Appendix C Learning More About: The Airport Influence Area and Evaluating Aircraft Operations

Introduction

This appendix has been developed to help planners understand the airport influence area and the airport operations that occur within it. It covers the fundamentals of: determining the area necessary for the initial study area to address airport land use compatibility planning, identifying the airport influence area, identifying airport and aircraft operational characteristics, and impacts associated with airport activity.

Study Area

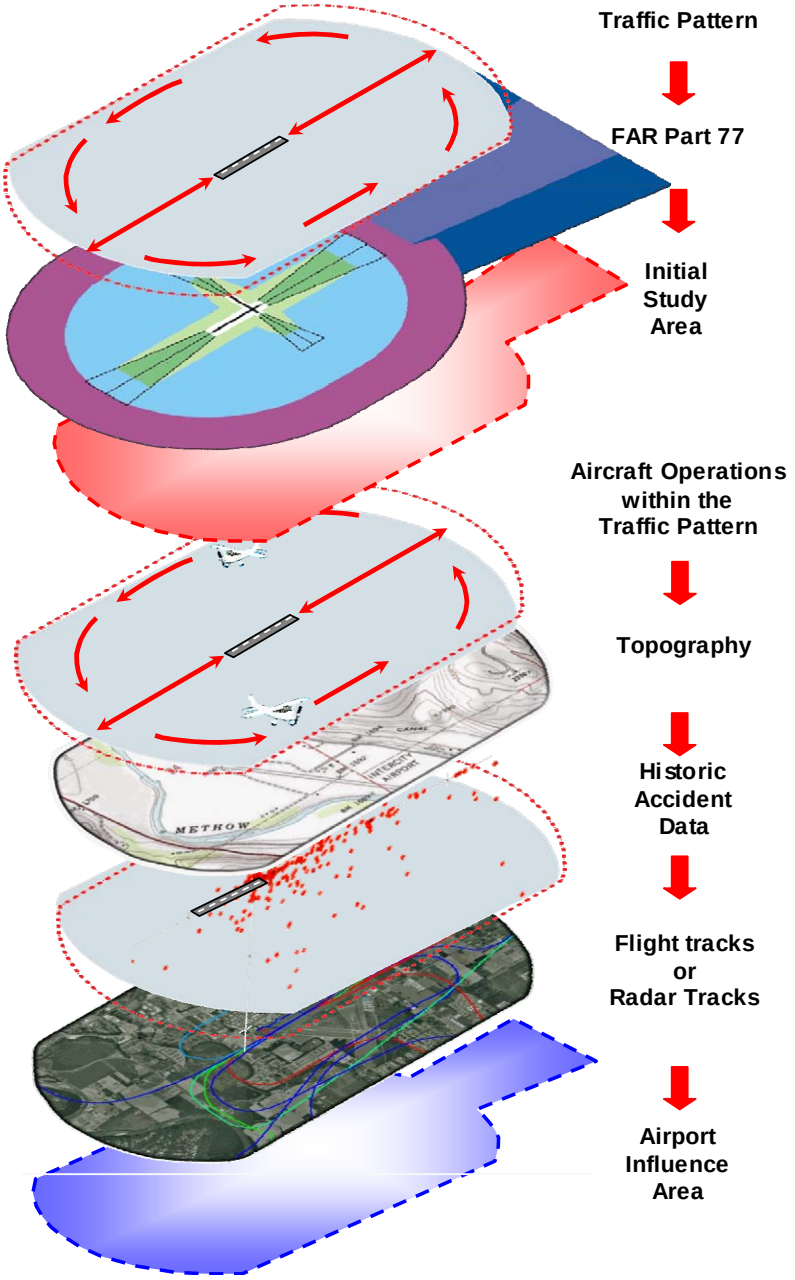
The initial study area is inclusive of the airport ownership, airport traffic pattern, and Critical Airspace Surfaces identified in FAR Part 77. In most cases, these aeronautical factors will identify areas where normal aircraft operations occur and where conflict could potentially arise.

Airport Influence Area

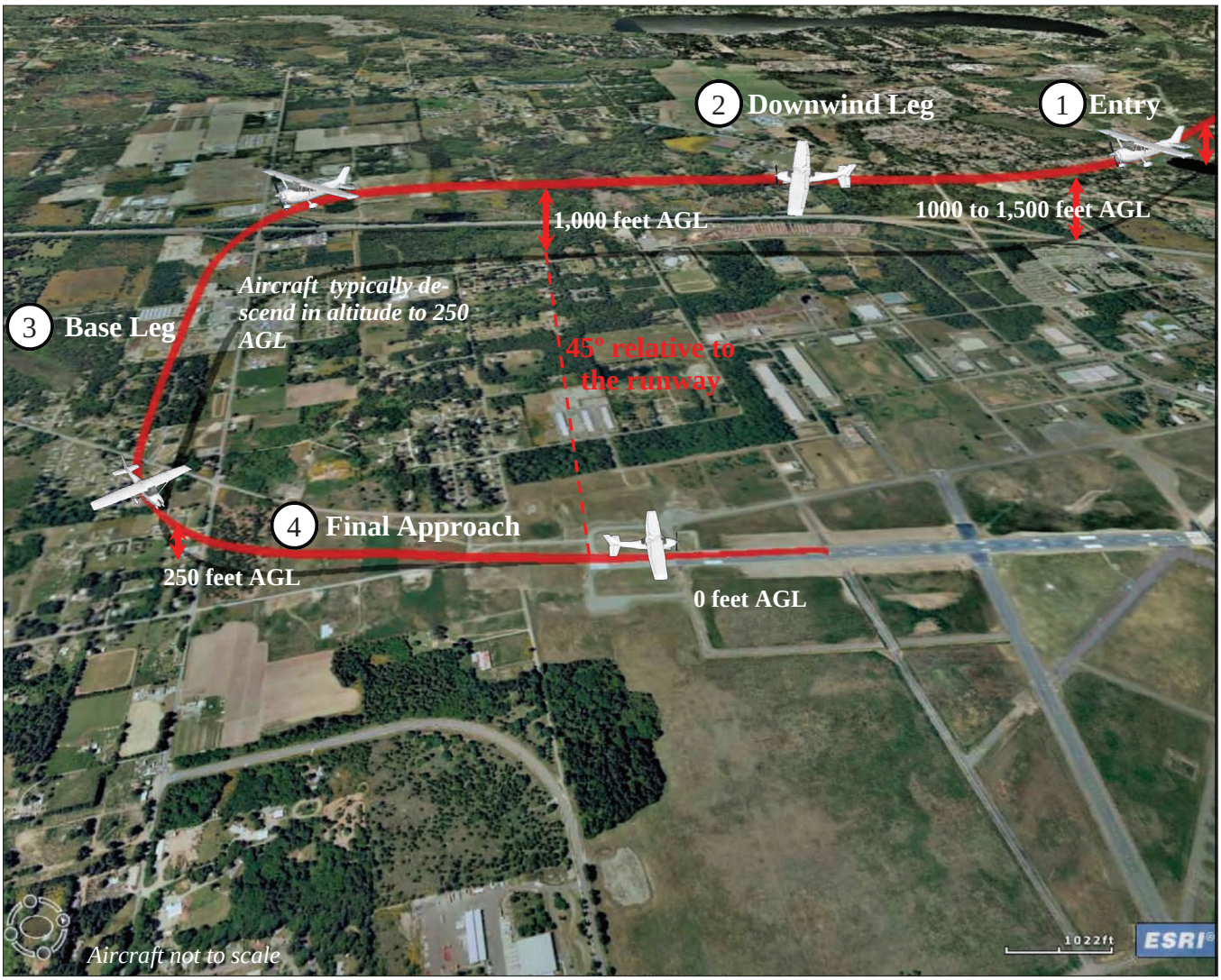
The airport influence area is derived from the initial study area and may be larger, smaller, or the same size as the study area boundary depending on the airport and aircraft operations, flight characteristics, and land features. The jurisdiction should analyze the following elements:

- Airport and aircraft operations and characteristics.
- Airport traffic pattern.
- Topography.
- Historic accident data.
- Flight tacks or radar tracks (when available).
- Critical Airspace surfaces (FAR Part 77).

