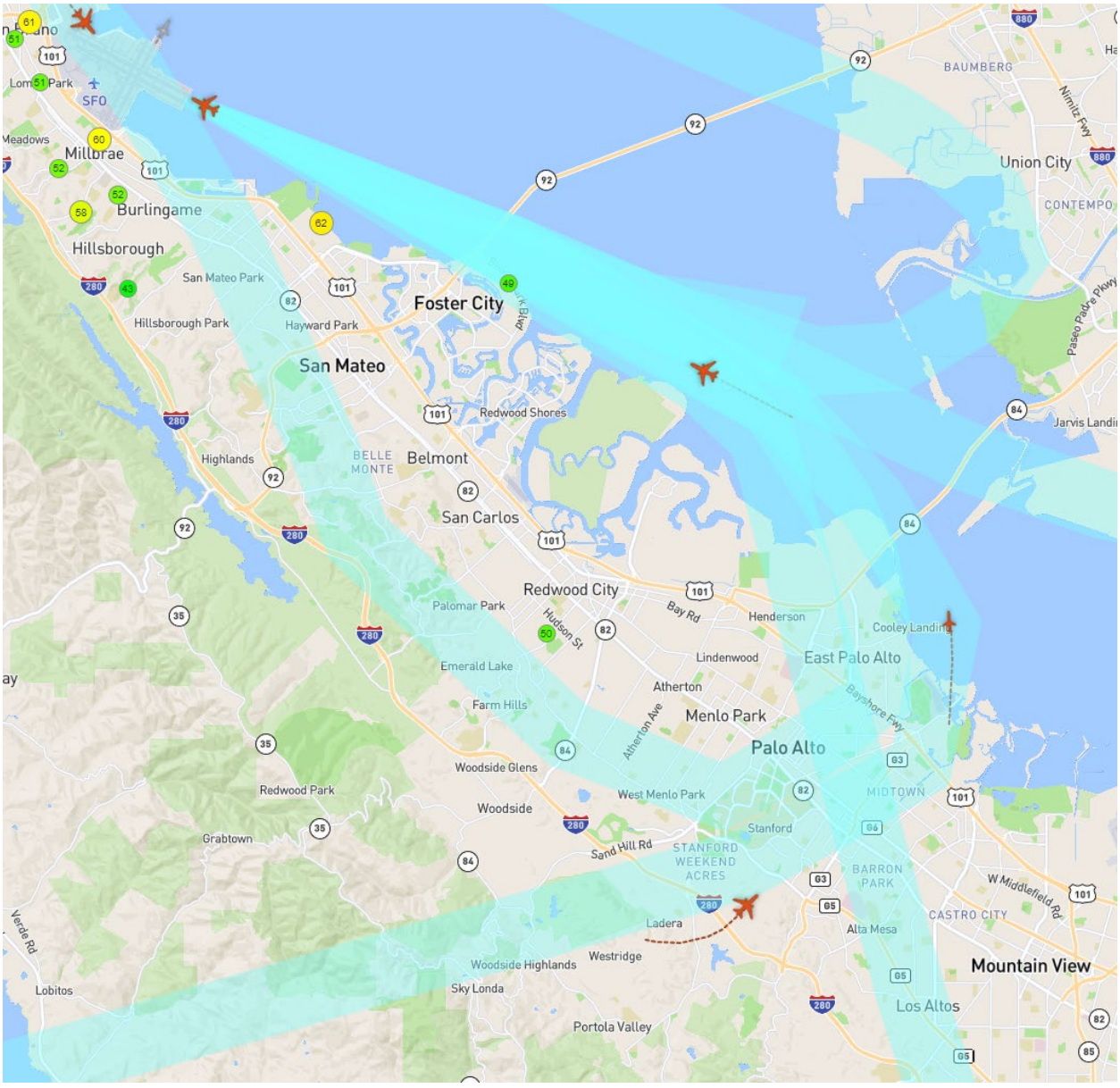
REPORT OF PROFESSIONAL SERVICES
PALO ALTO, CALIFORNIA

March 17, 2022

Review of the Ground Based Augmentation System (GBAS) Innovative Approach Initiative at the San Francisco International Airport (SFO)



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- GLS-R RWY 28R (EDDYY)
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- GLS-TT RWY 28R (Tip Toe Visual EDDYY)

DIFFERENCE IN NOISE EXPOSURE BETWEEN GLS – ILS:

The design of GBAS Landing System (GLS) Innovative Approaches (IA) typically allow for an idle thrust descent where aircraft reduce speed by deployment of speed brakes and flaps at higher altitudes than conventional approaches. The anticipated effect can be seen by the comparison between current and proposed altitudes, speed, and noise exposure contours. Our comparisons are focused at the EDDYY and SIDBY waypoints. An actual Ground Based Augmentation System (GBAS) Noise Measurement Study was performed in December 2021 by San Francisco International Airport (SFO) and United Airlines. As part of SFO's GBAS implementation, SFO deployed six (6) Portable Noise Monitoring Terminals (PNMTs) in the cities of Menlo Park, Los Altos, and Palo Alto to analyze the noise exposure associated with aircraft overflights. The PNMTs captured noise produced by aircraft using the existing approaches and noise produced by United Airlines Boing 737 MAX 8 aircraft flying both the proposed GLS IA and the existing RNAV (GPS) approach procedures on December 2 and December 16, 2021. Eight approaches were flown, and dB levels were recorded for those specific approaches.

December 2, 2021, between 18:40 and 19:38 local time:

