

WAAS

Wide Area Augmentation System

the navigation system that dramatically increases the accuracy, integrity and availability of GPS



Using WAAS, aircraft can access over 3,500 runway ends in poor weather conditions with minimums as low as 200 feet. WAAS can even get you into places where an Instrument Landing System (ILS) may not be available. In addition to its unprecedented benefits related to airport access, WAAS also offers a number of other benefits. There are now twice as many WAAS procedures (LPVs and LPs) as there are ILS glide slopes in the U.S. National Airspace System.

WAAS LPVs Outnumber Category I ILS Approaches Within the U.S.

As of January 31, 2019:

- 3,969 published LPVs
- Serving 1,931 airports
- 1,938 LPVs serving 1,164 non-ILS airports
- FAA is adding more new WAAS procedures each year

Benefits of WAAS compared with GPS for Flight Planning, Terminal and Enroute Operations

- [REDACTED]
- Provides vertically-guided approach procedures capability at airports that do not have ground-based navigational aides (*Some infrastructure upgrades may be required to get the best possible minimums. More information is available in "Maximizing Airport Operations Using the Wide Area Augmentation System" available at <http://gps.faa.gov/>*)
- [REDACTED]
- Allows RNAV (GPS) approaches to be used for alternate airport flight planning

- Increases number of alternate airport options which improves flight planning flexibility

- Eliminates RAIM check requirement per AC 90-100A
- Provides two additional ranging sources (from WAAS GEOs)
- Enables extension of terminal mode operations for both departure and arrival to beyond 30 nautical miles from the airport reference point
- Increased accuracy and availability
- Eliminates ILS critical areas
- Enables ADS-B

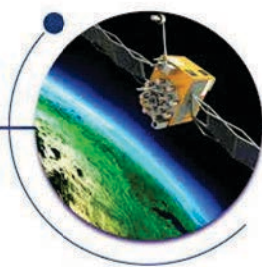
GPS/WAAS Technical Standard Orders

TSO-C145c - "Airborne Navigation Sensors Using the GPS Augmented by the Satellite-Based Augmentation System"

TSO-C146c - "Stand-Alone Airborne Navigation Equipment Using the GPS System Augmented by the Satellite-Based Augmentation System"

WAAS LPVs Provide Similar Level of Service to Category I ILS

- Vertical guidance
- Glidepath more stable than that of ILS
- Minimums as low as 200 feet, which is lower than all Required Navigation Performance (RNP) Authorization Required (AR) approaches and all conventional (e.g. VOR, NDB) non-precision approaches



LPV Approaches Enabled by a WAAS Receiver

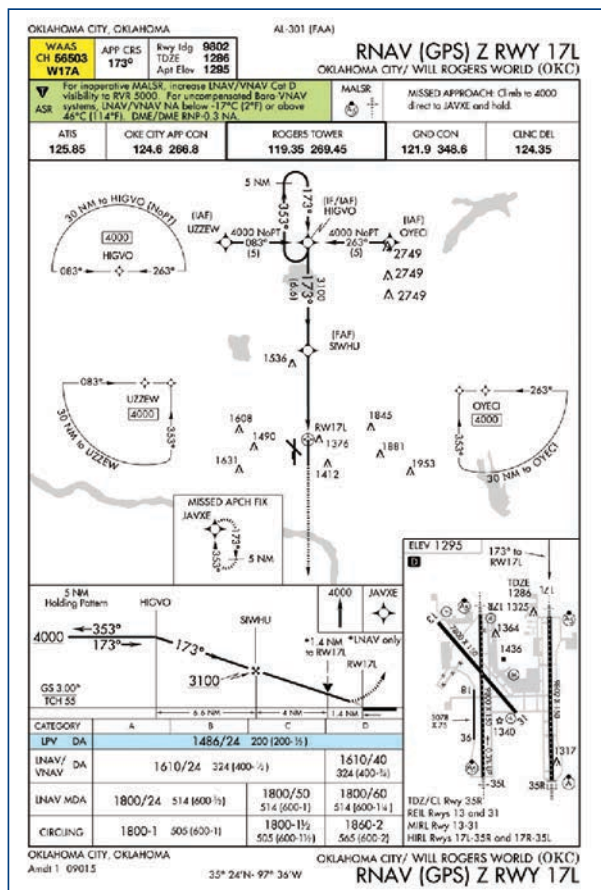
The Localizer Performance with Vertical guidance (LPV) procedure takes advantage of the accuracy of WAAS to provide an instrument approach procedure equivalent to a Category I ILS approach. While an LPV approach looks and flies like an ILS approach, it provides the pilot with more stable vertical guidance. An LPV approach can provide minimums as low as 200 feet at qualifying airports.