Airport and aircraft information is available from the airport sponsor and from WSDOT Aviation.



3D Phase of Flight Within a Standard Left Hand Traffic Pattern



1 **Entry** - Arriving aircraft should be at the appropriate traffic pattern altitude before entering the airport's traffic pattern. Entry to the downwind leg should be at a 45 degree angle. It is recommended that airplanes observe a l,000 feet above ground level (AGL) traffic pattern altitude. Large and turbine-powered airplanes should enter the traffic pattern at an altitude of 1,500 feet AGL or 500 feet above the established pattern For airport specific traffic pattern altitude, see the Federal Aviation Administration (FAA) Airport/Facility Directory.

2 **Down Wind Leg**– Aircraft parallel the runway at the recommended traffic pattern altitude, generally an altitude of 1,000 feet AGL.

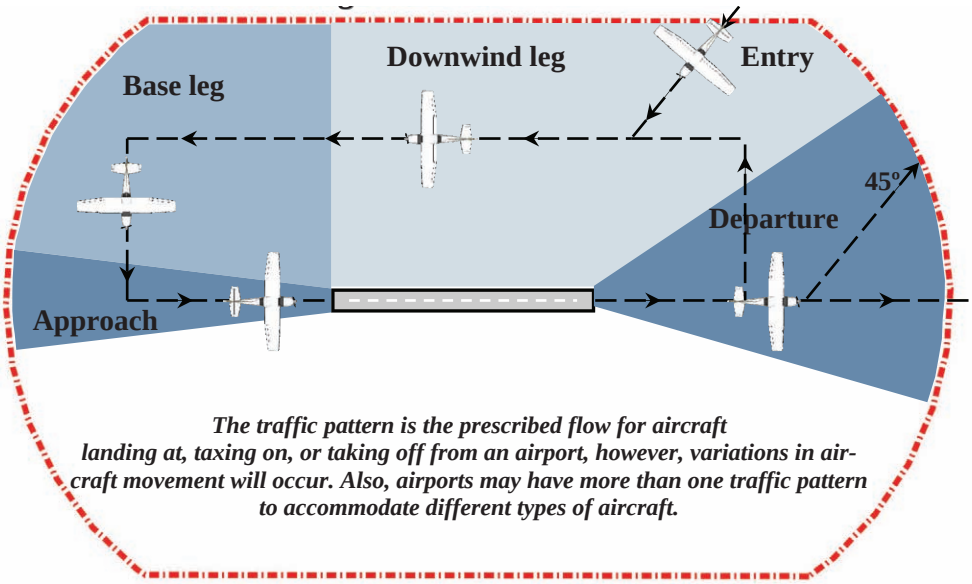
3 **Base Leg-** Aircraft begin their turn at a point 45 degrees relative to the runway's threshold. Aircraft typically descend in altitude from 1,000 feet AGL to 250 feet AGL.

4 **Approach** - Aircraft begin their approach at 250 feet AGL and descend to the runway.

Traffic Patterns

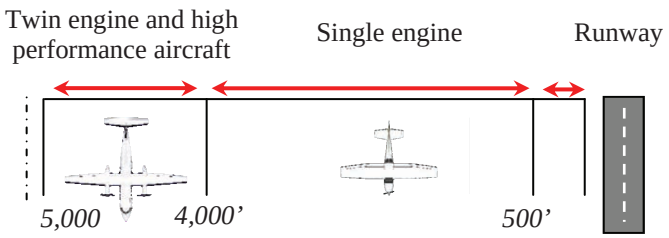
Phases of flight within the traffic pattern generally consist of the entry, downwind leg, base leg, approach, and departure. The width of typical general aviation airport's traffic pattern is generally 5,000 feet, but can vary between airports. Individual aircraft flight tracks within the traffic pattern will vary according to aircraft performance, wind, weather, piloting technique, topography, and aircraft weight. It is critical to understand that aircraft operate in a dynamic environment. They all do not fly along the same path.

Phase of Flight Within the Traffic Pattern



AC No. 90-66A states that "A pilot may vary the size of the traffic pattern depending on the aircraft's performance characteristics"

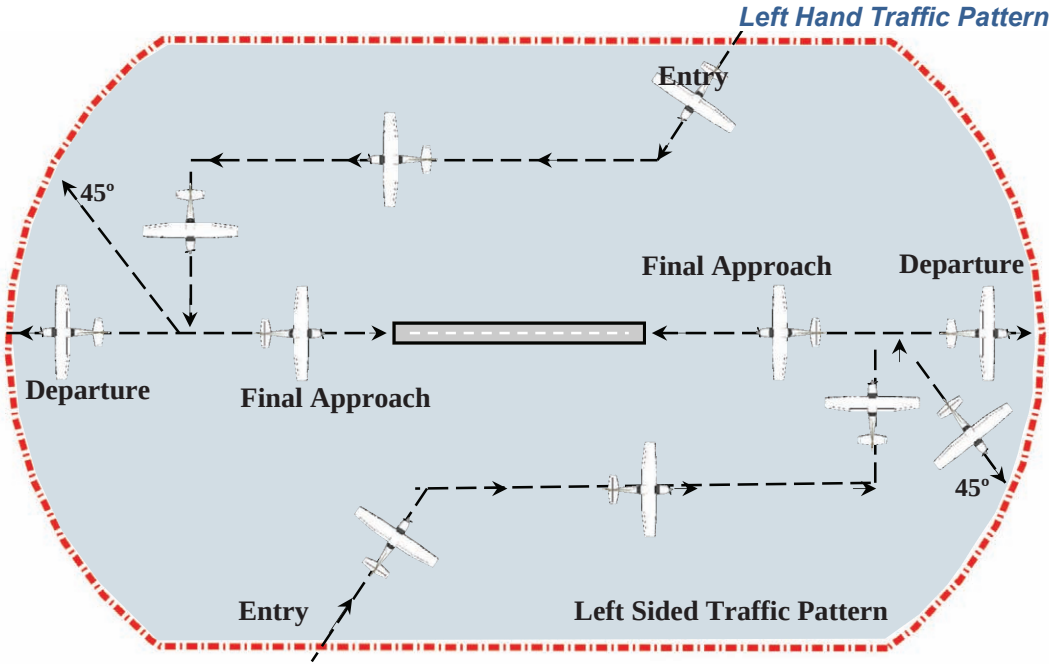
Traffic Patterns Width and Aircraft Performance



Higher performance aircraft, in many cases, will fly a higher wider pattern, while slower flying aircraft often fly a tighter pattern. The direction of the aircraft landing on the airport runway may also vary depending on wind conditions.

