centerline located along the T-hangars from 105 to 152 feet.

These dimensional changes would result in minor clearance deficits of 18 to 25 feet. Remedies for such conditions may include tiedown relocations, use restrictions, or the application of "modifications-to-standards." Each of these alternatives is discussed in later chapters of the AMPU.

Overall, OXC currently meets most FAA design standards for both the current and future ARC. The existing runway width, parallel taxiway offsets, and recent RSA improvements have positioned the Airport well for accommodating aircraft in ARC D-III. The previous 1995 Master Plan Study anticipated these newer and slightly larger aircraft to be the ultimate business users of OXC. However, note that no additional change in the ARC beyond D-III is anticipated during or after the planning period. In other words, ARC D-III is anticipated to be the final classification of Waterbury-Oxford Airport.

3.3 Runway Requirements

The 2004 runway and RSA extension project essentially completed the final runway development anticipated for OXC in the foreseeable future. The surrounding topography, existing development, and limited availability of property would make additional runway expansion difficult. As such, only a brief review of runway requirements for OXC is provided below.

3.3.1 Runway Length

Runway length requirements are based on the most demanding aircraft group anticipated to utilize the runway on a regular basis. For OXC, this group includes the large business jets based at the Airport with maximum gross takeoff weights of over 60,000 lbs. (e.g., Gulfstream IV & V, and Bombardier Global Express). In 2003, over 20 such aircraft were based at OXC, with more anticipated during the short-term planning period.

FAA Advisory Circular (AC) 150/5325-4A, *Runway Length Requirements for Airport Design*, requires the use of aircraft manufacturer manuals to determine runway requirements for these aircraft. A brief review of aircraft manuals indicated that the required runway takeoff length for these aircraft is between 5,500 and 6,100 feet under standard temperatures and conditions and full payload. Under higher temperatures, the required runway length for each aircraft would exceed 6,000 feet. Thus, a runway longer than the current length at OXC is justified. However, it was previously determined that no additional runway length is feasible at OXC due to site conditions and available property. Thus, the current runway length of 5,800 will be maintained throughout the planning period.

At OXC, full use of the 5,000 feet of runway between the landing thresholds is available for all users and operations. The 2004 runway and RSA improvements provided an additional 300 feet on Runway 18 and 500 feet on Runway 36 for use on takeoff. The 2004 project paved portions of the RSA as runway to provide a total length of 5,800 feet. This additional runway pavement provides flexibility in payload and range to jet operators. However, most operators of jets over 60,000 lbs. still need to limit their payloads at OXC based on current conditions and aircraft performance capability.

The available runway lengths at OXC are as follows:

	Runway 18	Runway 36
• Takeoff Run Available (TORA)	5,800 feet	5,800 feet
• Accelerate-to-Stop-Distance Available (ASDA)	5,300 feet	5,500 feet
• Landing Distance Available (LDA)	5,000 feet	5,000 feet

Note that the TORA is generally used by propeller driven aircraft only. The TORA includes the entire length of the runway that is suitable for takeoff run requirements. Jet aircraft, which predominately operate under more stringent FAR Part 135, typically can only use the runway length declared available for Accelerate-to-Stop-Distance purposes. The ASDA is the portion of the runway available for aircraft to accelerate to near takeoff speed, then to decelerate to a full stop. For OXC, the ASDA is less than the TORA in order to provide an adequate RSA length beyond the runway end.

3.3.2 Runway Orientation

The ideal orientation of a runway is a function of wind speed and direction, and the ability of aircraft to operate under crosswind conditions. As a general rule, the primary runway at an airport should be oriented as closely as practical in the direction of the prevailing winds. This enables aircraft to takeoff and land in the direction of the wind, which improves safety. The most ideal runway alignment provides the highest wind coverage percentage. The desired wind coverage for the runway system is set by the FAA at 95 percent, and assumes that small aircraft can handle crosswinds of no greater than 10.5 knots (12 mph). This is the crosswind component.

