

**WIDE AREA AUGMENTATION SYSTEM
NOTICES TO AIRMEN (NOTAM) OPERATIONAL CONCEPT
April 28, 2008**

Jimmy R. Snow
Satellite Navigation Consultant
Norman, OK, USA
Tel: 405-249-4329
Fax: 405-329-0636
E-Mail: cjsnow@cox.net



ABSTRACT

Satellite navigation has changed the concept and requirements of aeronautical information distribution and considerations. It is no longer a system of reporting what has happened or is scheduled to happen, but now must predict what is expected to happen. The Global Positioning System (GPS) approach procedures were first published in the United States in 1995. Receiver autonomous integrity monitoring (RAIM) provided the integrity monitoring for the system with RAIM predictions provided as aeronautical information by the Flight Service Stations on request. With the commissioning of WAAS in July 2003, the FAA provided outage predictions at the airports with WAAS approaches. These predictions were classified as Notices to Airmen information. The purpose of this paper is to present the background, system criteria, and regulatory guidance behind WAAS predictive NOTAMs, and the impact they have on WAAS users. In addition, the United States NOTAM System is being reorganized to comply with ICAO guidance and to make the system more user friendly. This new system will be discussed and the recommended changes to WAAS predictive NOTAMs will be presented. The experience gained since WAAS commissioning, new hardware, and software will provide a basis for improved operational capability and user support.

INTRODUCTION

One of the WAAS goals is to provide pilots with increased navigation capability throughout the National Airspace System (NAS). The availability of WAAS is dependent on the operational status of the Global Positioning System (GPS) satellite constellation, WAAS assets (reference stations, master stations, ground uplink, geostationary satellites, and communications network), and ionospheric interference which is out of the control of the FAA. Satellite navigation is different from ground-based navigation aids since the impact of

satellites out of service is not intuitively known and the area of degraded service is not stationary. Pilots need to know where and when WAAS is predicted to be unavailable. This requires a predictive service volume model (SVM) system that pilots and the FAA can rely on to forecast outages over a period of time for specific areas and airports. WAAS requires distribution of two types of information: (1) event-driven notification of system degradation (e.g. satellite out of service) and (2) algorithmically derived predictions of the potential site-specific impact of system outages.

FAA Order 7930.2, Notices to Airmen, outlines the process for time-critical aeronautical information which is of either a temporary nature or not sufficiently known in advance to permit publication on aeronautical charts or in other operational publications receives immediate dissemination via the National Aeronautical Information System. *NOTAM information is aeronautical information that could affect a pilot's decision to make a flight. It includes such information as airport or primary runway closures, changes in the status of navigational aids, ILSs, radar service availability, and other information essential to planned en route, terminal, or landing operations.* NOTAM information is classified into four primary categories. These are NOTAM (D) or distant, and Flight Data Center (FDC) NOTAMs, Pointer NOTAMs, and Military NOTAMs. Just recently local NOTAMs were suspended and converted into D NOTAMs.

BACKGROUND

WAAS uses a network of wide area reference station (WRS) sites to measure various errors affecting GPS performance. Atmospheric corrections and GPS constellation status corrections are generated by a WAAS Master Station (WMS) and broadcast via geostationary earth orbit (GEO) satellites to WAAS receivers. These receivers apply the corrections, resulting in a position determination that is very accurate and whose integrity is assured.

WAAS equipped aircraft are capable of conducting the following flight operations using WAAS for guidance:

- En Route Navigation
- Terminal Navigation
- RNAV-LNAV Approach
- RNAV-LNAV/VNAV Approach
- RNAV-LPV Approach

En route, terminal, and RNAV approach operations are currently approved in the United States using GPS (TSO C129a) or WAAS (TSO C145b/146b) avionics installed in accordance with the appropriate advisory circular. GPS requires a receiver autonomous integrity monitor (RAIM) check for project availability that WAAS does not require.

LNAV/VNAV approaches may be flown by aircraft equipped with GPS and Baro VNAV. The GPS signal is used for the lateral guidance, and the barometric altitude data is used to provide the vertical guidance by calculating a barometric glide path. Baro VNAV operations are typically available on airline and business aviation aircraft equipped with flight management systems. The commissioning of WAAS services have extended this capability to all WAAS equipped aircraft, with WAAS being used to provide both the vertical and lateral guidance.