WAAS LP Approaches Introduced

The smaller LP OCS footprint provides greater potential for avoiding more obstructions in the final approach segment that would otherwise require the minima to be higher. LPs will be published at locations where the terrain or obstructions do not allow publication of LPV procedures. As of January 31, 2019 there are 698 LPs serving 522 airports, 569 of those serving 421 non-ILS airports.

NOTE -

Receivers capable of flying LP procedures must contain a statement in the Flight Manual Supplement or Approved Supplemental Flight Manual stating that the receiver has LP capability, as well as the capability for the other WAAS and GPS approach procedure types.



Important RNAV Approach Information

WAAS
CH 56503
W17A

WAAS Channel Number: CH **56503**

WAAS Approach ID: **W17A**

W: WAAS

17: Runway 17L

A: 1st WAAS Approach to RWY 17L

For inoperative MALSR, increase LNAV/VNAV Cat D visibility to RVR 5000. For uncompensated Baro-VNAV systems, LNAV/VNAV NA below -17°C (2°F) or above 46°C (114°F). DME/DME RNP-0.3 NA.

Temperature Restriction does not apply to WAAS equipment

LPV DA 1486/24 200 (200-1/2)

LPV Minimum Line (flown with WAAS receiver only)

How to Request an LPV or LP Approach at Your Airport

Click on the header above or go to <http://gps.faa.gov> and type "request an LPV" in the search box.

Where to Find Listing of Airports with LPV and LP Approaches

Click on the header above or go to <http://gps.faa.gov> and click on "GPS/WAAS Approaches" in the sliding banner of image links (In the News) near the top of the page.

<http://gps.faa.gov>



Federal Aviation
Administration



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Satellite Navigation - WAAS - Benefits

The Wide Area Augmentation System (WAAS) offers many benefits. Today, in the U.S., there are over 80,000 WAAS aviation users. Many others are using WAAS for non-aviation applications.

Watch the WAAS Experience video to learn what WAAS users are saying. Benefits covered in the [video](http://www.faa.gov/tv/?mediaId=730) (www.faa.gov/tv/?mediaId=730) include improved safety, improved airport access, and fuel savings.



www.faa.gov/tv/?mediaId=730) The video features users from Northern Air Cargo in Alaska; Mercy Medical Center in Iowa; Cape Air in Massachusetts; Horizon Air in Washington State; and the Aircraft Owners and Pilots Association (AOPA) in Frederick, Maryland.

Watch the Video ([www.faa.gov/tv/?](http://www.faa.gov/tv/?mediaId=730)

[mediaId=730](http://www.faa.gov/tv/?mediaId=730))