To determine the wind coverage at OXC, wind data between 1988 and 1994 was collected from the OXC Airport Weather Observation System (AWOS) as part of the 1995 master plan. That analysis indicated that the most prevalent wind direction is north-northwest and northwest. As such, the existing runway is well oriented with the prevailing winds as it contains an orientation of nine degrees west of true north (i.e., North 9^o West - true). This orientation provides approximately 96 percent wind coverage for a 10.5-knot crosswind component. The wind coverage is higher for larger aircraft that can handle stronger crosswinds of 13 to 16 knots.

Nevertheless, approximately four percent of the time, strong crosswinds at OXC make runway operations difficult, particularly for lighter aircraft. These crosswinds are typically from the west and west-northwest, and generally occur in winter months. Due to these crosswinds, the Airport previously provided a crosswind runway. However, the available property and topography did not enable an adequate runway length with a standard Runway Safety Area. Furthermore, OXC has a high demand for additional landside facilities. As such, the crosswind runway was decommissioned and the property was redeveloped for hangars, aprons, and vehicle parking.

3.3.3 Lighting, Marking, & Signage

Runways that provide an Instrument Landing System (ILS) precision approach should be provided with several standard items. For OXC, these items include High Intensity Runway Lights (HIRL) and precision runway markings to improve pilot reference during low visibility conditions and at night; grooved pavement to enhance braking for heavier aircraft over 12,500 pounds; and required FAA signage. OXC currently provides each of these facility requirements.

On individual runway ends, a Visual Glide Slope Indicator (VGSI) provides lights that guide the pilot to the appropriate approach slope to the runway touchdown point. These systems improve safety and help to standardize approach altitudes. At OXC, two different VGSI systems are provided. A Precision Approach Path Indicator (PAPI) is installed on the Runway 36 end and a Visual Approach Slope Indicator (VASI) is provided on the Runway 18 end.

Runway End Identifier Lights (REIL) consist of two high intensity flashing white lights installed at the runway end and directed toward the approach zone. The REIL enable pilots to identify the threshold of a usable runway from a distance and in reduced visibility conditions. The FAA recommends REIL for runway ends that provide instrument approach capability. At OXC, REIL are provided on the Runway 36 end, and should also be provided on the Runway 18. REIL are considered a low-cost approach lighting system.

The standard approach lighting system for airports with an ILS is a Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR). A MALSR is standard equipment on FAA-owned and maintained Instrument Landing Systems. Although OXC has an ILS on Runway 36, only REIL are currently provided. The addition of a MALSR would significantly enhance pilot reference during low visibility conditions and is recommended for OXC. If existing Runway 36 approach obstructions could be removed, the MALSR would also enable reduced visibility minimums on the published ILS approach.

However, due to limited property, the Larkin State Trail, steep topography, and other site conditions, a MALSR system would be difficult to install on Runway 36, and thus, has not been initiated in the past. The alternative evaluation of this study further addresses the need, cost, and impacts of providing a MALSR system on Runway 36.

Table 3-4 provides a summary of the existing and recommended runway facilities at OXC.

TABLE 3-4 – RUNWAY LIGHTING & FACILITIES

	Existing 2003	**Required 2023**	**Deficit**
Runway 18-36	HIRL Precision Markings Grooved Pavement Standard Signage	HIRL Precision Markings Grooved Pavement Standard Signage	- - -
Runway End 18	VASI	VASI/PAPI REIL	REIL
Runway End 36	PAPI REIL	VASI/PAPI MALSR	MALSR

Notes:
VASI – Visual Approach Slope Indicator
PAPI – Precision Approach Path Indicator
REIL – Runway End Identifier Lights
MALSR – Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights

In summary, the runway at OXC currently provides most required facilities, and few additional items will be considered in this AMPU. However, the potential development of an approach lighting system (i.e., MALSR) on the Runway 36 end should be considered.

3.4 Instrument Approach Procedures

OXC is currently served with instrument approaches to each runway end. Both precision and nonprecision instrument approaches are available to Runway 36, while Runway 18 is served with only nonprecision approaches. Table 1-5 previously provided a listing of the existing Instrument Approach Procedures (IAP) available at OXC.