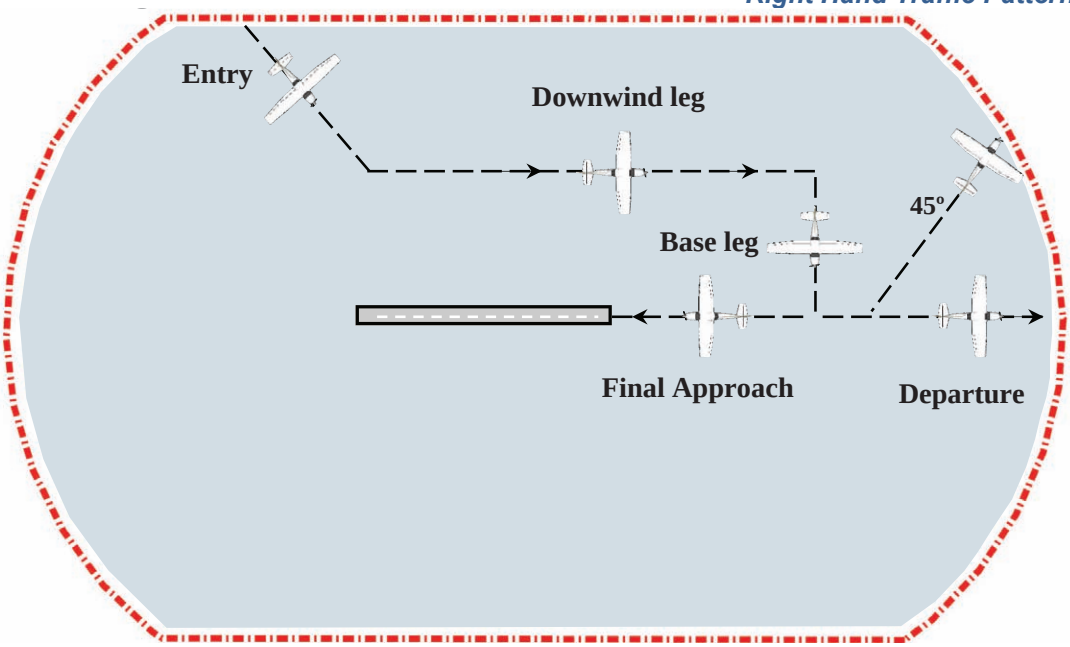
Most runways have a standard left-hand traffic pattern. However, this may vary depending on natural features near the airport, airport traffic pattern policies, and if the airport has more than one traffic pattern to address multiple types of aircraft. For example, variations may occur for helicopters, gliders, ultra lights, and jets.

Left Hand Traffic Pattern



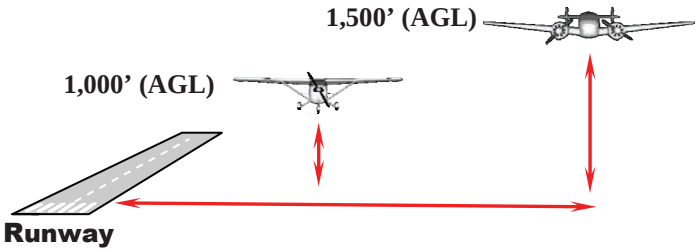
Some runways have a non-standard right-hand traffic pattern. This means that aircraft enter the pattern and parallel the runway on the right side, before turning on the baseleg and executing their final approach.

Right Hand Traffic Pattern



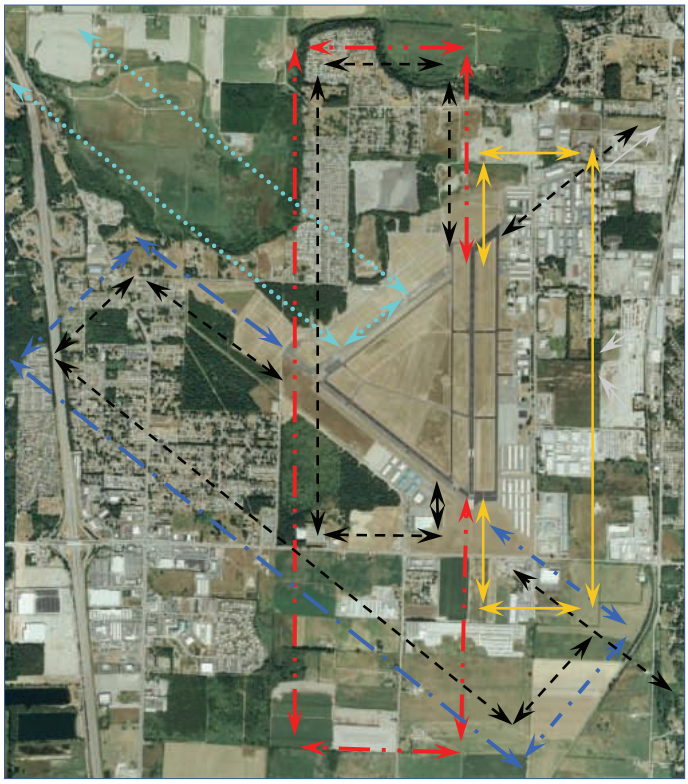
In many cases, higher performance aircraft will fly a higher traffic pattern. The FAA's AC No. 90-66A states that large aircraft should enter the traffic pattern at an altitude of 1,500 feet AGL or 500 feet above the standard traffic pattern. Some pilots, regardless of aircraft, prefer a higher pattern altitude since it gives them a higher probability of making a successful landing in an engine out scenario.

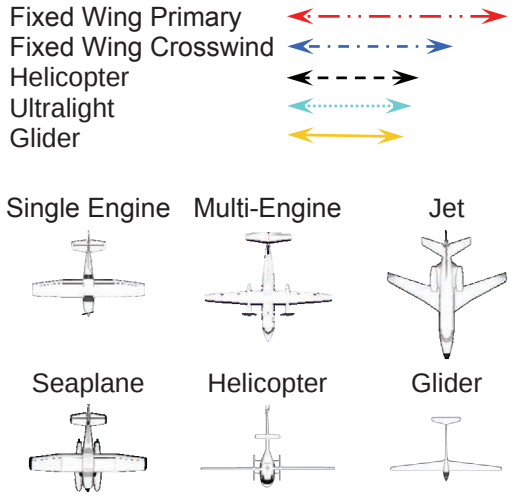
Traffic Patterns Altitude and Aircraft Performance



Some airports have established recommended traffic patterns for specific aircraft. Understanding the types of aircraft and where they fly gives you an idea of where the highest impacts occur. Be sure to consult with your airport manager and pilot community regarding the airport's and aircraft's unique operational characteristics.