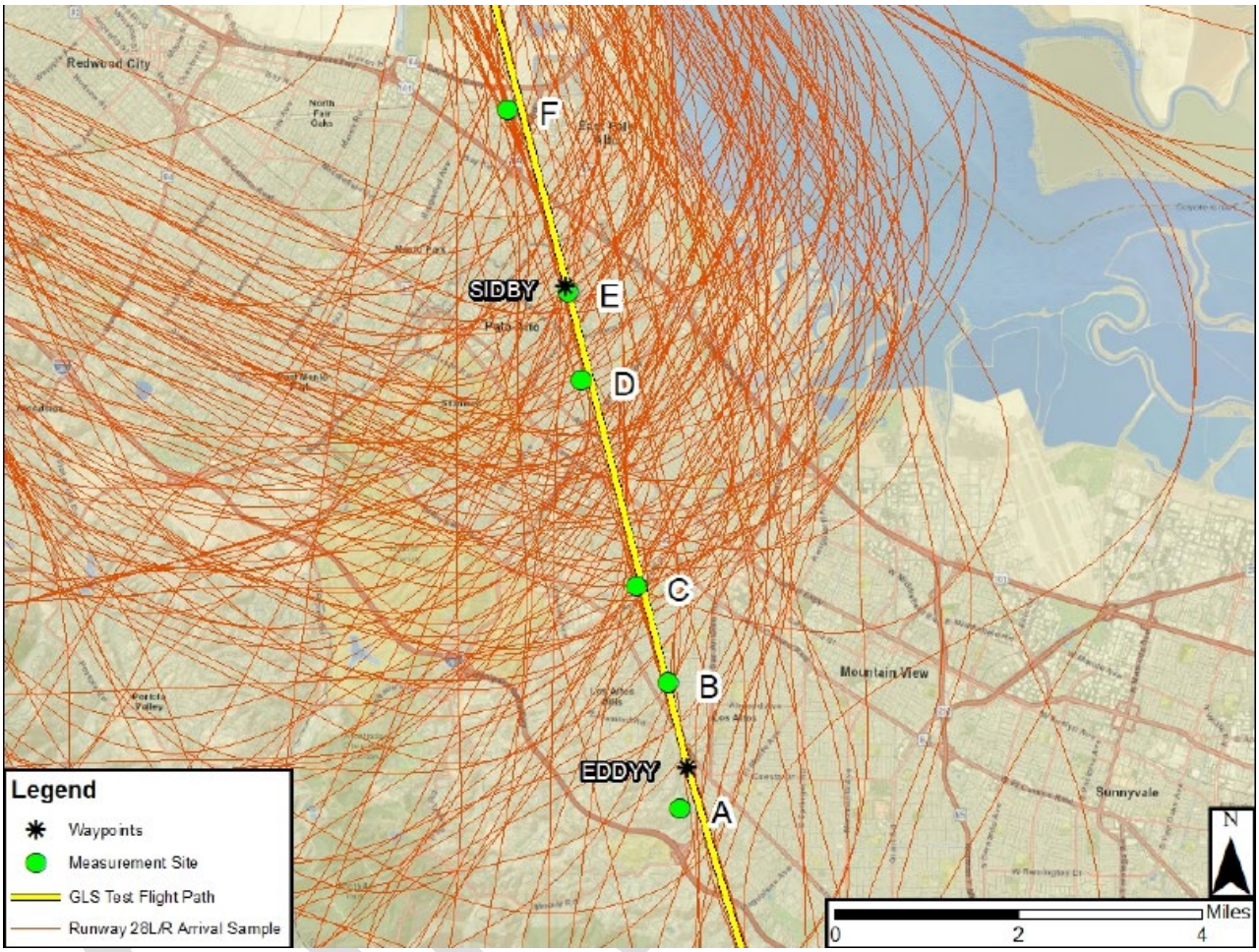
- Approach #1 - RNAV (GPS) RWY 28L
- Approach # 2 - GLS-A RWY 28L
- Approach #3 - RNAV (GPS) Z RWY 28R
- Approach #4 - GLS -A RWY 28R

December 16, 2021, between 6:35 and 7:28 local time:

- Approach #5 - RNAV (RNP) Y RWY 28R
- Approach #6 - RNAV (GPS) RWY 28L
- Approach #7 - GLS-R RWY 28R
- Approach #8 - GLS-A RWY 28L

SFO did not consider Approach #8 as a successful GLS approach, and no explanation was provided as to the reason. Therefore, only three (3) GLS IA approaches were flown during the measurement period (Dec 2-Dec 16, 2021). Compared to approximately 2700 approaches over the Peninsula (source: SFO GBAS Noise Measurement Report) used as establishing a baseline for community noise exposure levels, the actual GLS IA sample size is .0011 (3 divided by 2700). Due to the small sample of GLS approaches, it is impossible to draw any meaningful conclusions related to the noise exposure levels associated with the new GLS IA in comparison to the existing approaches. Based on the limited data, there is insufficient evidence on which to base any defensible conclusions as to whether use of the GLS will increase or decrease noise exposure for impacted communities.

The graphic below provides a 12-hour snapshot of arrival tracks over the study area on October 8, 2021.



The noise comparison tables on the following page refers to "Location E," which is the SIDBY waypoint. There are two comparisons. One compares the SEL at location "E" between the actual reported (as flown) RNAV and GLS IA procedures of the B737 MAX-8, as reported in the GBAS Noise Measurement Report. The other comparison is between the actual reported (as flown) and modeled expectation SEL of the B737 MAX-8 as reported in the GBAS Noise Measurement Report.

Site E SEL Data Comparisons

	Site E SEL data - RNAV Actual vs. GLS			Site E SEL data - GLS Actual vs. GLS Modeled		
	RNAV Actual	**GLS Actual**	**Delta** (GLS minus RNAV)	**GLS Actual**	**GLS Modeled** (table K page 10 of noise report)	**Delta** (Actual minus Modeled)
12/2	RNAV 28L #1	GLS-A 28L #2		GLS-A 28L #2		
	66.4 dB	65.1 dB	- 1.3 dB	65.1 dB	69.0 dB	- 3.9 dB
	Flaps: 0	Flaps: 0				
	Brakes: Deployed	Brakes: Stowed				
	Landing gear: Up	Landing gear: Up				
12/2	RNAV Z 28R #3	GLS-A 28R #4		GLS-A 28R #4		
	72.8 dB	64.5 dB	- 8.3 dB	64.5 dB	69.0 dB	- 4.5 dB
	Flaps: 5	Flaps: 0				
	Brakes: Deployed	Brakes: Stowed				
	Landing gear: Up	Landing gear: Up				
12/16	RNAV Y 28R #5	GLS-R 28R #7		GLS-R 28R #7		
	70.5 dB	76.7 dB	+ 6.2 dB	76.7 dB	69.0 dB	+ 7.7 dB
	Flaps: 1	Flaps: 0				
	Brakes: Stowed	Brakes: Stowed				
	Landing gear: Up	Landing gear: Up				
12/16	RNAV 28L #6	GLS-A 28L #8		GLS-A 28L #8		
	72.8 dB	Not successful				
	Flaps: 15					
	Brakes: Deployed to Stowed		NA	Not successful	NA	NA
	Landing gear: Up to Down					

- GLS-BVE RWY 28R – FMS Bridge Visual RWY 28R
    - No test flights were conducted
    - No perceptible change in SEL or CNEL is expected based on practical experience worldwide.
- GLS-DB RWY 28R - This procedure, if utilized effectively, would relocate the downwind transition away from SIDBY to a flight path northeast of SFO airport, over the Bay which joins the extended runway centerline at CEPIN, effectively removing the noise exposure from several Peninsula communities from the downwind
- GLS-TT RWY 28L – Tipp Toe Visual RWY 28L
    - No test flights were conducted.
    - No perceptible change in SEL or CNEL is expected based on practical experience worldwide.
- GLS-TT RWY 28R – Tipp Toe Visual RWY 28R
    - No test flights were conducted.
    - No perceptible change in SEL or CNEL is expected based on practical experience worldwide.