By definition, a precision instrument approach provides lateral and vertical guidance to landing aircraft whereas a nonprecision approach offers only lateral guidance. Given the types of aircraft utilizing OXC on a daily basis, it would be desirable to provide precision approaches to both runway ends. Although Runway 36 has this capability using an ILS, approach obstructions and the lack of an approach lighting system limits the visibility minimum to 1 statute mile. Consideration to installing a MALSR, which is the least complex system compatible with a Category I precision approach, was given previously to lower the visibility minimum. Under ideal conditions, the visibility minimum could be reduced to ½-mile.

An instrument approach procedure to Runway 18 that provides vertical guidance can be achieved without the use of ground-based navigational aids such as an ILS. Satellite-based navigation using the Global Positioning System (GPS) in concert with the Wide Area Augmentation System (WAAS) can be employed to generate an instrument approach with Lateral Precision with Vertical guidance (LPV) minimums.[1] Such a procedure is recommended for Runway 18, and can be provided with or without a MALSR.

Similarly, there is a safety benefit to providing a GPS-based instrument approach with lateral and vertical guidance to Runway 36 in the event that the existing ILS (i.e., localizer and/or glide slope) is temporarily out of service. The publication of a RNAV (GPS) procedure with LPV minimums to Runway 36 would provide this capability without the need for the existing ground-based terminal navigational aids. The term RNAV denotes area navigation and reflects the FAA's shift to instrument approach technology that embraces the concept of required navigation performance (RNP). RNAV will eventually apply to all approaches that have an area navigation avionics capability and will be included in all approach procedure titles. Those approaches that utilize GPS for navigation and which were referred to as stand-alone GPS are the first to be renamed as RNAV (GPS).

To provide for nonprecision approaches, the FAA has already published RNAV (GPS) with LNAV (lateral navigation) minimums to both Runways 18 and 36. These procedures are an improvement over the older nonprecision approaches at OXC, and are flown using the ground-based Waterbury NDB, as a result of the more precise positioning data offer by the satellite system. The addition of an approach lighting system for the nonprecision procedures could also result in lower visibility minimums.

A summary of the existing IAP at OXC and the facility requirements is provided in Table 3-5.

[1] Until WAAS reaches full operational capability, minimums for LPV will be limited to 250-½ and LPV is considered a quasi-precision approach. Thereafter, minimums as low as 200-½ are possible and the FAA may designate a new acronym for the procedure. Approach lighting will be needed for the ½ minimum.

TABLE 3-5 – INSTRUMENT APPROACH PROCEDURE REQUIREMENTS				
		Existing 2003	**Required 2023**	**Deficit**
Runway 18	Precision	None	RNAV (GPS) LPV	LPV
	Nonprecision	RNAV (GPS) LNAV NDB	RNAV (GPS) LNAV	- - -
Runway 36	Precision	ILS	ILS RNAV (GPS) LPV	LPV
	Nonprecision	RNAV (GPS) LNAV	RNAV (GPS) LNAV	- - -
ILS – Instrument Landing System (using ground based localizer and glide slope electronic equipment) LPV – Lateral Precision with Vertical guidance, using WAAS LNAV – Lateral Navigation NDB – Non-Directional Beacon				

The ability to achieve these instrument approach procedures is addressed in a subsequent chapter of this report. These analyses are conducted in accordance with IAP design criteria that consider a host of factors in the ability to provide a stabilized instrument approach to a runway end.

3.5 Taxiway Requirements

A taxiway system enables safe and efficient access between the runway and landside areas. At OXC, current taxiways include connector, exit, and parallel taxiways. This section describes the existing taxiway system and identifies necessary facility improvements.

Parallel Taxiway “A” was constructed on the west side of the runway at the time of the Airport’s initial development, with an exit taxiway provided at mid-field. At the time, all hangars and facilities were located on the west side of the Airport and the taxiway system was adequate. Airport activity and based aircraft have grown over the years, and now include a mixture of over 200 based aircraft, ranging from two-seat trainers to large business jets weighing nearly 100,000 lbs.

In 1993, development on the east side of the Airport began with the Northeast Ramp and partial parallel Taxiway “B.” In late 1990s, crosswind Runway 13-31 was closed because it did not provide an adequate length or RSA, as well as to enable additional landside development on the east side of the Airport to accommodate new users and tenants. Since then, development has continued on the east side of the runway, and has included seven new hangars (including Hangar G in 2005) and associated aprons and taxilanes.