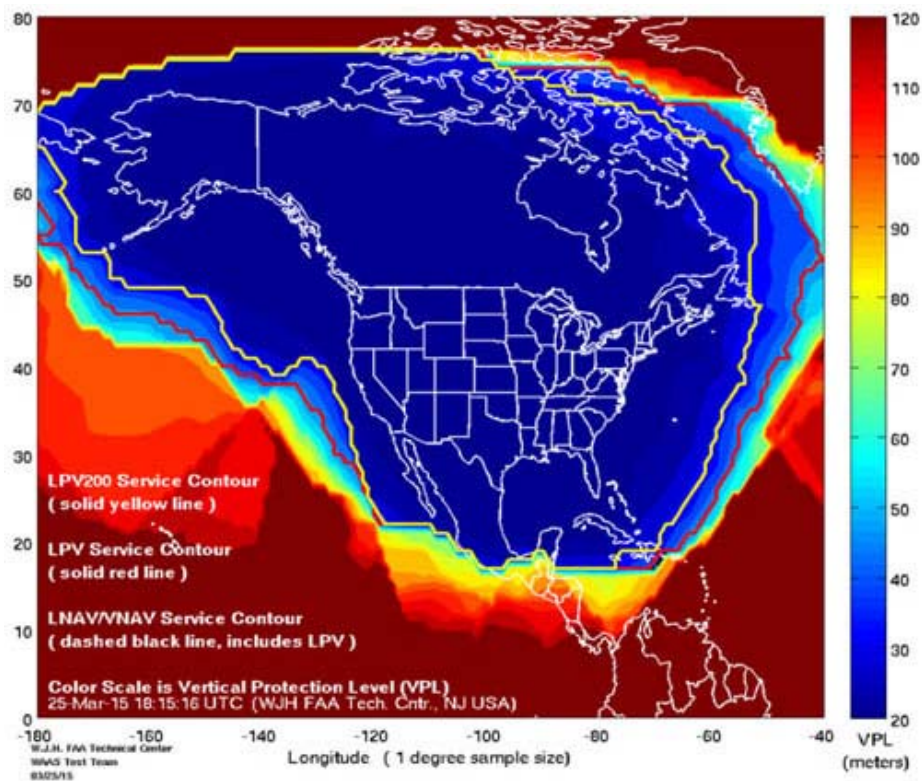
WAAS Benefit - Improved Airport Access

Using WAAS, aircraft can access over 3,400 runway ends in poor weather conditions with minimums as low as 200 feet. A WAAS Localizer Performance with Vertical guidance (LPV) line of minimum on an [RNAV \(GPS\) approach](#) (PDF) provides a similar level of service to the Category I [Instrument Landing System \(ILS\)](#). WAAS can even get you into places where an ILS may not be available. In fact, there are nearly three times as many WAAS-enabled LPVs than there are ILS glide slopes in the U.S. National Airspace System.

- To find out if there is a WAAS-enabled instrument approach procedure at an airport where you fly, please visit our [GPS/WAAS Approaches page](#).

WAAS Benefit - LPV Service Availability throughout the Continental U.S., Canada, and Mexico

WAAS enables LPV service throughout North America.



Sample view WAAS Vertical Navigation Service Snapshot Display

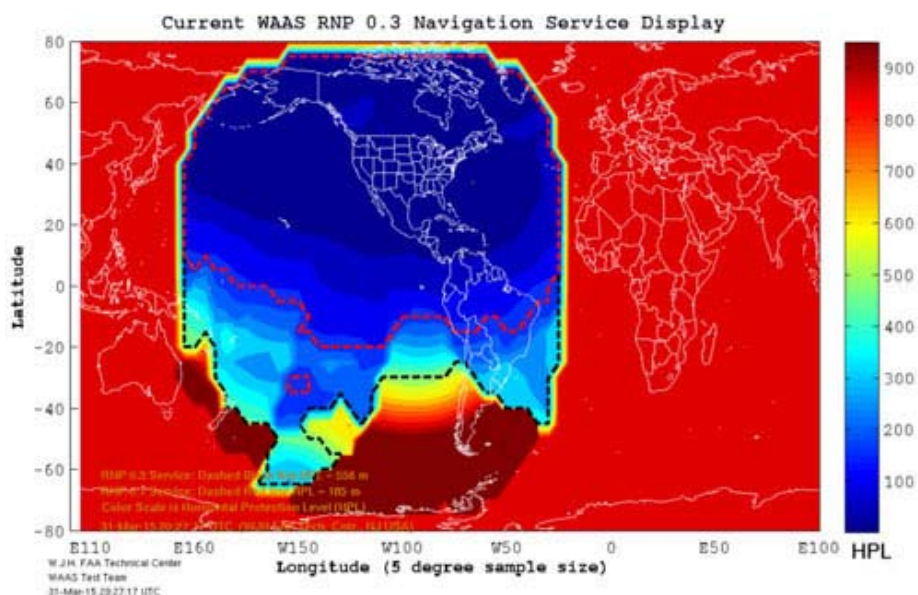
(http://www.nstb.tc.faa.gov/RT_VerticalProtectionLevel.htm)

For a real-time view of WAAS Vertical Navigation Service, including the WAAS LPV service area, please visit the [WAAS Vertical Navigation Service Snapshot Display](http://www.nstb.tc.faa.gov/RT_VerticalProtectionLevel.htm) (http://www.nstb.tc.faa.gov/RT_VerticalProtectionLevel.htm).

The service display page also includes a User Guide which provides a detailed explanation of the data shown.

WAAS Benefit - RNP 0.3 Service Availability in North and South America

WAAS can support Required Navigation Performance (RNP) values of 0.3.