LPV approaches are WAAS specific approaches that are constructed using the lateral obstacle clearance surface dimensions of the precision approach trapezoid, with vertical guidance provided by the WAAS where the vertical alarm limit is greater than 12 and equal to or less than 50 meters. These procedures are published on RNAV GPS approach charts as the LPV minima line. New LPV-200 approaches have been authorized that reduce the vertical alarm limit to 35 meters or less.

The FAA commissioned WAAS, including WAAS derived vertical guidance, for use in the National Airspace System (NAS) on July 10, 2003. The first LPV approaches were published on September 4, 2003.

Unlike traditional navigation aids, which use ground based monitors to ensure integrity, GPS and WAAS receivers perform this task in the avionics. They use continuously computed horizontal and vertical protection levels (HPL and VPL) that are guaranteed to bound the navigation system error to the specification for that phase of operation.

Horizontal and vertical alert limits (HAL and VAL) reflect performance standards for different flight operations. These have been established as follows:

Table 1. Horizontal and Vertical Alert Limits

Operation	HAL	VAL
En Route	2.0 NM	N/A
Terminal	1.0 NM	N/A
LNAV	0.3 NM	N/A
LNAV/VNAV	0.3 NM (556 m)	50 m
LPV	40 m	50/35 m

An operation is defined to be available when the HPL and VPL are less than the HAL and VAL, respectively.

The availability of LNAV was already very good, and with WAAS, it is virtually 100%. The availability of LNAV/VNAV and LPV is expected to be over 99% for the continental United States. These service availabilities are lower as the performance requirements are significantly higher for vertical guidance. GPS satellite outages, both scheduled (i.e. maintenance) and unscheduled (i.e. failure), and ionospheric disturbances caused by solar flares and storms affect availability. The effects of geometry and scheduled outages can be predicted, as can those caused by failures, once those failures have occurred. However, the effect on availability resulting from ionospheric activity cannot be predicted with certainty.

During the WAAS 60 day stability test conducted prior to WAAS commissioning, the William J. Hughes Technical Center, WAAS Branch, ACB-430 evaluated all of the LNAV/VNAV airports to determine the number of WAAS service outages involving vertical guidance that each experienced. With this outage data available, an FAA WAAS working group comprised of representatives from AFS, AIR, Technical Center, AND, AVN, and Volpe met to determine the impact these outages would have on the FAA Notice to Airman (NOTAM) System. It was determined that no NOTAM service and operational restrictions would be applied for all WAAS vertically guided procedures with more than 60 outages during the stability test due to vertical availability issues. There were 26 airports within the continental United States that had more than 60 outages during the 60-day stability test. Each of the LNAV/VNAV/future LPV procedures at these locations is identified in the remarks section with a negative symbol W (**W**) that is defined in the legend of each of the U.S. Terminal Procedures books. The restriction is as follows: “NOTE: The **W** symbol

indicates outages of the WAAS vertical guidance may occur daily at this location due to initial system limitations. WAAS NOTAMS for vertical outages are not provided for this approach. Use LNAV minima for flight planning at these locations, whether as a destination or alternate. For flight operations at these locations, when the WAAS avionics indicate that LNAV/VNAV or LPV service is available, then vertical guidance may be used to complete the approach using the displayed level of service. Should an outage occur during the procedure, reversion to LNAV minima may be required. As the WAAS coverage is expanded, the **W** will be removed.”

REGULATOR GUIDANCE (AIM, FAR, AND U.S. TERMINAL PROCEDURES)

Aeronautical Information Manual:

1-1-20.c.5. Prior to GPS/WAAS IFR operation, the pilot must review appropriate Notices to Airmen (NOTAMS) and aeronautical information. This information is available on request from an Automated Flight Service Station. The FAA will provide NOTAMS to advise pilots of the status of the WAAS and level of service available.

1-1-20.c.5. (a) The term UNRELIABLE is used in conjunction with GPS and WAAS NOTAMS. The term UNRELIABLE is an advisory to pilots indicating the expected level of WAAS service (LNAV/VNAV, LPV) may not be available.WAAS UNRELIABLE NOTAMS are predictive in nature and published for flight planning purposes. Upon commencing an approach at locations NOTAMed WAAS UNRELIABLE, if the WAAS avionics indicate LNAV/VNAV or LPV service is available, the vertical guidance may be used to complete the approach using the displayed level of service. Should an outage occur during the approach, reversion to LNAV minima may be required.

1-1-20.c.5.(a) (1) Area-wide WAAS UNAVAILABLE NOTAMS indicate loss or malfunction of the WAAS system. In flight, Air Traffic Control will advise pilots requesting a GPS or RNAV (GPS) approach of WAAS UNAVAILABLE NOTAMS if not contained in the ATIS broadcast.