A clear need exists for a full parallel taxiway on the east side of the runway, which is the highest priority airfield facility requirement for OXC. A full parallel taxiway could be provided by extending Taxiway “B” to the Runway 36 end.

Full parallel taxiways are of critical importance to airports with significant levels of activity. They provide for aircraft ingress and egress at the ends of the runway, and therefore:

- Prevent the need for aircraft to back-taxi on the runway
- Eliminate most runway crossings
- Reduce taxi time and operational delays
- Reduce controller and pilot workload

Based on each of the above items, parallel taxiways are a critical element of airfield systems as they improve safety by reducing the risk of runway incursions. An incursion generally occurs when an aircraft on the ground creates a loss of separation or collision hazard with another aircraft that is landing or departing. More specifically, an incursion occurs any time one aircraft is within the runway holdline while another aircraft is landing or departing. Incursions also include vehicles, equipment, or people on the ground that interfere with an aircraft operation.

Although incursions always involve some degree of human error, the primary means for general aviation airports to reduce the number of incursions is to provide an efficient and logical taxiway layout that reduces back-taxiing, runway crossings, and taxi time. From a safety standpoint, reducing runway incursions is a high priority of the FAA and National Transportation Safety Board (NTSB), second only to RSA improvements.[2]

To support the parallel taxiway system, exit taxiways are needed along the length of the runway. Although there is no FAA requirement for the number or location of exit taxiways, guidelines are provided in AC 150/5300-13 for planning exit taxiway locations. Suitably-located exit taxiways improve both efficiency and safety by minimizing runway occupancy time. At OXC, if landing aircraft overrun the existing midfield exit taxiway (i.e., Taxiway “G”), they must continue on the runway for another 2,500 feet to reach the next exit location.

FAA data indicates that most light aircraft should not overrun the Taxiway “G” exit, but only 10 percent of large aircraft (over 12,500 lbs.) will exit the runway by Taxiway “G,” which is located 2,500 feet from the landing thresholds. However, over 80 percent of large aircraft could exit the runway if an exit taxiway was located 3,500 to 4,000 feet from the landing threshold.

Therefore, to enable more efficient runway use, three additional exit taxiways are recommended for OXC; one on the east side of the runway and two on the west side. This recommendation would double the number of exit taxiways and could reduce runway occupancy time by about 30 seconds per landing for aircraft that currently overrun exit Taxiway “G.” The recommended locations of the additional exit taxiways are identified in later chapters of the AMPU.

Connector Taxiway “D” also warrants consideration. This taxiway is 20 feet in width, and serves a 10-bay T-hangar, apron tiedown for 15 aircraft, and a maintenance hangar (Executive Flight Services). Taxiway “D” connects this development area to Taxiway “A.” As the hangars are located approximately 20 feet below Taxiway “A,” Taxiway “D” requires a non-standard

[2] FAA Runway Incursion Airport Assessment Report, Technology Assessment Team (TAT), December 2002.

longitudinal grade of approximately three percent to reach the apron elevation of the development area.

Taxiway "D" serves small aircraft under 12,500 pounds that fall within ARC B-I. For these type of light aircraft, the FAA maximum grade for taxiways is two percent, with a minimum width of 25 feet (per FAA AC 150/5300-13). As such, connector Taxiway "D" does not satisfy FAA design standards. Thus, the AMPU should investigate alternatives to improve these deficiencies.

In summary, the taxiway facility requirements for OXC include the following:

- Extend Taxiway "B" to the end of Runway 36 to provide a full parallel taxiway on the east side of the runway.
- Provide three additional exit taxiways (1 on the east side; 2 on the west side)
- Upgrade Taxiway "D" to meet FAA standards for grade and width (if feasible).