SEL Performance from B737 MAX 8 as flown versus modeled SEL

	B737 MAX 8			
	AS FLOWN			EXPECTED
POINT	GLS-A RWY 28L	GLS-A RWY 28R	GLS-R RWY 28R	MODELED
A	65.4	65.8	66.7	66
B	65.4	64.9	69.9	67
C	64.3	64.2	**70.4**	67
D	65.3	65.2	**75.8**	68
E	**65.1**	**64.5**	**76.7**	69
F	66.4	67.4	**72.2**	69
FLAPS	0	0	0	
SPEED BRAKES	STOWED	STOWED	STOWED	
GEAR	UP	UP	UP	

Green is more than 3 DB lower than modeled B737 MAX 8

RED is more than 3 DB higher than modeled B737 MAX 8

No fill is within 3 DB from modeled B737 MAX 8

SECTION 2: POTENTIAL FOR INCREASED FREQUENCYAND NUMBER OF ARRIVALS

As the pandemic subsides, SFO can expect an increase in operations returning to the same levels as 2018/19. The communities should remember that "normal" (pre-COVID) traffic levels have yet to be reached, as the table below indicates.

OPSNET : Airport Operations : Standard Report

From 01/2011 To 12/2021 | Facility=SFO

	IFR Itinerant					VFR Itinerant					Itinerant				
Calendar Year	Air Carrier	Air Taxi	General Aviation	Military	Total	Air Carrier	Air Taxi	General Aviation	Military	Total	Air Carrier	Air Taxi	General Aviation	Military	Total Operations
2011	296,426	89,656	11,289	594	397,965	16	843	2,157	2,694	5,710	296,442	90,499	13,446	3,288	403,675
2012	317,615	88,106	11,013	633	417,367	15	914	2,268	2,758	5,955	317,630	89,020	13,281	3,391	423,322
2013	319,439	84,835	10,178	393	414,845	7	1,050	2,548	2,465	6,070	319,446	85,885	12,726	2,858	420,915
2014	335,420	79,966	10,260	390	426,036	8	948	2,391	2,583	5,930	335,428	80,914	12,651	2,973	431,966
2015	354,564	58,733	10,868	320	424,485	12	991	2,874	2,156	6,033	354,576	59,724	13,742	2,476	430,518
2016	379,642	54,856	10,396	411	445,305	5	626	2,295	2,160	5,086	379,647	55,482	12,691	2,571	450,391
2017	397,489	47,650	9,195	470	454,804	3	700	2,661	2,178	5,542	397,492	48,350	11,856	2,648	460,346
2018	407,147	47,865	9,389	414	464,815	5	781	2,352	2,213	5,351	407,152	48,646	11,741	2,627	470,166
2019	393,867	50,132	8,385	313	452,697	2	785	2,617	2,401	5,805	393,869	50,917	11,002	2,714	458,502
2020	193,722	28,668	4,513	375	227,278	1	707	798	2,380	3,886	193,723	29,375	5,311	2,755	231,164
2021	215,767	38,629	6,672	324	261,392	0	1,031	566	2,612	4,209	215,767	39,660	7,238	2,936	265,601
Total:	**3,611,098**	**669,096**	**102,158**	**4,637**	**4,386,989**	**74**	**9,376**	**23,527**	**26,600**	**59,577**	**3,611,172**	**678,472**	**125,685**	**31,237**	**4,446,566**

Report created on Wed Jan 26 10:42:07 EST 2022
Sources: The Operations Network (OPSNET)

The implementation of new innovative flight procedures does not encourage more flights or the use of any specific arrival flow. They have the potential to maximize the efficiency of existing flows, by the utilization of automation and design, whereby the workload of ATC is reduced. This may enable the shift of traffic away from populated land areas to over unpopulated water areas, such as the Bay. As the majority of GBAS procedures overlay existing procedures (both instrument and radar vectored) the number of flights will not change simply because a GBAS procedure is available. An increase in SFO operations would be driven by increased demand and the availability of GBAS or other innovative procedures is not expected to affect total operations.

SECTION 3: COMMENTS

Risks:

1. Continued concentration of flight paths. However, due to the use of existing RNAV procedures, most of the concentration has already been realized. GBAS, or IA alone, are not expected to add significantly to that concentration. Even without GBAS IA, the use of RNAV and RNAV RNP is expected to grow, increasing precision which results in concentration of flight operations.
2. Scientifically insignificant sample size. Drawing any conclusions based on a sample size of .0011 would be premature.

Benefits of GLS Group 1 IAs:

1. Noise Benefit:
    a. Group 1 DBAY IA: there is an expected noise benefit.
        i. DBAYY is expected to reduce noise for several Peninsula communities because of fewer SFO arrivals flying over several densely populated areas (helps all Peninsula communities south of SFO, including Palo Alto).
        ii. In addition, DBAYY will allow ATC to gain experience on GLS approaches and may reduce ATC workload (once on DBAYY, interactions between ATC and pilots should be minimal)
        iii. Note that negative noise impacts on the ground are not anticipated. Per SFO (Section 5/Question 2 of GBAS Compiled Q&A file): "At this time, the only Innovative Approach procedure concept which introduces an RNAV path to replicate existing vectors is the Down the Bay (GLS DB RWY 28R) approach. However, the RNAV approach portion begins at 11,000 feet and take aircraft almost exclusively over the Bay until it connects with the intermediate and final approach segments."
    b. Group 1 EDDYY IAs: Noise benefit or disbenefit cannot be clearly identified or evaluated due to the indeterminate GBAS Noise Measurement Report. There simply isn't enough data to make any conclusions.

c. Group 1 IA Visuals (BVE and TT): No test flights were conducted to measure SEL reports, and no modeling was contained in the GBAS Measurement Report. No conclusions can be drawn due to lack of data.