Arlington Municipal Airport's Traffic Pattern

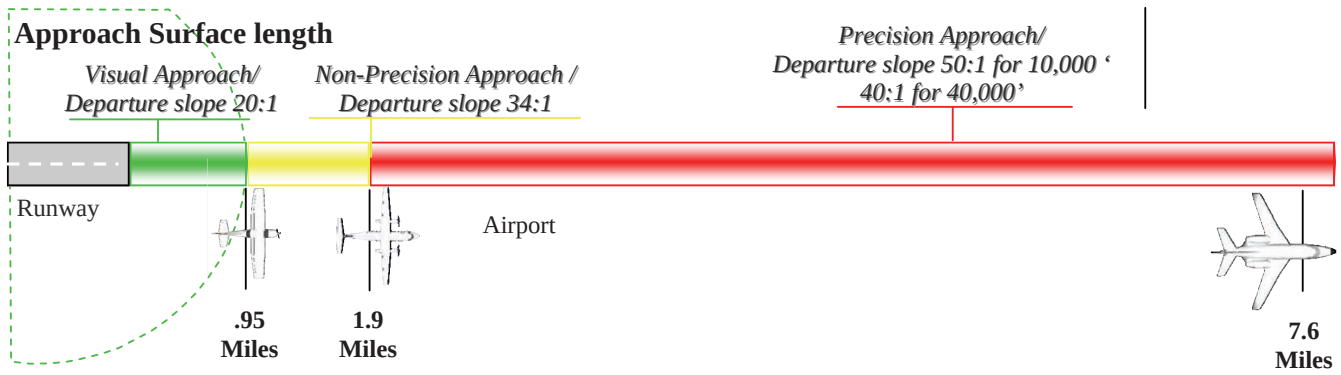




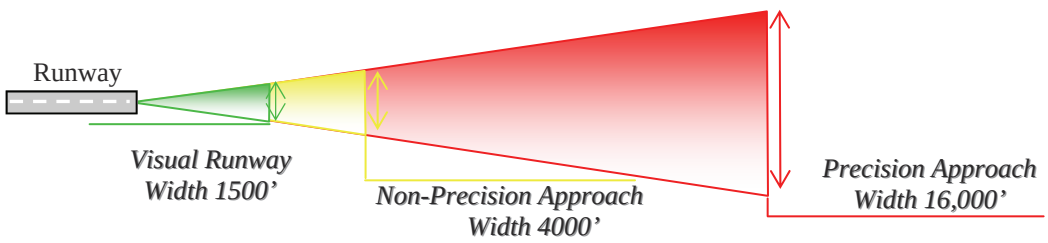
Understanding Airport Approaches

The following diagrams illustrate the three basic types of airport approaches and their fundamental characteristics. Understanding your airport's current and future approaches will help you identify areas that should be included in your initial study area and eventual airport influence area.
*All approach slope are based on the FAA's FAR Part 77 *Imaginary Airspace Surfaces*, and are the typical approach slopes found at all airports.

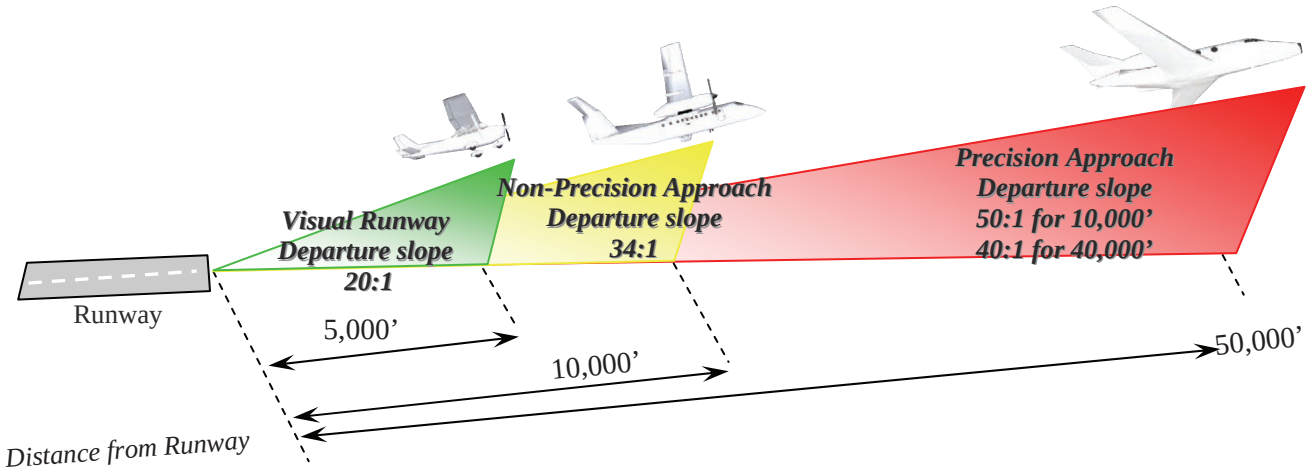
Approach Surface Length



Approach Surface Width



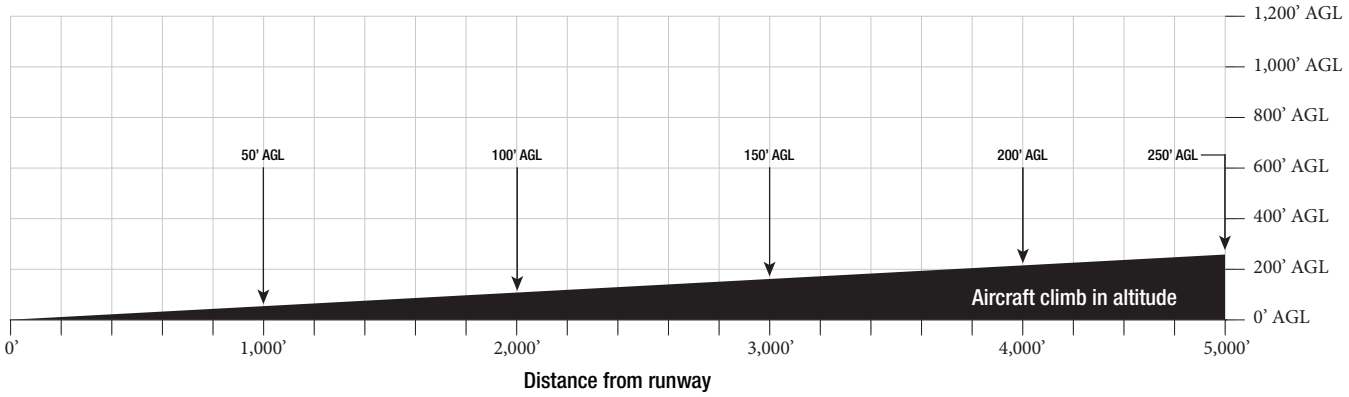
Approach/Departure Gradient



Airport Approach/Departure Gradient and Length

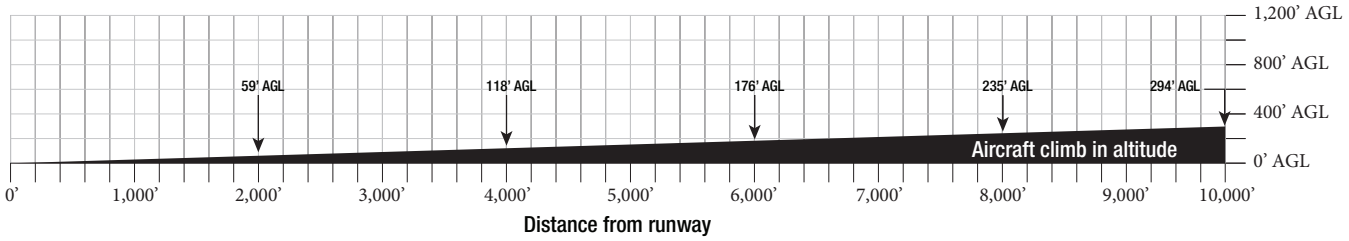
The following diagrams illustrate the three basic types of airport approaches and aircraft altitude in relation to their distance from the runway. Generally the lower the altitude the greater the impacts. The following approach/departures gradients are based upon the minimal airspace identified in the FAR Part 77 Imaginary airspace surfaces.

Visual Runway Approach/Departure Slope: 20:1



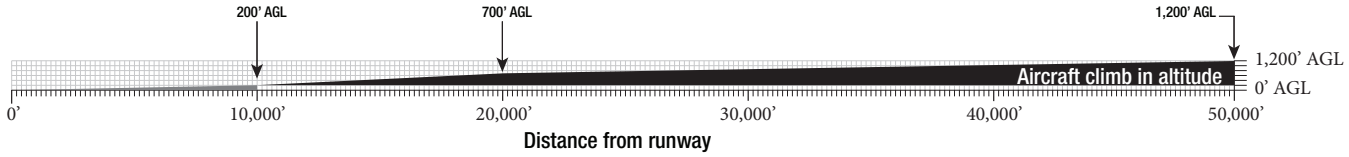
Use a run rise ratio of 20 to 1. So for every twenty feet the surface rise one foot.

Non-Precision Approach/Departure Slope: 34:1



If the airport has instrument approach procedures, a more extended area may be affected by aircraft flying at altitudes below that of the normal traffic pattern.