3.6 Landside Facility Analysis

This section describes the guidelines and methodologies used to develop landside facility requirements for OXC. The identified requirements are based on industry planning standards and FAA guidelines. The following categories were examined as part of this AMPU:

- Hangar Requirements
- Aircraft Apron Requirements
- Fueling Facility Requirements
- Airport Administration/Maintenance/ARFF Facilities
- Service Road Requirements
- Land Acquisition

3.6.1 Hangar Requirements

Hangar requirements for a general aviation airport are a function of the number of based aircraft, type and relative value of aircraft to be accommodated, owner preferences, and area climate. Requirements for hangar space were estimated from industry planning standards, and through discussions with airport tenants and management. In general, owners/operators of large corporate aircraft prefer conventional hangar storage, which provides heating, security, office space, and enables maintenance and other services. Owners of light piston-powered aircraft generally prefer low cost T-hangars or apron tiedowns.

Hangar space requirements for OXC were calculated using the following assumptions:

Aircraft Type	Desired Type of Storage	Area Requirement
Piston (single & multi)	50% T-Hangar	1,200 sf / aircraft
	50% Apron Tiedown	300 sy / aircraft
Turboprop & Rotorcraft	100% Conventional Hangar	1,600 sf / aircraft
Turbo-Jet	100% Conventional Hangar	2,500 sf / aircraft

These space planning assumptions were applied to the 2003 based aircraft and 2023 forecasts listed in Table 3-6.

TABLE 3-6 – BASED AIRCRAFT SUMMARY

Aircraft Type	2003	2023
Piston (single & multi-engine)	188	200
Turboprop & Rotorcraft	11	15
Jet	37	72
Total	**236**	**287**

Source: Chapter 2, Table 2-5
Note: Helicopters are included with turboprops for landside planning purposes.

Existing and future hangar requirements are shown in Table 3-7. Conventional hangar space for turboprop and jet aircraft was estimated for 2003 and 2023. Existing and future T-hangar bays and tiedown requirements for piston-powered aircraft were also estimated.

TABLE 3-7 – BASED AIRCRAFT HANGAR & APRON REQUIREMENTS				
Facility by Aircraft Type	**2003**		**2023**	
	Aircraft	**Area**	**Aircraft**	**Area**
Conventional Hangar				
Turboprop / Rotorcraft	11	17,600 sf	15	24,000 sf
Jet	37	92,500 sf	72	180,000 sf
Sub Total	**48**	**110,100 sf**	**87**	**204,000 sf**
Existing Availability[1]		108,000 sf		108,000 sf
Surplus (Deficit)		(2,100 sf)		(96,000 sf)[2]
Piston Aircraft				
T-Hangars	**94**	**112,800 sf**	**100**	**120,000 sf**
Existing T-Hangars[3]	64	76,800 sf	64	76,800 sf
Surplus (Deficit)	(30)	(36,000 sf)	(36)	(43,200 sf)
Apron Tiedowns (minimum)	**94**	**28,200 sy**	**100**	**30,000 sy**
Apron Tiedowns (+10%)[4]	103	30,900 sy	110	33,000 sy
Existing Apron Tiedowns	138	41,400 sy	138	41,400 sy
Surplus (Deficit)	35	10,500 sy	28	8,400 sy
Total Based Aircraft	**236**	**---**	**287**	**---**

Notes
[1]Estimate based on 80% of the combined conventional hangar space in Buildings 1-3, 9, 10 & 12 (assumes 20% of hangar space is used for aircraft maintenance and equipment).
[2]A 62,500 sf hangar is schedule for completion in 2006, which will reduce the future demand to an estimated 33,500 sf (see discussion below).
[3]Sum of all T-hangar bays in Buildings 5-8 & 11.
[4]The tiedown requirement is increased by 10% to account for seasonal fluctuations in based aircraft.

The current available conventional hangar storage space at OXC is approximately 108,000 square feet, compared to the approximately 110,000 square feet of estimated demand. Thus, the requirements for conventional hangar space are generally satisfied in 2003. However, note that the requirements can change based on specific aircraft models and the percentage of aircraft on overnight trips. Furthermore, available space can vary with the amount of hangar area used for maintenance. Thus, the calculations for Table 3-7 represent current practices at OXC.