2. Design Benefit: Our experience indicates that with equal atmospheric conditions, aircraft type and engines, thrust levels, aircraft configuration, and speeds, the farther away, laterally or at higher altitude, an aircraft is from a sound measuring point, the less the noise exposure. With equal conditions, a GLA-IA with a higher altitude profile should in principle be "quieter" than any existing procedure with an altitude profile closer to the ground. Whether any individual can perceive the sound difference is unknown.

Findings

1. The GBAS Noise Measurement Report reveals a lack of sample size to baseline data. Three (3) valid test GLS-IA approaches were identified. All 4 GLS-IA approaches had almost no perceptible change combined with lower and higher noise levels. Actual noise reports from the test aircraft indicate louder noise that appear to coincide with the use of flaps, speed brakes, and landing gear deployment. We are unable to conclude that GLS-A and GLS-R approaches, as tested, are quieter. On the other hand, the SFO Group 1 IA EDDYY analysis tests highlighted the over energy problem of the current EDDYY transitions at and after waypoint EDDYY. Pilots must use speed brakes and flaps to slow down thus causing noise impacts on residential communities. This over energy problem is independent of GBAS. However, the findings from the SFO GLS EDDYY IAs analysis and tests are helpful data towards reducing the transitioning noise problem.

2. The GLS-DB IA is not an overlay of an existing instrument approach, it is simulating the existing vectoring of aircraft by air traffic control for a visual approach. As traffic returns to pre-Covid levels, the opportunity to utilize the GLS-DB IA to shift the left (south) downwind traffic over Palo Alto to right (north) downwind traffic over the bay, would potentially provide significant relief of noise for the community. Although this procedure

would not affect the SERFR arrivals, it would greatly reduce the total number of aircraft that overfly the community.

3. Using the B737 MAX 8, arguably one of the quietest aircraft flying, should be tempered with test flights utilizing other "louder" aircraft. Even the B737 MAX 8 at times produced noise readings more than 3 dB louder than modeled in the CFPP and the GBAS Noise Measurement Report. As the GBAS Noise Measurement Report indicates, louder aircraft such as B747 and B767 also use these fight paths.
4. The SEL differences between the 3 Actual GLS tests and the modeled GLS show wide differences ranging from -4.5 dB to + 7.7 dB. This limited data set cannot be used to determine if the modeling predictions are accurate.
5. SEL differences between Actual RNAV and Actual GLS ranged from - 6.2 dB to + 8.3 dB. Two out of the three GLS approaches were quieter than the RNAV approach, and one GLS approach was louder than the RNAV approach. The results are inconclusive. Therefore, no expectations on noise changes should be set.
6. Based on available information and data, the same potential risks and benefits will extend to other mid-Peninsula cities close to Palo Alto.
7. The risks of implementing Group 1 IAs that do not provide perceptible noise reductions are unknow. The tests were inconclusive and showed large differences between actual noise measurements and modeled noise utilizing an extremely limited data set. Due to the use of existing RNAV and RNP procedures, most of the flight path concentration has already been realized and GBAS or IA alone is not expected to add significantly to that concentration. Implementation of GLS approaches in and of themselves, will not be a catalyst for higher volumes of air traffic. Traffic volume is determined by airport capacity and GLS will not positively or negatively affect airport capacity.
8. All instrument rated pilots gain experience by actually flying an instrument procedure. Most airline pilots are monitoring the flight management system while the autopilot does the flying. As new equipment enters the cockpit, airlines are responsible to train the pilots on how to use that equipment. If more GLS approaches are available to different runways at SFO, it makes sense that more pilots would have the opportunity to fly the GLS procedure, if the airplane is properly equipped. It is unclear as to who needs, or is

requesting the experience, and for what purpose. GBAS is available if the airport and airlines invest in the equipment. Pilots also fly GLS approaches in the simulators during training.

9. Without specific information from the Air Traffic Controllers as to how/if they intend to continue vectoring aircraft after implementation of GLS approaches, or change traffic patterns of the SERFR Arrival, it is unknown if GBAS will have any effect. However, the IA procedures as designed would indicate, given a properly spaced flow of traffic into the San Francisco Terminal Arrival Area, and subject to no weather impact causing aircraft to deviate from the procedures, that vectoring may not be necessary, and the published procedure could be the actual flight path.

SECTION 4: SUMMARY

GBAS / GLS / IA Procedures are strategically tested, intended to be environmentally friendly, and incrementally implemented throughout the National Airspace System (NAS). As technology progresses, it is utilized to improve the efficiency of the NAS while maintaining an equivalent level of safety. The federal government also has a commitment to reduce the environmental impacts of any procedure, not just the IA procedures that are the subject herein.

The GBAS Noise Measurement Report for Group 1 is inconclusive. It fails to provide enough testing, or sample size, to adequately address the noise impacts (positive or negative) of GLS approaches over residential communities such as Palo Alto. It reveals and confirms that existing use of flaps, speed brakes and landing gear to reduce airspeed over populous areas of Palo Alto and neighboring communities increases the SEL and Lmax readings. There are vast differences between actual SEL readings and the modeled SEL for the B737 MAX 8, which reduces confidence in the modeling numbers used to promote the project with communities. The use of the B737 MAX 8 as the test aircraft reduces the confidence of the public without the measuring of other commonly used, and possibly louder, aircraft.

Before it is reasonable to make any conclusions concerning how the implementation of GBAS will affect communities such as Palo Alto, a much more data set would be required with a diverse cross section of aircraft. Utilizing the B737 MAX 8, one of the quietest aircraft available, is not representative of the noise exposure communities experience from much louder aircraft on a daily basis.

DEFINITIONS

AEDT Aviation Environmental Design Tool

CFPP Community Flight Procedure Package

CNEL Community Noise Equivalent Level

dB (Decibels) is a unit for expressing the ratio between two physical quantities, usually amounts of acoustic or electric power, or for measuring the relative loudness of sounds.

dBA dB measurement adjusted to consider the varying sensitivity of the human ear to different frequencies of sound. A-weighted decibels, abbreviated dBA, or dBa, or dB(a), are an expression of the relative loudness of sounds in air as perceived by the human ear. In the A-weighted system, the decibel values of sounds at low frequencies are reduced, compared with unweighted decibels, in which no correction is made for audio frequency. This correction is made because the human ear is less sensitive at low audio frequencies, especially below 1000 Hz, than at high audio frequencies.

GBAS (Ground Based Augmentation System) is a Global Navigation Satellite System-dependent alternative to Instrument Landing System (ILS) which uses a single GBAS airport ground station to transmit corrected GNSS data to suitably equipped aircraft to enable them to fly a precision approach with much greater flexibility.