1-1-20.c.5.(a) (2) Site-specific WAAS UNRELIABLE NOTAMS indicate an expected level of service, e.g., LNAV/VNAV or LPV may not be available. Pilots must request site-specific WAAS NOTAMS during flight planning. In flight, Air Traffic Control will not advise pilots of WAAS UNRELIABLE NOTAMS.

1-1-20.c.7.(a) Due to initial system limitations there are certain restrictions on WAAS operations. Pilots may plan to use any instrument approach authorized for use with WAAS avionics as a required alternate. However, when using WAAS at an alternate airport, flight planning must be based on flying the RNAV (GPS) LNAV minima line, or minima on a GPS approach procedure, or conventional approach procedure with “or GPS” in the title. Code of Federal Regulations (CFR) Part 91 nonprecision weather requirements must be used for planning. Upon arrival at an alternate, when the WAAS navigation system indicates that LNAV/VNAV or LPV service is available, then vertical guidance may be used to complete the approach using the displayed level of service.

Code of Federal Regulations Part 91:

91.169 IFR flight plan: Information required.

(a) *Information required.*

(a) (2) Except as provided in paragraph (b) of this section, an alternate airport.

(b) Paragraph (a)(2) of this section does not apply if:

(1) Part 97 of this chapter prescribes a standard instrument approach procedure to, or a special instrument approach procedure has been issued by the Administrator to the operator, for the first airport of intended landing; and

(2) Appropriate weather reports or weather forecasts, or a combination of them, indicate the following:

(i) *For aircraft other than helicopters.* For at least 1 hour before and for 1 hour after the estimated time of arrival, the ceiling will be at least 2,000 feet above the airport elevation and the visibility will be at least 3 statute miles.

(c) *IFR alternate airport weather minima.* Unless otherwise authorized by the Administrator, no person may include an alternate airport in IFR flight plan unless appropriate weather reports or weather forecasts, or a combination of them, indicate that, at the estimated time of arrival at the alternate airport, the ceiling and visibility at the airport will be at or above the following weather minima:

(1) If an instrument approach procedure has been published in part 97 of this chapter, or a special instrument approach procedure has been issued by the Administrator to the operator, for that airport, the following minima:

(i) *For aircraft other than helicopters:* The alternate airport minima specified in that procedure, or if none are specified the following standard approach minima:

(A) *For a precision approach procedure.* Ceiling 600 feet and visibility 2 statute miles.

(B) *For a nonprecision approach procedure.*
Ceiling 800 feet and visibility 2 statute miles.

U. S. Terminal Procedures:

TERMS/LANDING MINIMA DATA: NOTE: The **W** symbol indicates outages of the WAAS vertical guidance may occur daily at this location due to initial system limitations. WAAS NOTAMS for vertical outages are not provided for this approach. Use LNAV minima for flight planning at these locations, whether as a destination or alternate.

CURRENT WAAS NOTAMS PROCESS:

To generate WAAS NOTAMS, a predictive model of WAAS determines service availability and areas expected to experience outages. The WAAS SVM currently in use was developed at the John A. Volpe National Transportation System Center. The SVM relies on GPS satellite status from the GPS Master Control Station, received in the format of a NOTAM from the FAA; GPS almanac data from a GPS receiver with a backup source from Schriever Air Force Base; location information for airports with Area Navigation (RNAV) and GPS procedures from a listing provided by Aviations System Standards that is converted into a database by VOLPE.

The SVM generates the WAAS service availability for a 30-hour period once every 24 hours. The data is processed at one-minute intervals over the 30-hour prediction window. Any predicted outages are formatted as NOTAMS and use the following criteria:

Current Criteria:

1. WAAS Predictive NOTAMS are based on airport reference point coordinates.
2. WAAS Predictive NOTAMS are calculated at one minute intervals/outages.
3. WAAS Predictive NOTAMS are published for a minimum of 15 minutes regardless of the length of the outage.
4. Three minutes are added to the beginning of the outage.
5. Three minutes are added to the end of the outage.
6. A minimum of 15 minutes will separate outages or they will be combined into a single outage.

7. Outages are based on a vertical alert limit of greater than 50 meters or a horizontal alert limit of greater than 40 meters.

Outages are based on WAAS service unavailability for LNAV, LNAV/VNAV, and LPV approaches, and also are designed to provide outage information for en route operations. If WAAS service is unavailable, the algorithm reverts to determining availability for horizontal guidance based on TSO C145/146 RAIM with selective availability set to zero.