In 2023, due to the number of additional anticipated turboprop and jet aircraft, a deficit of 96,000 square feet of conventional hangar space would occur if no additional hangars were constructed. Key Air is in the process of developing Hangar G, with a storage area of 62,500 square feet. Once complete, this new conventional hangar would reduce the future deficit to approximately 33,500 square feet, but additional conventional hangar space will still be necessary during the planning period.

Piston-powered aircraft rely primarily on T-hangars and apron tiedown storage. As shown above, OXC provides a total of 64 T-hangar bays in five buildings. The current T-hangar demand is estimated at 94. Thus, a T-hangar deficit of 30 bays may presently exist. By 2023, the deficit is anticipated to grow to 36. At present, no T-hangar developments are planned at OXC.

3.6.2 Aircraft Apron Requirements

Aircraft aprons provide maneuvering and tiedown space (i.e., parking positions) for based and transient aircraft, as well as staging areas for aircraft stored in conventional hangars. The apron area requirements for based aircraft differ from that of transient aircraft. Both requirements are described below.

Based Aircraft Requirements

Table 3-7 indicates that apron tiedowns are needed for 103 piston aircraft to accommodate the 2003 demand. However, this requirement assumes that all required T-hangar bays are provided. As this is not the case, the number of tiedowns must also accommodate the current deficit of 30 T-hangar bays, resulting in a 2003 total tiedown demand of 133.

Currently, there are 126 tiedowns available for based aircraft at the four aircraft parking aprons at OXC. There are also an additional 12 State tiedowns at the Executive Flight facility, for a total of 138 tiedowns.

- Northeast Ramp: 40
- Northwest Ramp: 50
- Main Ramp: 10
- South Ramp: 26
- Executive Flight: 12

Total: 138

With a total 2003 apron tiedown demand of 103 and 138 tiedowns currently available, based aircraft tiedowns are adequate to satisfy the demand. However, considering the current T-hangar deficit of 30 bays, the effective tiedown demand is 133 (i.e., 103 + 30). Thus, capacity is just adequate at 138 tiedowns to satisfy the 2003 requirements of 133.

In 2023, assuming that additional T-hangars are ultimately provided at OXC, 110 based aircraft tiedowns would be needed. With 138 tiedowns available today, no tiedown shortfall is anticipated. However, if no additional T-hangars are provided at OXC, the forecast of piston-powered based aircraft would require 146 tiedowns (110 tiedowns, plus the 36 bay T-hangar deficit = 146), which is eight more than currently available. In summary, surplus tiedown positions are currently providing for the deficit of T-hangar bays; however, during the planning period a deficit of both tiedowns and T-hangars will occur if additional facilities are not provided.

Transient Aircraft Requirements

Transient aircraft include visiting corporate and private general aviation aircraft, and aircraft using maintenance, training, or other local services. Transient aircraft parking is needed on a short-term basis, typically from a few hours to several nights. The size of the apron required to meet future transient aircraft demands was estimated from the forecast number of itinerant operations using the following procedure:

- Using the forecast level of itinerant activity (Table 2-9), calculate the average number of daily itinerant landings.
- Assume a busy day is 10 percent busier than the average day.
- Assume that one-third of the itinerant landings are conducted by transient aircraft needing apron parking (two-thirds are returning based aircraft).
- Calculate the transient ramp requirements using a factor of 500 sy per aircraft to accommodate a wide range of aircraft sizes.

Applying this approach to the itinerant operations forecast yields the apron demand shown in Table 3-8. Currently 18 transient parking positions totaling 9,000 square yards of space are needed at OXC. In 2023, 26 transient parking positions totaling 13,000 square yards of space will be needed to accommodate future demand.

TABLE 3-8 – TRANSIENT AIRCRAFT APRON REQUIREMENTS

	2003	**2023**
Annual Itinerant Operations	35,839	51,200
Busy Day Itinerant Landings	54	77
Transient Tiedowns Required	18	26
Transient Apron Area Required	9,000 sy	13,000 sy
Existing Transient Apron	8,000 sy	8,000 sy
Surplus (Deficit)	(1,000 sy)	(5,000 sy)

Source: Annual Itinerant Operations: Table 2-9
Note: Busy Day Itinerant Landings = [(Annual Itinerant Operations / 365) / 2]*1.1

At OXC, the only apron designated for transient aircraft is a small portion of the Main Ramp located directly in front of the Keystone FBO facility (Building 2 on Figure 1-2). This portion of the ramp includes an area of about 225 feet by 320 feet or approximately 8,000 square yards. The remainder of the Main Ramp is leased by Keystone for hangar staging, and for 10 based aircraft tiedowns.