GLS GBAS Landing System

GNSS (Global Navigation Satellite System) is a term given to a worldwide position, velocity, and time determination system, which includes one or more satellite constellations, receivers, and system integrity monitoring, augmented as necessary to support the required navigation performance for the actual phase of operation.

GPS (Global Positioning System) is a space-based radio-navigation system consisting of a constellation of satellites broadcasting navigation signals and a network of ground stations and satellite control stations used for monitoring and control.

Lmax Maximum Sound Level is a noise metric that represents the maximum amount of acoustic energy (a.k.a. sound pressure) which occurs during an individual noise event regardless of its duration.

NM Nautical Mile

PBN (Performance Based Navigation) is when specified RNAV or RNP accuracy must be met 95 percent of the flight time. This information is detailed in International Civil Aviation Organization's (ICAO) Doc 9613, Performance-based Navigation (PBN) Manual and the latest FAA AC 90-105, Approval Guidance for RNP Operations and Barometric Vertical Navigation in the U.S. National Airspace System and in Remote and Oceanic Airspace.

RNAV (Area Navigation) is a method of navigation that permits aircraft operation on any desired flight path within the coverage of ground- or space-based navigation aids, or within the limits of the capability of self-contained aids, or a combination of these.

RNP (Required Navigational Performance) is a PBN system that includes onboard performance monitoring and alerting capability.

RWY Runway

SEL (Sound Exposure Level) is a noise metric that represents all the acoustic energy (a.k.a. sound pressure) of an individual noise event as if that event had occurred within a one-second time period. SEL captures both the level (magnitude) and the duration of a sound event in a single numerical quantity, by "squeezing" all the noise energy from an event into one second. This provides a uniform way to make comparisons among noise events of various durations.

APPENDICES

- GBAS Noise Measurement Report, Group 1 Innovative Approach Procedures - January 2022 – San Francisco International Airport
- CFPP GLS A RWY 28L EDDYY V1.1
- CFPP GLS A RWY 28R EDDYY V2
- CFPP GLS BVE RWY 28R EDDYY V1
- CFPP GLS DB RWY 28R DBAYY V1
- CFPP GLS R RWY 28R EDDYY V2
- CFPP GLS TT RWY 28L EDDYY V1
- CFPP GLS TT RWY 28R EDDYY V1
- June 9, 2021, SFO GBAS AND GLS Procedures
    - Palo Alto Workshop
- August 26, 2021, SFO GBAS AND GLS Procedures
    - Palo Alto Workshop
- September 22, 2021, SFO GBAS Overlay AND Innovative GLS
    - SFO Roundtable Technical Working Group
- November 24, 2021, SFO GBAS AND GLS
    - SFO Roundtable Technical Working Group
- Sound Level Descriptors FHA

GBAS Noise Measurement Report

Group 1 Innovative Approach Procedures

January 2022

PREPARED BY

San Francisco International Airport

SFO

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1 Introduction

San Francisco International Airport (SFO) is pursuing the installation of a technology for arriving aircraft, known as the Ground Based Augmentation System (GBAS). GBAS uses Global Positioning System (GPS) receivers and broadcast antennas positioned on airport grounds to produce high-precision landing procedures for properly equipped aircraft.

GBAS may offer improved safety through greater precision guidance for arriving aircraft, reduced flight delays during poor weather conditions by allowing more efficient use of runways, and reduced aircraft noise and emissions by allowing curved or offset approaches that keep aircraft over the Bay and approaches at increased glideslope angles that allow aircraft to fly at a higher altitude over communities. SFO is committed to thoroughly evaluating and communicating all GBAS procedures it develops with active and ongoing input from our communities.

As part of the GBAS implementation, the Federal Aviation Administration (FAA) designed GBAS Landing System (GLS) Overlay approach procedures that are identical to existing approach procedures. Additionally, SFO designed GLS Innovative Approach procedures that would provide noise reduction when compared to existing approach procedures. The use of GLS procedures does not increase airport capacity (the number of arrivals and departures that can operate at the airport) or increase the actual number of arrivals and departures that use the airport, which is a function of passenger demand and airline scheduling. SFO's noise reduction objective is to identify and implement GLS Innovative Approach procedures that are noticeably quieter than existing approach procedures. If the GLS Innovative Approach procedures prove to deliver real world (measured) noise benefits then the FAA, aviation and community stakeholders can choose to update existing Area Navigation (RNAV) approach procedures to match GLS approach procedures.

SFO developed online information that describes how GBAS works, the GBAS implementation process, and how the public can get involved with the GBAS project. Additionally, the online content includes detailed documents called Community Flight Procedure Packages (CFPPs) that describe and compare each proposed Innovative Approach procedure to existing procedures. The CFPPs can be found at https://noise.flysfo.com

Specific Innovative Approach test flights that targeted Group 1 Innovative Approach procedures were made possible with the assistance and participation of United Airlines and the FAA. On December 2 and December 16, 2021 United Airlines flew two new Boeing 737 MAX 8 aircraft – from the Boeing factory in Seattle, WA – without passengers to test the GLS procedures. Eight passes were performed, which tested the GLS procedures. To capture aircraft noise levels, SFO deployed six (6) Portable Noise Monitoring Terminals (PNMTs) starting on October 5, 2021 and ending on December 18, 2021 in the cities of Menlo Park, Los Altos, and Palo Alto under the GLS approach path. Although the number of measurement samples was relatively low, the report shows a comparison of the measured noise levels produced by non-GLS approaches to those produced by GLS Innovative Approaches. This report describes the noise and flight evaluation methodology, criteria, and results for the measurement period between December 2 and December 16, 2021.

2 Executive Summary

As part of the San Francisco International Airport (SFO) Ground Based Augmentation System implementation, SFO deployed six (6) Portable Noise Monitoring Terminals (PNMTs) in the cities of Menlo Park, Los Altos, and Palo Alto to capture the noise levels of aircraft in flight. The PNMT's captured baseline noise levels produced by aircraft that used existing approach procedures and aircraft noise levels produced by the GBAS Landing System (GLS) test flights performed by a United Airlines Boing 737 MAX 8 on December 2 and December 16, 2021. Below is a summary list of the noise measurement results:

- At the measurement sites, the Aircraft CNEL range was between 41 and 53 decibels (dB[1])
- At the measurement sites, the Community CNEL range was between 39 and 65 dB
- Daily average SFO arrival Sound Exposure Level (SEL) range was between 69 to 72 dB
- Daily average SFO arrival Peak Noise Level (Lmax) range was between 54 to 59 dB
- Daily average Community Ambient noise level range was 36 to 43 dB
- The Embraer 175 (E75L), the Airbus A-320 (A320), and the Boeing 737-800 (B738) aircraft produced the most noise events at the PNMTs
- The loudest noise events were produced by the Boeing 747-400, 747-8, 767-300 aircraft.
- The non-GLS approaches were three (3) to six (6) dB SEL and four (4) to seven (7) dB Lmax higher than the test GLS approaches
- Non-GLS approaches flew at higher altitudes over sites A, B, and C, but at lower altitudes over sites D, E, and F compared to the test GLS approaches

[1] Decibel level described in this report are based on the A-weighted scale (dBA), which focuses on the noise frequencies that the human ear hears the most.