Precision Approach/Departure Slope: 50:1 for 10,000 feet, 40:1 for 40,000 feet



What are general aviation aircraft?

General aviation aircraft come in all sizes and types. They range from ultralights and single engine airplanes to business jets as large as a 747 or A380 commercial airliner. Helicopters, seaplanes, sailplanes, former military aircraft, and even hot air balloons are all general aviation aircraft. For basic planning purposes, aircraft can be further broken down into the follow categories: single engine, multi engine, jet, high performance, sea plane, helicopter, lighter than air, and gliders. Understanding your community airport's fleet mix will help determine potential impacts

Single Engine Aircraft make up the majority of Washington State's aircraft fleet. These aircraft generally fly the traffic pattern at un-towered airports. Sound characteristics vary greatly between modes.

Twin Engine Aircraft typically fly a wider and higher traffic pattern. These aircraft may use a straight in and out approach or the traffic pattern. Aircraft often climb to altitude quickly. Twins engine aircraft often require a longer runway than single engine aircraft. A loss of one engine may pull the aircraft to the left or right of their flight path

Jets on average are larger than single engine aircraft. These aircraft typically fly a straight in and out approach and require a longer runway than their single engine counterparts.

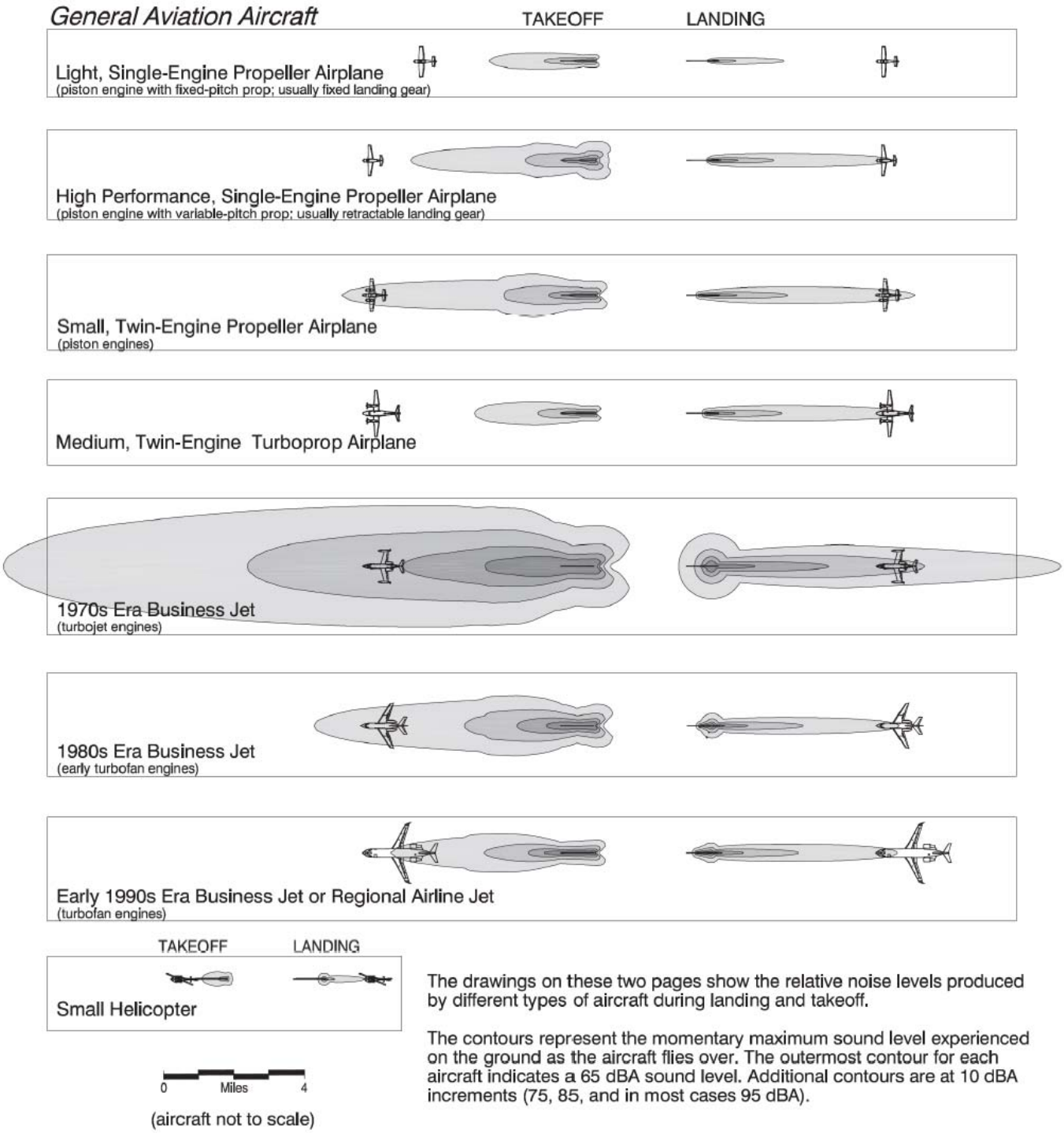
Ultralight Aircraft are generally light-weight, slow moving, 1-or-2-person airplanes that may be equipped with an engine or have similar characteristics to gliders.

Seaplane/Float Plane is an amphibious aircraft that can take off and land both on conventional runways and water. Piston driven sea planes are often slow and posses a larger noise signature. Their climb profile is often shallow.

High Performance Aircraft have an engine of more than 200 horsepower (AC61.3). Some high performance aircraft include Cessna 182 and Cirrus SR 22. Aircraft may fly a straight in and out approach or a higher and wider traffic pattern.

Helicopters often fly a parallel traffic pattern, different than fixed wing aircraft. Helicopters fly lower and climb slowly than single engine or jets. The aircraft's main rotor produces a particularly noticeable noise signature.