Table 3-8 identifies that with only 8,000 square yards of transient apron available, a current deficit of 1,000 square yards exists today. This deficit will grow to 5,000 square yards by 2023.

Keystone currently leases the majority of the Main Apron and is allowing transient aircraft to utilize their leased portion of the apron for aircraft parking. This accommodates the current deficit in the transient apron area.

3.6.3 Fueling Facility Requirements

There are two different types of fuel operators at OXC. Keystone Aviation operates a traditional fuel service, providing both Jet-A and Avgas (i.e., 100 octane low lead) fuel to the traveling public. Double Diamond and Executive Flight are private operators and store and dispense fuel strictly for the use of their own operations and clients. All three operators build, maintain, and operate their fueling facilities on land leased from ConnDOT.

Keystone Aviation and Executive Flight operate fuel facilities on the west side of the Airport along Christian Street. Double Diamond has a fuel facility located just south of their hangar. Table 3-9 summarizes fuel type and quantity for each operator. All tanks are self-contained and above-ground.

TABLE 3-9 – AIRCRAFT FUEL STORAGE

OXC Tenant	**Fuel Storage Capacity**	
	Avgas	**Jet A**
Keystone Aviation	12,000 gal. tank	Three 15,000 gal. tanks
Executive Flight	8,000 gal. tank	- - -
Double Diamond	- - -	15,000 gal. tank
Total Capacity	**20,000 gal.**	**60,000 gal.**


Keystone Aviation


Executive Flight


Double Diamond

According to Keystone Aviation, the fuel storage capacity at OXC currently meets requirements, and adequate space is available at the main fuel farm location for two additional 15,000-gallon tanks. Thus, the Airport's Jet-A storage capacity could be increased by 50 percent. These additional tanks could be installed when needed, and should satisfy demand throughout the planning period. Note that additional operators/tenants are not restricted from selling fuel at OXC should that operator meet all federal, state, and local requirements.

3.6.4 Airport Administration/Maintenance/ARFF Facilities

A single Airport Management/Maintenance/ARFF facility is provided at OXC. The main two-story building contains the ARFF bay and airport offices on the upper apron-level, with vehicle maintenance bays below and to the rear of the building. The facility provides approximately 2,400 square feet of space per level. A separate 1,200 square-foot garage and ¼-acre outdoor parking area are also provided for airport vehicles.

As several pieces of airport equipment are currently stored outdoors at OXC, a second garage/equipment building should be provided. Garage storage reduces maintenance costs by protecting equipment from the elements. The additional building should be sized to accommodate future airport needs. An area of 2,400 square feet will be used for planning purposes.

3.6.5 Service Road Requirements

Airport service roads or perimeter roads are used by airport personnel and fixed based operators to transport fuel trucks, snow plows, and other service vehicles throughout the Airport property. Service roads are ideally located inside the airport perimeter fence, but clear of all airport operational areas (i.e., runways, taxiways, and safety areas). A service road layout should enable vehicles to operate safely, without interference to aircraft, or the need for communication with the Air Traffic Control Tower (ATCT). At OXC, no airport service roads are provided. Thus, fuel trucks and service vehicles operate on the active airfield, and must maintain contact and obtain clearances from the ATCT.

The National Transportation Safety Board (NTSB) and the FAA have placed increased emphasis on reducing runway incursions as airport activity has increased nationwide.[3] As such, one initiative is to reduce the need for vehicles to drive across runways. At OXC, maintenance vehicles and mobile fuelers must currently cross the runway to access the east side of the field. Most fuelers and other vehicles cannot drive around the Airport on public roads, as they are non-licensed vehicles. Thus, airport vehicles share the existing taxiways with aircraft, and cross the runway at the north end or on Taxiway "G."