Sample view of the WAAS RNP 0.3 Navigation Service Display

(http://www.nstb.tc.faa.gov/RT_NPACoverage.htm)

WAAS can support Required Navigation Performance (RNP) values of 0.3 and higher. For a real-time view of the WAAS RNP 0.3 coverage area, please visit the [FAA RNP 0.3 Navigation Service Snapshot Display](http://www.nstb.tc.faa.gov/RT_NPACoverage.htm) (http://www.nstb.tc.faa.gov/RT_NPACoverage.htm). Data is updated every three minutes.

The service display page also includes a User Guide which provides a detailed explanation of the data shown.

WAAS Benefit - Interoperability with Other Satellite Based Augmentation Systems (SBAS)

Satellite Based Augmentation Systems (SBAS), like WAAS, are available in Europe, Japan, India, and are being developed in other regions of the world. All are designed to be interoperable. Interoperability allows aircraft equipped with WAAS to use these other systems too.

WAAS Benefit - WAAS Improves the Horizontal and Vertical Accuracy Provided by GPS

WAAS accuracy

Accuracy	GPS Accuracy Requirements (as specified in the GPS Performance Standard)	GPS Actual Performance*	WAAS LPV-200 Accuracy Requirements (as specified in the WAAS Performance Standard)	WAAS LPV-200 Actual Performance
Horizontal 95%	36 m	2.9 m	16 m	0.7 m

Accuracy	GPS Accuracy Requirements (as specified in the <u>GPS Performance Standard</u> (http://www.gps.gov/technical/ps/))	GPS Actual Performance*	WAAS LPV-200 Accuracy Requirements (as specified in the <u>WAAS Performance Standard</u> (http://www.gps.gov/technical/ps/))	WAAS LPV 200 Actual Performance
Vertical 95%	77 m	*4.3 m	4 m	1.2 m

**GPS and WAAS performance is monitored and measured by the FAA WAAS Test Team. Quarterly, Performance Analysis Reports for both GPS and WAAS are produced and made available on [FAA WAAS Test Team website](http://www.nstb.tc.faa.gov/) (<http://www.nstb.tc.faa.gov/>).*

WAAS Benefit - Navigation Sensor for ADS-B

Automatic Dependent Surveillance-Broadcast (ADS-B) is a surveillance system that uses inputs from navigation systems, such as the Global Positioning System (GPS) and WAAS to determine an aircraft's position.

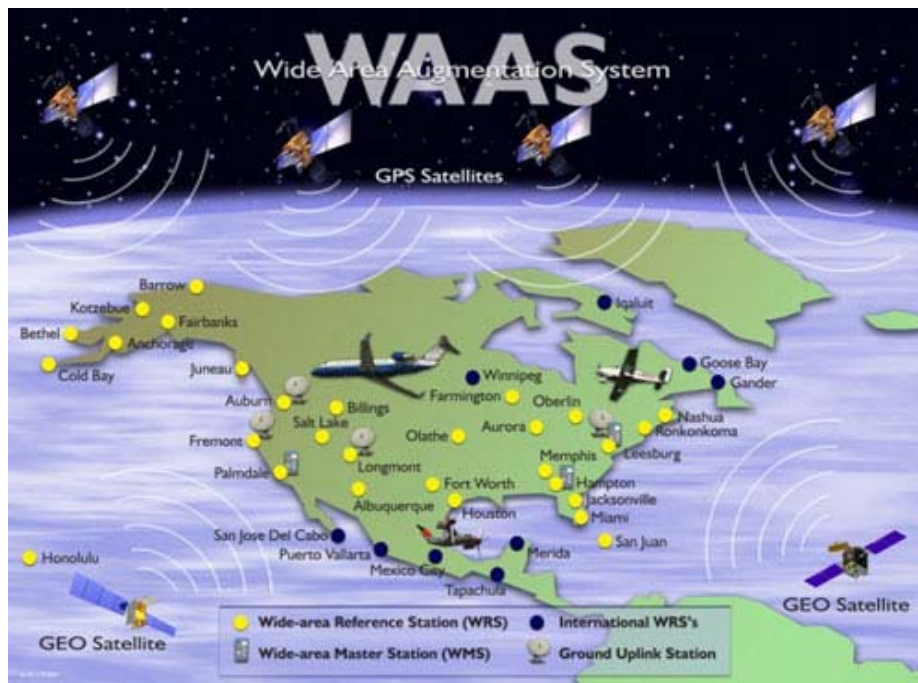
Aircraft meeting the ADS-B Out 2020 mandate will broadcast their position allowing air traffic control and ADS-B In equipped aircraft to receive and utilize this information.