3 Noise Measurements

SFO PNMTs measured one-second Equivalent Continuous Sound Level (Leq). The SFO Airport Noise and Operations Monitoring System (ANOMS) correlated flight data with PNMT noise data to calculate the Sound Exposure Level (SEL) and Maximum/Peak Level (Lmax) per noise event. ANOMS used a noise-to-aircraft correlation tool called ANEEM, which provides higher quality data for environmental noise reporting compared to traditional noise threshold-based methods. ANEEM can determine whether an aircraft is the dominant source or a contributing source of a noise event, or whether the event is dominated by other noise sources. The following subsections describe the PNMT locations and noise measurement results.

3.1 Measurement Site Descriptions

Six (6) PNMTs were deployed to the cities of Menlo Park, Los Altos, and Palo Alto. Each site was located as close to the proposed GLS approach path as possible, which rendered clear line-of-sight from microphones to aircraft. Arriving aircraft flew over the PNMT's in the sequence of Site A, B, C, D, E, and F.

Site	General Location	City	Elevation (ft, MSL)
A	University Ave. & Manresa Way	Los Altos	380
B	Yerba Santa Ave. & Los Altos Ave.	Los Altos	150
C	Donald Dr. & Arastradero Rd.	Palo Alto	80
D	Cowper St. & Santa Rita St.	Palo Alto	30
E	Tevis Pl. & Center Dr.	Palo Alto	33
F	Hollyburne Ave. & Hamilton Ave.	Menlo Park	10

3.2 Measurement Site Map

Figure 3-1 shows a map of all six (6) measurement sites. **Figure 3-2** shows the measurement sites, a 12-hour period of SFO Runways 28L/R arrival flight tracks on October 8, 2021, the GLS test flight path, and nearby navigational waypoints.

Figure 3-1 GBAS Measurement Site Map

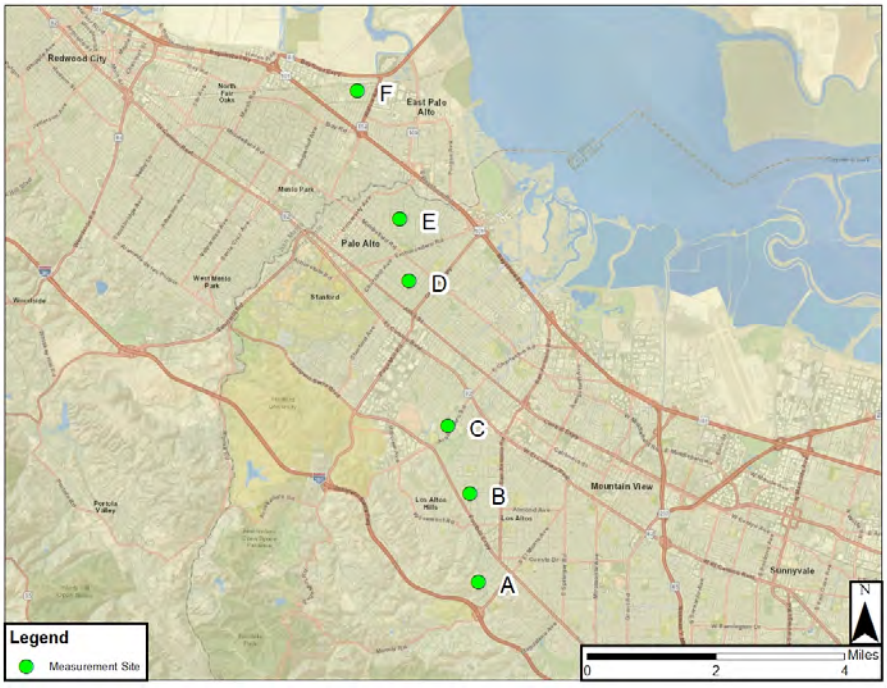
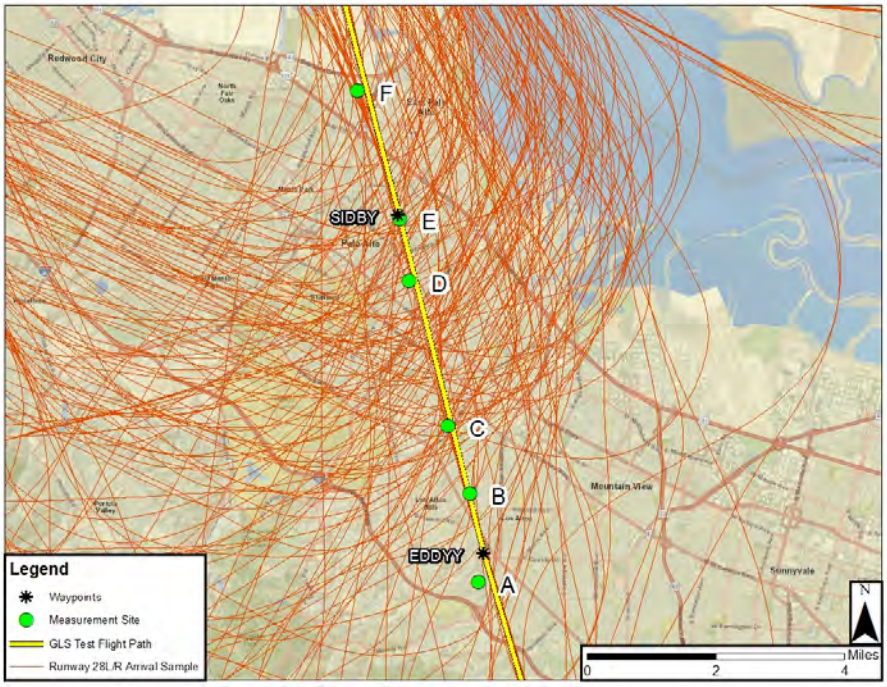