As such, construction of a service road at OXC is considered a high priority requirement. Due to the physical constraints on the Airport (i.e., wetlands, excessive grades), the location of a service road is difficult to site.

3.6.6 Land Acquisition

Ideally, an airport should own the area within the RPZs, OFAs, and the defined Building Restriction Line. This ownership provides control over the placement of airport facilities and adjacent development.

[3] As documented in FAA's Runway Incursion Airport Assessment Report (December 2002), NTSB has included reducing runway incursions on its "most wanted" list of safety improvements since 1990.

With a total of 430 acres, the OXC property occupies the majority of these areas, with the exception of the outer portions of the RPZs. On the north side of the Airport, the Triangle Boulevard residential development occupies approximately 20 acres of the 30 acre RPZ. As this property is fully-developed and occupied, acquisition would require residential relocations and may not be feasible. On the south side of the Airport, a State Park Trail and privately-owned commercial property occupy most of the RPZ (approximately 26 of the 30 acre RPZ).

As such, while full ownership of all property in the RPZs is desirable, it is not anticipated in the foreseeable future. Thus, easements over these areas should be considered to protect the Airport from future non-compatible development. The easements would prohibit additional residential development, as well as enable the control of object and vegetation heights.

3.7 Airport Staffing

During the AMPU process, an ongoing airport staffing shortfall was raised by tenants and airport personnel. The staffing shortfall is most pronounced during weekends and nights, when airport staff are not scheduled and only available on-call. Furthermore, during snow and occasional emergency events, all available staff are directed from their management and operational duties to maintenance and response. One of the most common problems is bird and animal control in the early mornings before business hours and on weekends when significant flight training activity occurs. The staffing shortfall is acknowledged here in the AMPU, but will be reviewed and addressed separately from this study effort by ConnDOT.

3.8 Facility Requirements Summary

The preceding sections have identified a variety of facility requirements for the Waterbury-Oxford Airport. Table 3-10 compares the existing facilities to the ultimate requirements, and identifies deficits that are anticipated during the planning period.

TABLE 3-10 – FACILITY DEFICIT SUMMARY			
Facility	**Existing**	**2023 Requirement**	**2023 Deficit**
DESIGN STANDARDS			
RSA Length Beyond Runway End Runway 18 Runway 36	 920' 720'	 1,000' 1,000'	 80' 280'
Taxiway Width	40-50'	50'	0-10'
Runway Centerline To: Edge of Aircraft Parking Parallel Taxiway Centerline	 475 feet 400 feet	 500 feet 400 feet	 25 feet - - -
Taxiway Centerline To: Fixed or Moveable Object Parallel Taxilane Centerline	 75 feet 130 feet	 93 feet 152 feet	 18 feet 22 feet
Taxiway "D" Grade Width	 3% 20'	 2% 25'	 1% 5'
AIRFIELD			
Runway Lighting Runway 18 Runway 36	 VASI PAPI, REIL	 VASI/PAPI, REIL PAPI, MALSR	 REIL MALSR
Taxiway "B"	Partial Parallel	Full Parallel	Full Parallel
Exit Taxiways East Side West Side	 2 1	 3 3	 1 2
LANDSIDE			
Conventional Hangar	108,000 sf	204,000 sf	96,000 sf[1]
T-Hangar Bays	64 Bays	100 Bays	36 Bays
Apron Tiedowns	138 Tiedowns	110 Tiedowns	None[2]
Transient Apron Area	8,000 sy	13,000 sy	5,000 sy
Maintenance Garage	3,600 sf	6,000 sf	2,400 sf[3]
Service Road	None	Service Road[4]	Service Road[4]
Land Acquisition Owned in Fee Easement	 420 acres 0 acres	 420 acres 46 acres[5]	 0 acres 46 acres[5]

Notes:
[1]A 62,500 sf hangar is schedule for completion in 2006, which will reduce the future demand to an estimated 33,500 sf (see discussion below).
[2]A tiedown deficit will occur if adequate T-hangar bays are not provided
[3]Vehicle garage for storage of snow plows and maintenance vehicles and equipment.
[4]Service road to connect the landside facilities on the east and west sides of the Airport.
[5]Acquire easements for the off-airport property located within the Runway Protection Zones