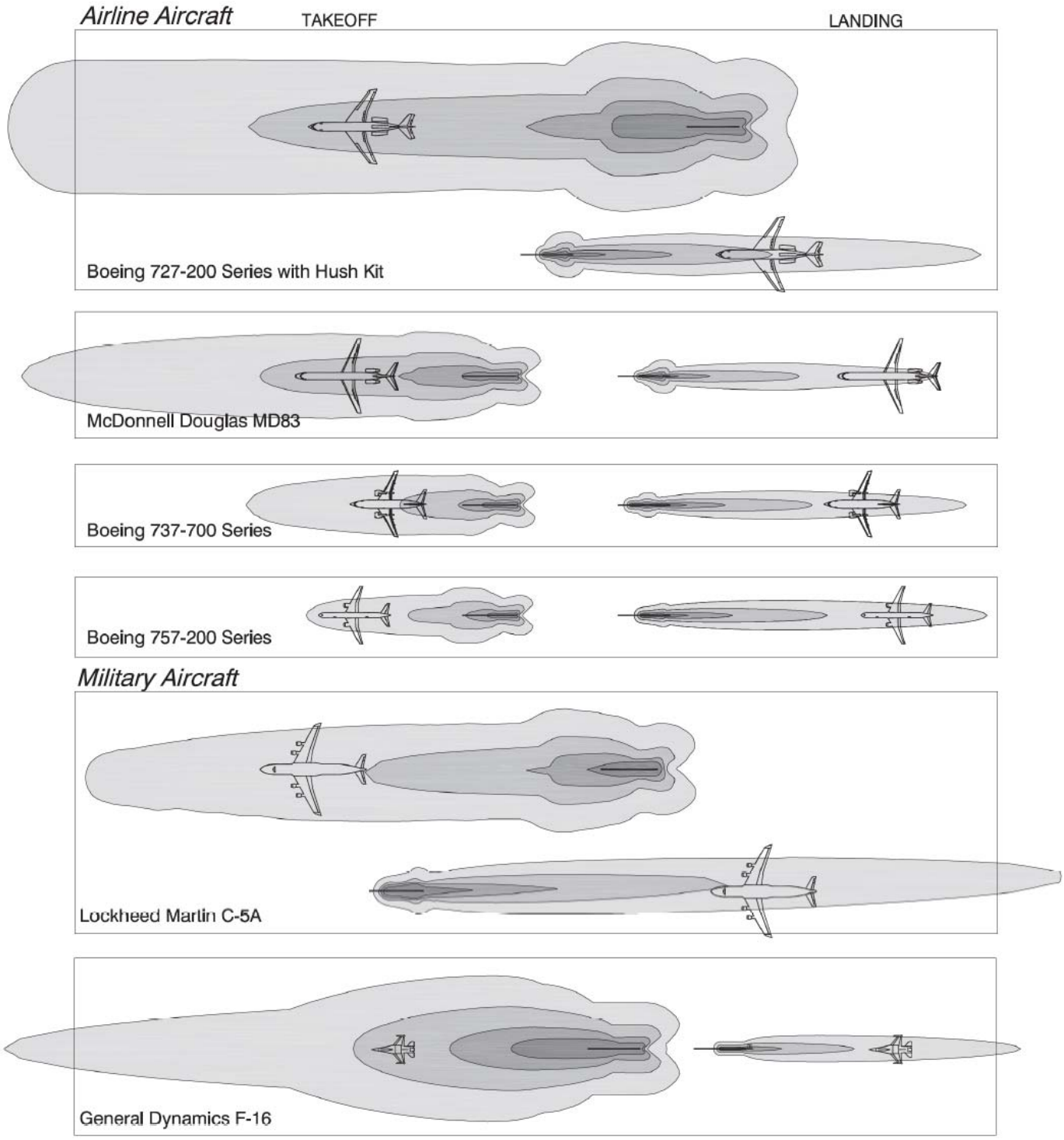
Gliders do not generate a noticeable amount of noise the tow planes used to bring the aircraft to altitude are a factor are generally single engine aircraft. Consult with you local pilot community for details on glider operations.



The drawings on these two pages show the relative noise levels produced by different types of aircraft during landing and takeoff.

The contours represent the momentary maximum sound level experienced on the ground as the aircraft flies over. The outermost contour for each aircraft indicates a 65 dBA sound level. Additional contours are at 10 dBA increments (75, 85, and in most cases 95 dBA).

Source: California Airport Land Use Planning Handbook, 2002



Source: California Airport Land Use Planning Handbook, 2002

Topography

When identifying your airport's influence area, be sure to consider how topography influences the airport and aircraft operations. Topography can impose physical constraints and unique operational challenges to aircraft movement as well as decrease the ability of the airport to attract business aircraft that rely on enhance navigational needs.

Disproportionate Impacts

Mountainous regions, ridgelines, and hills can be attractive places to construct residential dwellings, cell towers, and other facilities. However, these uses in the wrong place may impact the airport. The uses and activities may also be negatively impacted by noise, light, vibration, fumes, and low-flying aircraft.

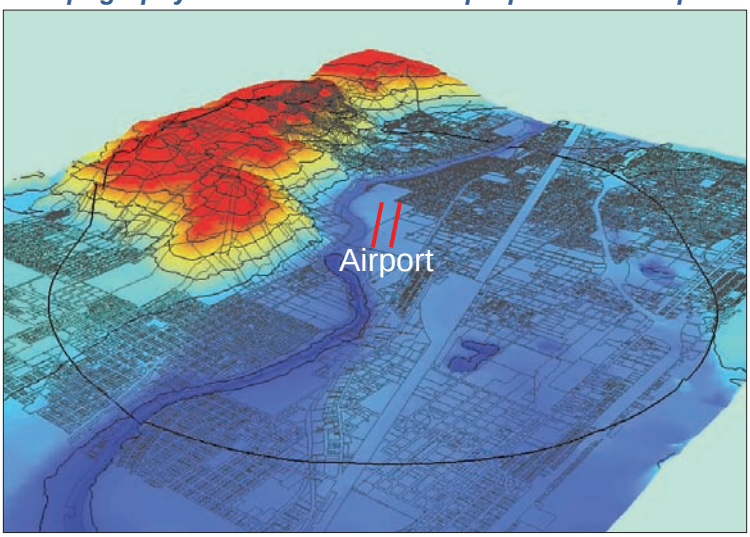
Analysis

Topographic information can be combined with other data to identify areas where noise and other negative impacts may pose a challenge to airport operation or reduce livability from increases in noise, low-flying aircraft, fumes, and vibration. In this example, the topography rises above the airport elevation and is within the airport influence area. Information on the airport, flight characteristics, and impacts from topographic features can be found within the Airport Master Plan and/or the airport manager, pilots, and aviation businesses.

Constraints

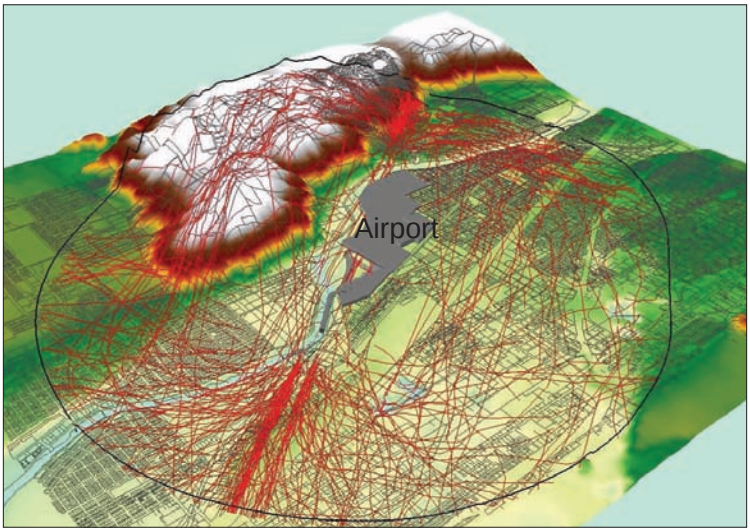
The topography within the airport influence area is an important factor to consider during your assessment. Terrain can significantly affect arrival and departure flight routes of an airport. In this example, an airport has a topographical feature that prohibits the execution of a left hand traffic pattern on one runway end. Aircraft traffic to the right of the runway will be reduced.