Most, but not all, GPS equipment will support the basic navigation performance requirements associated with ADS-B. Due to the improved navigation performance of WAAS over GPS alone, WAAS may be the best solution to meet the ADS-B mandate in some cases. Aircraft owners will need to check with their avionics providers to determine the best qualified navigation solution that meets the ADS-B Out 2020 mandate for their particular aircraft configuration.

WAAS Benefit - Key Component of the National Airspace System (NAS) Navigation Strategy

Air navigation is undergoing a global transformation, driven by the need to use airspace more efficiently, increase system capacity, and reduce fuel consumption and associated emissions (carbon footprint). This transformation is being enabled, to a large extent, by the position, navigation, and timing (PNT) services provided by Global Navigation Satellite Systems, such as GPS and GNSS augmentation systems - such as WAAS - that improve accuracy and integrity.

WAAS becomes increasingly more vital as older equipment such as Non Directional Beacons (NDB), [Very High Frequency Omni-Directional Ranges \(VOR\)](#), and [Instrument Landing Systems \(ILS\)](#) are removed from service. Also, WAAS provides better coverage with more services as compared to legacy systems and requires less infrastructure as (e.g., approximately 50 WAAS facilities compared to hundreds of VORs).



For additional benefits of WAAS, please see our [WAAS: Quick Facts](#) (PDF).

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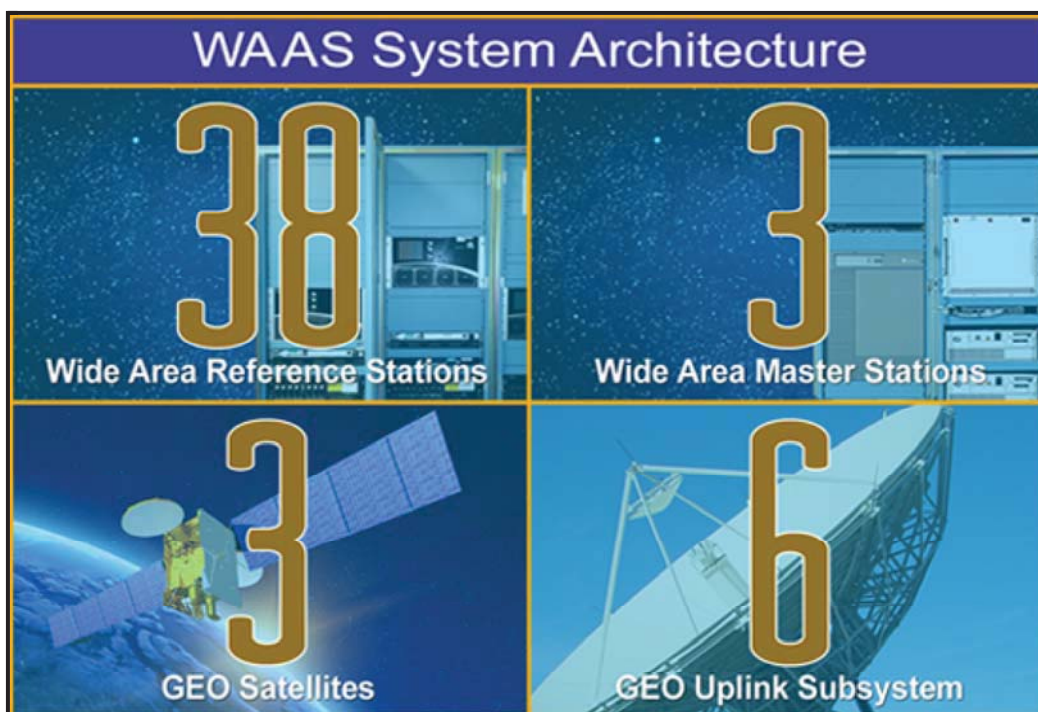
https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/waas/benefits/



Federal Aviation Administration

Satellite Navigation - WAAS - How It Works

Unlike traditional ground-based navigation aids, the WAAS provides navigation services across all of the National Airspace System (NAS). The WAAS provides augmentation information to GPS/WAAS receivers to enhance the accuracy and integrity of position estimates.