Airfield specific NOTAMs are sent to Flight Service Stations (FSS). NOTAMs are formatted in the U.S. domestic NOTAM format. Airfields that have been determined not to have a high enough availability (98% or an average of one outage per day or more) are marked with an inverse **W** to indicate that WAAS NOTAM information is not provided and certain flight planning restrictions apply to that airfield.

The WAAS NOTAM generations function resides on the MILOPS operating environment. The WAAS NOTAM system receives outages formatted as NOTAM from the WAAS SVM, parses the NOTAM text to determine the responsible Automated Flight Service Station (AFSS) for the locations involved, and then transmits the NOTAM text via a Service B message to the AFSS. Specialists at the AFSS receive the NOTAM text, review it, and transmit it to the US NOTAM System (USNS) for processing. Once processed, USNS sends a response back to the originating AFSS with the USNS NOTAM number.

Predicted outages are based on airport status versus runway end for each procedure. As new airports are added the calculation process is slowed. Currently the MILOPS system is using 16 CPUs and requires 18 plus hours to complete the computations. The contractor collects the almanac and satellite outages and begins the calculations at 0100Z. The system completes the calculations at about 1930Z and sends these predictions to the various Flight Service Stations at 2000Z for processing and assignment of NOTAM numbers for an effective time of 0001Z. The time between completing the calculations at 1930Z and the transmission time of 2000Z is the remaining MILOPS system expansion capability. As more WAAS approaches are added to the MILOPS database, system expansion capability decreases.

NOTE: The Aeronautical Information Management Group is in the final process of transferring the WAAS Predictive NOTAMS system from MILOPS to the NAIMES platform with new hardware for NOTAM calculations. This should occur in mid May

2008, after this paper is submitted for publication. If the transfer is successful, the 30 prediction calculation should take less than an hour and will allow other improvements to the system.

Current System Limitations:

1. The current SVM runs too slowly. The MILOPS hardware platform at WAAS IOC was configured with 8 CPUs at 450Mhz/ea. This hardware is on the order of 10 years old and does not support upgrading with modern high-speed processor technology. At the WAAS IOC, it took approximately 10 hours to complete a 30-hour prediction. By the first quarter of FY-06, the processing time was approximately 20 hours. An additional 8 processors have been added to the MILOPS platform which reduced the processing time, this expansion however has been overcome by additional airports in the database. The planned growth rate for additional WAAS procedures will exceed the MILOPS capability very shortly.

2. The current SVM runs too slowly to handle unscheduled events that can affect WAAS service availability. Due to the lengthy runtime, unscheduled GPS satellite outages cannot be processed in a timely manner with current hardware performance. Also, input on the real-time status of WAAS from an operational external interface cannot be incorporated into the prediction.

3. Automated Flight Service Station Specialist do not always enter WAAS NOTAM data into the USNS. The content of WAAS NOTAMs is sometimes changed at the AFSS. This has been an ongoing issue since WAAS IOC.

4. There is no redundancy of hardware and no backup system which has resulted in unavailability of WAAS NOTAMs when there are problems with the MILOPS platform.

5. The airport database update process is a manual process and is not always updated correctly and in time to meet the 28-day cycle.

WAAS SERVICE VOLUME MODEL PREDICTIVE NOTAM REPLACEMENT SYSTEM:

Operational Concept:

Predictive WAAS reductions in service level can take either the form of aeronautical information or NOTAMs. There are no anticipated changes for FDC

procedure NOTAMs or WAAS system outage NOTAMs.

WAAS predictive service reductions are anticipations of WAAS service at specific airports based on the conditions at the time of the predictions. As the status of the various WAAS components change the predictions must change to reflect these new conditions. This process must be automatic and seamless in the aeronautical information system, and timely enough to provide the most current predictions to pilots that are flight planning as well as airborne. The specifications below list those items that are considered essential to this system in terms of capability.

The residence of this system is not important to the requirements and can be decided when it is acquired based on size, interface requirements, and operations support. The system must be capable of receiving routine updates on system status for daily predictions automatically. The routine updates for WAAS and GPS data must have a backup source. The airfield/approach database must be automated and updated with each 28 day publication cycle. The source of the data can come from the National Aeronautical Charting Group database as they publish each procedure cycle or the National Flight Data Center (NFDC) who controls the publication cycle. The predictions should follow essentially the current distribution system, except the National Operations Command Center and WAAS Operators should be added to the real time distribution.