Topography With Potential for Disproportionate Impacts



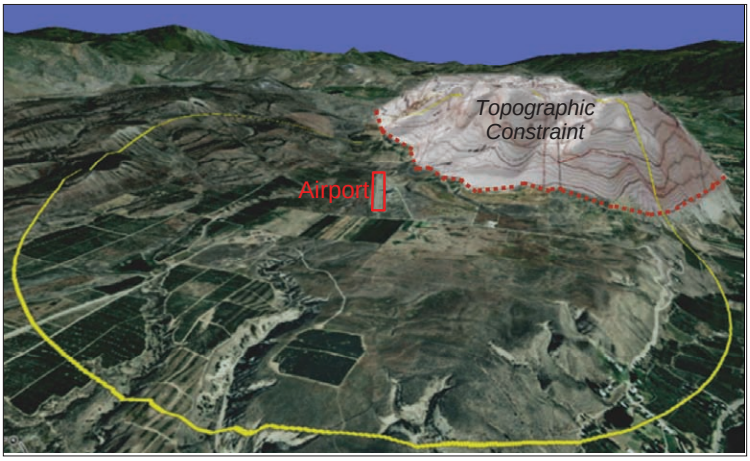
Felts Field, WA

Radar Track Data Clipped and Draped Over Topography



Felts Field, WA

Tonasket Municipal Airport



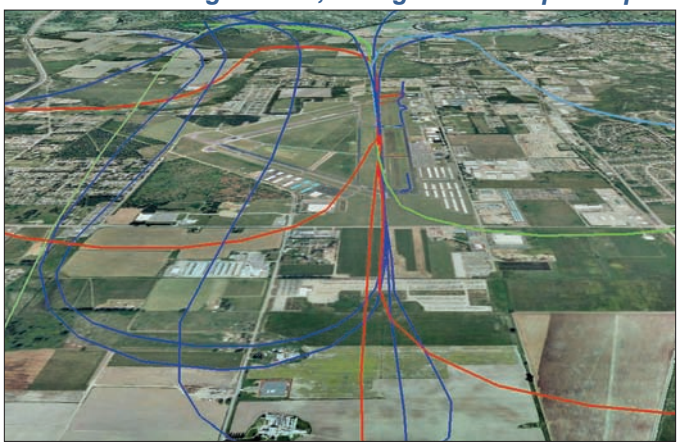
GPS Flight Tracks

Flight track data can be a useful tool to identify airspace used by aircraft and identify areas impacted by airport operations. It can be an extremely effective tool in communicating flight characteristics to decision makers.

If flight track data is not available for your airport it may be generated by using GPS equipped aircraft. GPS data may be gathered in coordination with aviation services or the airport sponsor. Also, check with WSDOT Aviation. While this type of data will not be as good as a sampling of radar track data from the FAA, it can provide useful information and assist in addressing land use within the airport influence area. Data collection should following the following principles:

- Include an adequate sampling of data.
- Record weather conditions during data collection.
- Represent the airport's current fleet mix.
- Represent the airports traffic pattern.
- Record actual operations.
- Identify all aviation activities such as flight school, parachute, and ultralight activity.

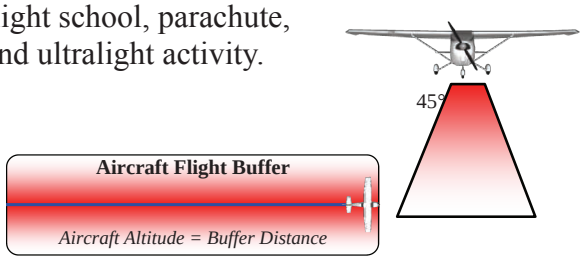
GPS Flight track, Arlington Municipal Airport



GPS Flight track data is not a necessary component of the airport land use compatibility planning process, but can be an effective tool in educating decision makers and the public.

Why are GPS tracks good tools for planners?

- 3D visualization tool for decision makers.
- Precise spatial representation of aircraft: location, altitude.
- Makes visualizing complex concepts like the airport influence area easier.

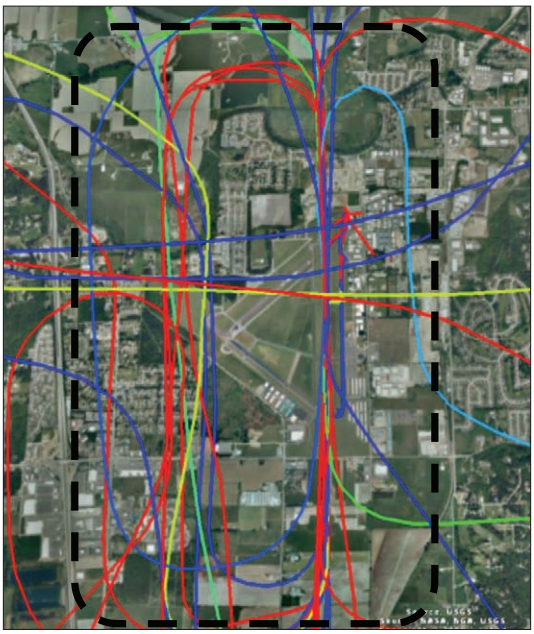


Remember to include the airport traffic pattern and buffer.

Aircraft operations may vary depending on weather conditions, aircraft design, and pilot characteristics. Flight impacts, such as noise, are also not limited to just directly below the aircraft, and can extend outward affecting large areas. A good rule of thumb may be to encompass a corridor of land within which the aircraft can be heard and seen, within a 45° angle downward from the aircraft.

Aircraft Flight Track/GPS Analysis

When drawing the airport influence area boundary, do not attempt to encompass every flight track, aim for about 80 percent of the flight data. If you are defining the boundary based on information from pilots and others, you will not have 100 percent coverage in any case. However, even with GPS flight track data, you can omit the stray tracks that do not follow the typical routes.

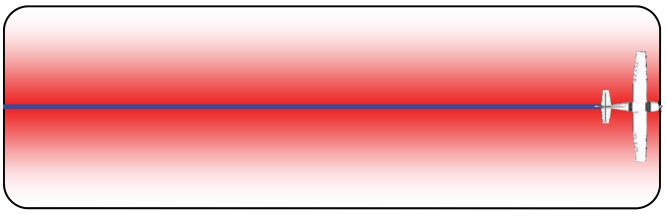


The Airport Influence Area includes 80 to 85 percent of Aircraft Operations

Radar Tracks

When available, radar tracks can be a helpful tool in identifying areas overflown by aircraft. Radar track data is generally available at towered airports and may also be available if your airport is within a short distance of an airport with a radar tower. Airport managers will be your best point of contact when requesting this data.

Radar track data is not a requirement to effectively analyze airport land use compatibility. But like GPS tracks, they can be an effective tool in educating decision makers and the public on where aircraft fly. The adjacent diagram of Felts Field shows flight track data from an FAA Tower. The flight data tracts represent the location and vertical altitude of the aircraft.



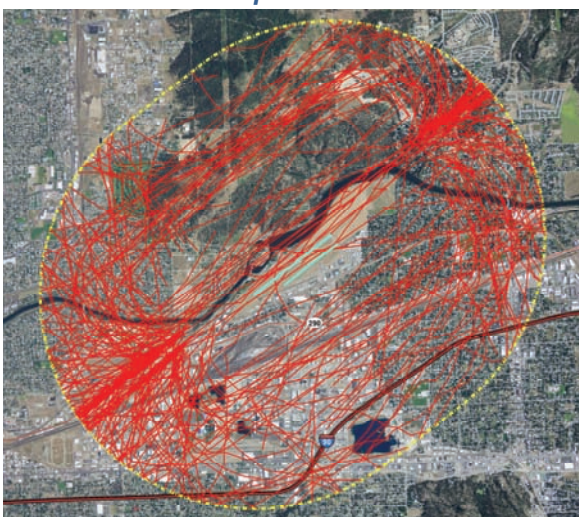
Remember to include a buffer beyond where the radar tracks are drawn.

Aircraft impacts, such as noise, are not limited to areas directly below the aircraft similar to GPS data. Aircraft operations may vary depending on weather conditions, aircraft design and pilot characteristics. Flight impacts. A good rule of thumb may be to encompass a corridor of land within which the aircraft can be heard and seen, within a 45° angle downward from the aircraft.