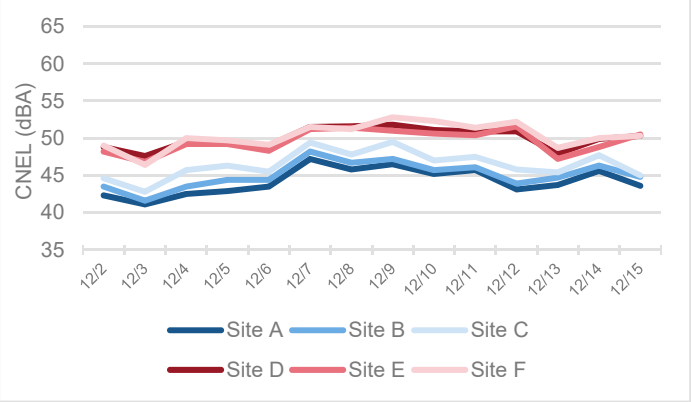
Figure 3-2 GBAS Measurement Site Map with Flight Tracks



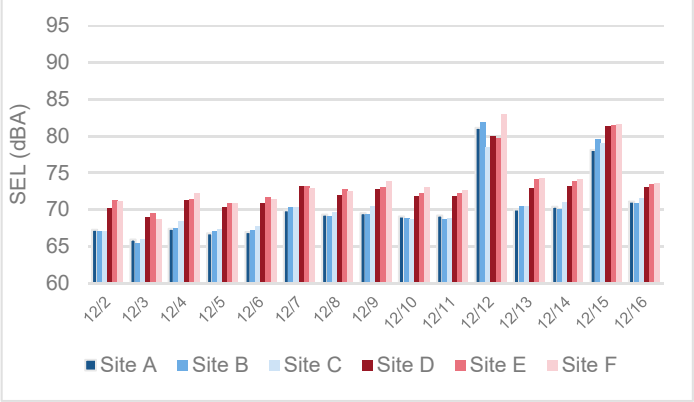
4 Measurement Results

This section includes 10 parts (charts and graphics that represent summaries of the aircraft noise-related data (values are subject to rounding) collected during the measurement period between December 2 and December 16, 2021. Each part and key terms used in this report are described in **Appendix** and **Glossary**, respectively. Shown on graph **A – Aircraft CNEL**, sites A, B, and C – the first three sites underneath an arrival flight path from the south – have similar Aircraft Community Noise Equivalent Level (CNEL) and are colored in shades of blue. Sites D, E, and F have similar Aircraft CNEL and are colored in shades of red. Aircraft CNEL at sites D, E, and F are higher than those at sites A, B, and C due to factors including the decreasing altitude of aircraft on arrival and the number of additional arrivals from the north and west (BDEGA Arrival Procedure), and go-arounds from missed approaches that merge into the flight path from the south (SERFR Arrival Procedure). During the measurement period, the Aircraft CNEL range was 41 to 53 decibels (dB) and the Community CNEL range – from noise produced by non-aircraft sources – was 39 to 65 dB and is shown on graph **C – Community CNEL**. The average daily SFO Runways 28 L/R arrival aircraft Sound Exposure Level (SEL) remained fairly constant over the measurement period except for December 12 and 15 when one arrival produced high noise levels compared to other arrival aircraft noise events during those days (see tables **E** and **H).**

A – Aircraft CNEL



B – Average Aircraft SEL



C – Community CNEL

D – Average Community SEL

Table **E – SFO Aircraft Daily Noise Event Averages** shows that the SFO Runways 28 L/R daily average noise levels at Sites A, B, and C were 69 dB SEL and 54/55 Peak Noise Level (Lmax), and for sites D, E, and F were 72 dB SEL and 57/59 dB Lmax. Of the 5,001 arrivals to SFO Runways 28 L/R, approximately 2,700 flew approaches over the Peninsula, and the rest over the San Francisco Bay. Additionally, the daily average Community Ambient noise level range was 36 to 43 dB.

E – SFO Aircraft Daily Noise Event Averages

Date	Site A				Site B				Site C				Site D				Site E				Site F			
	Noise Events	Avg SEL (dB)	Avg Lmax (dB)	Community Ambient (dB)	Noise Events	Avg SEL (dB)	Avg Lmax (dB)	Community Ambient (dB)	Noise Events	Avg SEL (dB)	Avg Lmax (dB)	Community Ambient (dB)	Noise Events	Avg SEL (dB)	Avg Lmax (dB)	Community Ambient (dB)	Noise Events	Avg SEL (dB)	Avg Lmax (dB)	Community Ambient (dB)	Noise Events	Avg SEL (dB)	Avg Lmax (dB)	Community Ambient (dB)
12/2	96	67	53	41	129	67	52	36	160	67	52	36	178	70	55	39	121	71	58	40	141	71	56	41
12/3	106	66	53	39	135	65	51	30	167	66	52	30	181	69	55	35	135	69	56	37	164	69	54	34
12/4	110	67	54	38	142	67	53	32	164	68	54	32	171	71	57	36	143	71	58	37	163	72	57	37
12/5	133	67	53	37	156	67	52	34	192	67	53	34	192	70	55	37	136	71	57	37	182	71	56	38
12/6	140	67	53	38	179	67	53	31	203	68	53	31	191	71	56	35	141	72	58	35	170	71	55	36
12/7	118	70	56	40	141	70	56	34	175	70	56	34	192	73	59	36	168	73	60	36	180	73	58	38
12/8	124	69	56	39	154	69	55	32	189	70	56	33	191	72	57	36	134	73	59	37	139	72	57	38
12/9	119	70	56	41	157	69	56	37	196	70	57	37	214	73	59	40	155	73	61	40	185	74	60	44
12/10	124	69	56	42	142	69	55	37	183	69	55	37	191	72	58	39	141	72	59	39	190	73	59	43
12/11	112	70	56	40	131	69	55	34	164	69	55	34	189	72	58	37	152	72	59	37	157	73	59	42
12/12	1	83	71	43	1	82	72	36	3	78	61	36	3	80	63	38	3	80	59	41	1	83	71	45
12/13	26	71	57	48	34	70	58	43	39	70	57	41	30	73	60	44	16	74	63	44	22	74	60	47
12/14	112	70	57	41	137	70	56	37	158	71	57	37	156	73	60	40	121	74	61	40	117	74	60	45
12/15	2	81	67	46	2	80	69	38	2	79	68	38	2	81	70	39	2	81	69	40	2	82	69	46
12/16	47	71	57	40	67	71	56	38	83	72	58	37	82	73	59	41	56	73	60	41	58	74	58	41
Daily Average	**91**	**69**	**55**	**42**	**114**	**69**	**54**	**36**	**139**	**69**	**55**	**36**	**144**	**72**	**57**	**39**	**108**	**72**	**59**	**39**	**125**	**72**	**57**	**43**
Total Count	**1,340**				**1,707**				**2,078**				**2,163**				**1,624**				**1,871**			

Table **F – SFO Aircraft Noise Events by Time of Day** shows the SFO Runways 28 L/R average, minimum, and maximum SEL and Lmax, and the Community Ambient noise level during the daytime, evening, and nighttime hours.