The primary difference from current predictions will be the automatic update of WAAS predictions as the WAAS components, GPS satellites, and communications outages occur between routine calculations. As these outages occur the system must be capable of reproducing new predictions within 30 minutes and replacing the existing NOTAMs or Aeronautical information. This will present a challenge in determining how the losses of various WRS's affect the specific airports and runway ends.

Unlike the past a new LPV approach is being implemented that will use a VAL of 35 versus the 50 VAL that is currently being used. There is the potential that an airport will have a 50 VAL approach at one end of a runway and a 35 VAL approach at the other end. In these cases it must be determined whether the airport will be penalized by only calculating the 35 VAL for the entire airport or calculating availability for each end of runway based on the appropriate VAL. This has the potential to increase the size of the database by at least 30 to 40%

by converting to runway end versus airport predictions.

Specifications:

The following are recommended WAAS Service Volume Model (SVM) specifications for the predictive notice-to-airmen (NOTAM) replacement system:

1. Capable of providing all GPS Receiver Autonomous Integrity Monitor (RAIM), WAAS NOTAM/Aeronautical Information, and LAAS NOTAMs.
2. A hardware and software system that is capable of evaluating WAAS predicted performance based on GEO, GPS satellite, WRS's, and other system inputs.
3. Capable of providing WAAS NOTAMs/Aeronautical Information for airports, runway ends, or a combination of both.
4. Capable of providing WAAS NOTAMs/Aeronautical Information for LPV approaches that use various levels of VPL and HPL values.
5. Capable of automatic formatting of predicted outages into various NOTAM/Aeronautical Information formats as required.
6. User definable coverage regions for WAAS service assessment against WAAS operations specialist defined and/or variable performance requirements.
7. Generate WAAS service availability/Aeronautical Information for a 72 hour period into the future and 24 hours of history.
8. Generate WAAS service availability/Aeronautical Information update for a 72 hour period within 15 minutes for unscheduled outages of WRSs, GEOs, and GPS satellites.
9. Generate automated database updates to include airport ID, airport coordinates, runway number, and procedure service level (LNAV, LNAV/VNAV, or LPV).
10. Provide hardware with system capability for backup redundancy.
11. Provide a fully automated capability that can format WAAS NOTAMs/Aeronautical Information

and output them automatically into the U.S. NOTAM distribution process.

12. Provide necessary tracking after NOTAM numbers are assigned.
 13. Provide a fully automated capability that can format WAAS NOTAMs/Aeronautical Information and output them automatically in ICAO format.
 14. Expandable to accept input from up to 50 WAAS reference stations.
 15. Capable of predicting WAAS NOTAMs/Aeronautical Information for up to 15,000 RNAV approach procedures.
 16. Perform a NOTAM/Aeronautical Information validation for actual system performance versus predictions made and produce a daily performance report.
 17. Provide WAAS operators the capability to review active NOTAMs/Aeronautical Information predicted by the SVM.
 18. Capability to perform system modeling with various simulated outages.
 19. The ability to validate real-time SVM data with WAAS O & M data graphically on demand.
 20. Provide a composite display utilizing all available GEOs for WAAS operations specialists.
 21. Capable of interfacing with ICD requirements that will be established by ATO-R.
 22. WAAS Predictive NOTAMS must achieve an accuracy of 95% when compared to actual WAAS performance over a 30 day period under normal operating condition at the supported airports in the system database. Unexpected outages of WRS's, GPS satellites, and other system components do not apply to this accuracy percentage.
 23. An automated process for retrieval of required data from a specified FAA database for supported airports will be established and provided with the system.
- RECOMMENDATION:**
- Acquire a new SVM that has the capability and automation necessary to compute future requirements for up to 15,000 WAAS approaches and meets all operational specification of this paper.

Recommend Future Criteria:

1. WAAS Predictive Aeronautical Information is based on airport reference point coordinates.
2. WAAS Predictive Aeronautical Information is calculated at one minute intervals.
3. Actual outage times are used with no time added at either end of the predicted outage.
4. WAAS Predictive Aeronautical Information outages of less than five minutes are not reported as an outage. Up to 15 minute outages do not require reporting.
5. Multiple WAAS Predictive outages of one minute or more separated by five minutes or less is reported as a single continuous outage.
6. Outages are based on a vertical alert limit greater than 50 meters or a horizontal alert limit greater than 40 meters for LPV; 50 meters and 556 meters for LNAV/VNAV.
7. Airports with a 35 meter VAL requirement and a 50 meter VAL requirement shall be evaluated at the 35 meter VAL for all approaches using WAAS.