Wide Area Augmentation System - How It Works



The signals from GPS satellites are received across the NAS at numerous widely-spaced Wide Area Reference Stations (WRS) sites. The WRS locations are precisely surveyed so that any errors in the received GPS signals can be detected.



The GPS information collected by the WRS sites is transmitted to WAAS Master Stations (WMS). The WMS generates a WAAS User Message every second. These messages contain information enabling GPS/WAAS receivers to remove errors in the GPS signal, allowing for a significant increase in location

accuracy and integrity.

The messages are sent from the WMS to uplink stations for transmission to navigation payloads on geostationary (GEO) communications satellites.



The navigation payloads receive the messages and then broadcast the messages on a GPS-like signal across the NAS. The GPS/WAAS receiver processes the WAAS augmentation message as part of position estimation. The GPS-like signal from the navigation transponder can also be used by the GPS/WAAS receiver as an additional source for calculation of the user's position. GPS/WAAS receivers can achieve position accuracy of a few meters across the NAS.

WAAS also provides indications to GPS/WAAS receivers of where the GPS system is unusable due to system errors or other effects. Further, the WAAS system was designed to very strict integrity and safety standards: users are notified within six seconds of any issuance of hazardously misleading information that would cause an error in the GPS/WAAS receiver's position estimate. This provides very high confidence to the computed GPS/WAAS receiver position.



Wide Area Augmentation System (WAAS)



Updated May 01, 2018

The Wide Area Augmentation System (WAAS) is perhaps the most valuable tool for pilots today. Currently, it is the most precise location-providing service available in North America. The Federal Aviation Administration (FAA) has teamed with the Department of Transportation (DOT) to implement the WAAS throughout the aviation industry, making flying more efficient and safe for users.

What Is WAAS?

WAAS is an abbreviation for Wide Area Augmentation System, which is a fancy way of saying it's a system that uses widely-spaced ground stations to correct satellite ambiguities, improving upon the already-precise satellite system in North America. With satellite errors corrected, users can increase location accuracy, putting WAAS-enabled operations within FAA limits for certain navigational uses -- specifically, precision instrument approach procedures.

What's Wrong With Regular Old GPS?

Regular old GPS is a great [navigational aid](#). In fact, GPS is probably the most error-proof NAVAID on the market. Yet the system, like all systems, has its insufficiencies.

GPS data is vulnerable to a few different errors, including timing errors, disturbances from the ionosphere and satellite orbit errors. These errors aren't likely to cause many significant problems, but they are the reason that regular old GPS signals aren't accurate enough for use with precision instrument approaches.

Typical GPS alone doesn't meet the FAA's requirements for both vertical and horizontal navigational accuracy for precision approach procedures. A GPS with WAAS capabilities, however, exceeds those accuracy standards, making it possible for pilots to fly a precision approach with a WAAS-enabled GPS receiver.

How Does WAAS Work?

The wide area augmentation system uses 25 ground-based stations across the United States to monitor satellites. There are two Wide Area Master Stations and 23 Wide Area Reference Stations.

Satellite data is collected at the reference stations and sent to a master station. At the master station, that regular old GPS data is augmented and corrected. This adjusted data is sent back to the stationary satellites through an uplink station, where it is broadcast to WAAS-enabled GPS receivers as position data.

Practical Use of WAAS

The main benefit to the wide area augmentation system is greatly improved accuracy. Traditional GPS is accurate to 15 meters. WAAS-enabled GPS accuracy is less than three meters 95 percent of the time.

Along with accuracy comes the ability to utilize [Localizer Performance with Vertical Guidance \(LPV\) approaches](#), making the [national airspace system](#) more efficient altogether. With WAAS abilities, aircraft that might otherwise be required to fly to an alternate location in low visibility now have the ability to land with lower weather minimums utilizing an LPV approach, which means fewer delays and lower costs overall.

Improved accuracy also creates the opportunity for lower separation minimums and more direct routes for aircraft.

Finally, with WAAS in use at many airports nationwide, a large amount of money can be saved on equipment cost alone. Traditional radio navigation aids, such as the ILS and MLS require expensive equipment and costly maintenance to operate. With new precision approaches available with WAAS, such as the LPV approach, older navigational equipment like [VORs](#) will no longer be necessary to install or maintain.

As a part of the FAA's [NextGen program](#), LPV approaches are currently available at about 3,000 airports