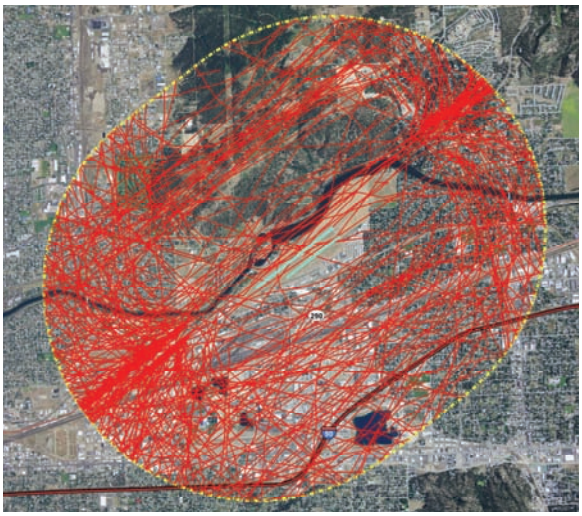
Radar Limitations

Depending upon the airport involved, a high percent of aircraft may not create a radar track because they are not equipped with transponders. Transponders are not required at airports located outside of Class C and Class B airspace, and radar coverage may be spotty or non-existent for some airports even within Class C and Class B airspace.

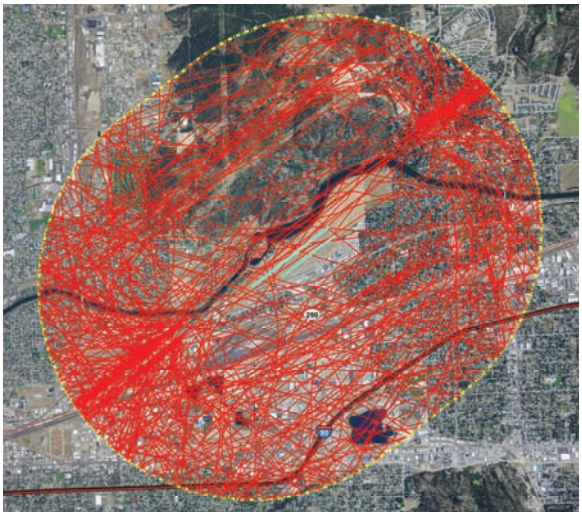
Aircraft Operation Under 1000' AGL



Aircraft Operation Under 1500' AGL



Aircraft Operation Under 2000' AGL



Felts Field Spokane, WA

Radar track data is representative of aircraft operations under 2,000 feet AGL for one week in October at Felts Field. Radar track data was sorted by altitude and clipped using a 10,000 foot buffer. In most cases, aircraft activity increases significantly during times of good weather

Aviation Impacts: Vibration, Light, Fumes and Low-flying Aircraft

Aviation impacts of vibration, light, fumes, and low flying aircraft can produce an adverse response in many people well beyond the airport boundary. These negative reactions are frequently expressed in the form of annoyance. Elsewhere, especially in locations beneath the traffic patterns of general aviation airports, a fear factor also contributes to some individuals' sensitivity to aircraft overflights.

Vibration

A vibration occurs when pressure waves or sound waves travel from one object to another, transferring energy. Sound waves are moving energy that travels through the air as a pattern of changing or oscillating pressure waves. Because air is a gas, it presents less friction to a pressure wave than a solid. Thus an unobstructed pressure wave can travel a longer distance before all of its energy is lost as heat. When a pressure wave strikes a wall of a home, part of the energy is transferred to the structure in the form of a vibration. This vibration in turn can create an annoyance for occupants of a structure.

Blade slap
Tieton State Airport

Helicopters produce the most notable source of vibration associated with general aviation activity. The rotating blade creates a phenomenon known as blade slap that varies in degree depending upon the speed and descent rate of the helicopter. Vibration mostly affects the airport approach and can also impact areas behind the start of takeoff roll for jet aircraft. Vibration can also be a problem with light, piston driven aircraft. For example, experience shows us a pre-1970 Cessna 185 on departure with a prop speed between 2,750 and 2,800 RPMs can produce a significant noise signature and related vibration.

Light

Although often overlooked as a compatibility factor, aviation related light can be a point of contention for airport neighbors. Light pollution, also known as photopollution or luminous pollution, is often defined as excessive or obtrusive artificial light. This aviation byproduct is most impactful in close proximity to the airport. Check with the airport manager to see if on airport light has been an issue in the past or could be an issue in the future.

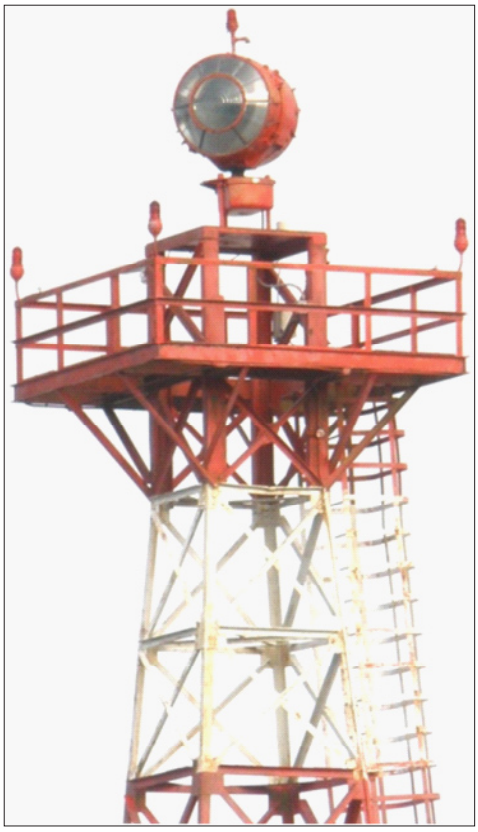
Approach Lighting System

On Airport light

The primary sources of on airport light are: the Approach Light Systems (ALS), rotating light beacon, runway lights and general facility lighting.

- The Approach Light Systems (ALS) provides the basic means to transition from instrument flight to visual flight for landing. Operational requirements dictate the sophistication and configuration of the approach light system for a particular runway.
- A rotating light beacon indicates the airport's location to pilots at night. It is often mounted on top of a tall structure or control tower above other buildings on the airport. It produces flashes of light very similar to a lighthouse.
- Runway lights come in a variety of intensities including High Intensity Runway Lights (HIRL), Medium Intensity Runway Lights (MIRL), and Low Intensity Runway Lights (LIRL). These types of lights are usually confined to airport properties in urban environments. Due to the nature of nighttime flight operations, aircraft landing lights are usually high intensity. Aircraft descending in altitude during the approach can impact adjacent property. In some cases, the landing lights of large aircraft can be seen for several miles.

Rotating Light Beacon



Fumes

The impact that aviation fumes have on the airport neighbors' quality of life is often hard to quantify. Aircraft operations can produce small particles of carbon-based chemicals, which can be easily inhaled and, in some cases, cause respiratory inflammation. Exposure to these chemicals may be greater for people living near smaller airports. Larger airports with commercial service typically have buffer to reduce the residents' exposure to fumes and pollution. Small airports in heavily populated areas often don't have these buffers; therefore, residents may be more directly exposed to aircraft emissions[1].

Jet Fumes

Fumes and unpleasant smells (e.g. kerosene) are particularly noticeable from turbine-powered aircraft (jets, turbo-props, and some helicopters). On airport industrial activity can also be a source of offensive odors. Planners and decision makers should consult the airport manager about areas within the airport's environment exposed to the highest levels of fumes.

Low-Flying Aircraft

The sight and sound of low flying aircraft in the traffic pattern can be perceived by some as dangerous, and produce a negative emotional response. Fear and anxiety are two common emotional responses linked with perceived threats. Fear is often related to the specific event and may be related to future events, such as worsening of a situation, or continuation of a situation that is unacceptable. Anxiety is often a result of ongoing or multiple threats, which are perceived to be uncontrollable or unavoidable. These emotional responses often increase stress and fuel opposition to normal airport operations.

On the Ground Perspective

[1] *Aircraft Emission Impacts in a Neighborhood Adjacent to a General Aviation Airport in Southern California,* Environ Sci. Technol. 2009, 43, 8039-8045