Justification:

The current SVM does not have the dynamics and capability necessary to support a primary navigation system for the United States National Airspace System in terms of predictive or system evaluation. This will partially be corrected with new hardware, but will still have many of the limitations inherent in the current system. The following issues support this recommendation:

1. Unscheduled outages of the various WAAS components have been ignored due to slow speed of prediction calculations.
2. Automated Flight Service Station Specialist reentry errors of WAAS NOTAMs into the USNS cause the NOTAM not to be issued.
3. During GPS satellite outages the number of WAAS NOTAMs impacts the AFSS's capability to enter NOTAMs and perform other required support activities.
4. There is no backup system which has resulted in unavailability of WAAS NOTAMs when there are

hardware or software problems with the MILOPS platform.

5. The airport database update process is a manual process and is not always updated correctly or on time. Numerous errors are discovered during each 28 day update cycle.

6. ICAO Annex 10, Volume 1, Radio Navigation Aids, Attachment D, Paragraph 9.3 States: "For scheduled events, notification should be given to the NOTAM authority at least 72 hours prior to the event. For unscheduled events, notification should be given within 15 minutes. Notification should be given for events of 15-minutes, or longer, duration."

TERMS OF REFERENCE:

1. Notice-to-Airmen (NOTAM): provide the most current essential flight operation information available, not known sufficiently in advance to publicize in the most recent aeronautical charts of airport/facilities directory (A/FD). NOTAMs provide information on airports and changes which affect the NAS that are time critical and in particular are of concern to IFR operations. Published FAA domestic/international NOTAMs are available by subscription and on the internet. Each NOTAM is classified as a NOTAM (D), a Pointer NOTAM, or an FDC NOTAM.

2. NOTAM (D): or distant NOTAM is given dissemination beyond the area of responsibility of a Flight Service Station. Information is attached to hourly weather reports and is available at Flight Service Stations. They are disseminated for all navigational facilities that are part of the U.S. NAS, all public use airports, seaplane bases, and heliports listed in the A/FD.

3. NOTAM (L): or local NOTAM requires dissemination locally, but does not qualify as NOTAM (D) information. A NOTAM (L) contains information such as taxiway closures, personnel and equipment near or crossing runways, and airport rotating beacon and lighting aid outages (This NOTAM was discontinued January 2008).

4. FDC NOTAMs: are issued by the National Flight Data Center (NFDC) and contain regulatory information such as temporary flight restrictions or amendments to instrument approach procedures and other current aeronautical charts.

5. Notices to Airmen Publication (NTAP): is published by Air Traffic Publications every 28 days

and contains all current NOTAM (D)s and FDC NOTAMs (except FDC NOTAMs for temporary flight restrictions) available for publication.

6. WAAS Predictive NOTAM: A predictive model of WAAS determines service availability and areas expected to experience outages. The platform that provides these predictions relies on GPS satellite status from the GPS Master Control Station, received in the format of a NOTAM from FAA; GPS almanac data from a GPS receiver with a backup source from Schriever Air Force Base; location information for airports with RNAV and GPS procedures from a database; and is designed to incorporate WAAS operational data including status of WAAS reference stations and GEO almanac data through an operational external WAAS interface.

7. Inverse W (**W**): located on the RNAV approach chart, the inverse W symbol indicates outages of the WAAS vertical guidance may occur daily at that location due to initial system limitations. WAAS NOTAMs for vertical outages are not provided for the approach they are located on. Use LNAV minima for flight planning at those locations, whether as a destination or alternate. For flight operations at these locations, when the WAAS avionics indicate that LNAV/VNAV or LPV service is available, then vertical guidance may be used to complete the approach using the displayed level of service. Should an outage occur during the procedure, reversion to LNAV minima may be required. As the WAAS coverage is expanded, the inverse W will be removed.

8. Term UNRELIABLE used in conjunction with GPS and WAAS NOTAMs: is an advisory to pilots indicating the expected level of WAAS service (LNAV/VNAV, LPV) may not be available. WAAS UNRELIABLE NOTAMs are predictive in nature and published for flight planning purposes. Upon commencing an approach at locations NOTAMed WAAS UNRELIABLE, if the WAAS avionics indicate LNAV/VNAV or LPV service is available, vertical guidance may be used to complete the approach using the displayed level of service.