F – SFO Aircraft Noise Events by Time of Day

		SFO Aircraft Noise Events								Community Noise
Site	Time of Day	Noise Events	Noise Events %	Avg SEL (dB)	Min SEL (dB)	Max SEL (dB)	Avg Lmax (dB)	Min Max (dB)	Max Lmax (dB)	Community Ambient (dB)
A	Day (7am–7pm)	932	68%	68	49	78	55	42	66	44
	Evening (7pm-10pm)	275	20%	69	52	77	55	45	66	42
	Night (10pm-7am)	163	12%	71	50	82	56	41	74	37
B	Day (7am–7pm)	1,203	70%	68	46	78	54	39	66	38
	Evening (7pm-10pm)	318	19%	69	46	77	55	39	69	37
	Night (10pm-7am)	186	11%	71	53	83	56	40	74	33
C	Day (7am–7pm)	1,452	70%	69	45	80	55	38	70	37
	Evening (7pm-10pm)	378	18%	69	45	80	55	38	69	37
	Night (10pm-7am)	248	12%	71	51	84	55	38	76	33
D	Day (7am–7pm)	1,484	69%	71	49	86	57	39	74	40
	Evening (7pm-10pm)	410	19%	72	52	81	58	40	69	39
	Night (10pm-7am)	269	12%	74	47	84	58	41	75	35
E	Day (7am–7pm)	1,080	67%	72	50	83	59	44	73	40
	Evening (7pm-10pm)	321	20%	73	54	80	59	47	68	40
	Night (10pm-7am)	223	14%	74	47	84	59	42	74	38
F	Day (7am–7pm)	1,258	67%	72	47	84	57	41	72	43
	Evening (7pm-10pm)	381	20%	73	47	81	59	39	71	44
	Night (10pm-7am)	232	12%	75	45	85	59	39	76	41

Table **H – Noise Events of the Most Frequent Aircraft** shows that the Embraer 175 (E75L), the Airbus A-320 (A320), and the Boeing 737-800 (B738) aircraft produced the most noise events at the PNMTs.

Table **I – Noise Levels of Loudest SFO Aircraft Arrival Events** shows that the loudest noise events were produced by the Boeing 747-400, 747-8, 767-300 aircraft. Note that simultaneous community noise contributed to the loudest noise event at Site D.

Comparison

Table **J– Comparison of Existing and GLS Innovative Approach Procedures** shows the comparison of the Group 1 GLS test approaches and non-GLS approaches to SFO Runways 28 L/R made by the United Airlines 737 MAX 8 (B38M) aircraft that flew over the PNMTs. Out of the 77 B38M aircraft SFO Runways 28 L/R arrivals during the measurement period, nine (9) used the SERFR Arrival Procedure, and only five (5) performed approaches that could be compared to the GLS test approaches. The UAL test flights are grouped by existing RNAV approaches and proposed GLS approaches.

United Airlines test flight UAL2694 performed four (4) GLS approaches over the PNMTs on Dec 2, 2021 between approximately 6:00 pm and 8:00 pm. Additionally, UAL2698 performed four (4) GLS approaches over the PNMTs on Dec 16, 2021 at approximately 6:30 am and 7:30 am. The average SEL, Lmax, altitude, and speed of the non-GLS approaches and test GLS approaches are shown on **Table J**. Altitudes are relative to SFO ground level of 11 ft.

Table **G – UAL Test Flights** lists each United Airlines (UAL) test approach procedure, the applied flap setting, the speed brake deployment, and the landing gear position over Site E. Note that approach number eight (8) was not considered a successful GLS-A approach. The aircraft flew at slower speeds and lower altitude than specified by the GLS-A approach procedure. The noise events for each approach are provided in **Appendix A**.

Table J shows that, on average, the non-GLS approaches were three (3) to six (6) dB SEL and four (4) to seven (7) dB Lmax higher than the test GLS approaches. Additionally, the non-GLS approaches flew at higher altitudes over sites A, B, and C, but at lower altitudes over sites D, E, and F compared to the test GLS approaches.

G – UAL Test Flights

Approach #	Date/Time	Procedure	Flaps*	Speed Brakes*	Landing Gear*	Notes
1	12/2/2021 18:40	RNAV (GPS) RWY 28L	0	Deployed	Up	
2	12/2/2021 18:57	GLS-A RWY 28L	0	Stowed	Up	
3	12/2/2021 19:19	RNAV (GPS) Z RWY 28R	5	Deployed	Up	
4	12/2/2021 19:38	GLS-A RWY 28R	0	Stowed	Up	
5	12/16/2021 6:35	RNAV (RNP) Y RWY 28R	1	Stowed	Up	
6	12/16/2021 6:53	RNAV (GPS) RWY 28L	15	Deployed to Stowed	Up to Down	
7	12/16/2021 7:10	GLS-R RWY 28R	0	Stowed	Up	
8	12/16/2021 7:28	GLS-A RWY 28L	0 to 1	Stowed to Deployed	Up	Not considered a successful GLS-A approach

Note: GLS approaches highlighted in green.
* Aircraft settings over Site E

H – Noise Levels of the Most Frequent Aircraft

Site A				Site B				Site C				Site D				Site E				Site F			
Aircraft / Events	Avg SEL (dB)	Avg Lmax (dB)	Duration (s)	Aircraft / Events	Avg SEL (dB)	Avg Lmax (dB)	Duration (s)	Aircraft / Events	Avg SEL (dB)	Avg Lmax (dB)	Duration (s)	Aircraft / Events	Avg SEL (dB)	Avg Lmax (dB)	Duration (s)	Aircraft / Events	Avg SEL (dB)	Avg Lmax (dB)	Duration (s)	Aircraft / Events	Avg SEL (dB)	Avg Lmax (dB)	Duration (s)
E75L / 266	67	54	37	E75L / 317	66	53	40	E75L / 341	67	53	40	E75L / 362	69	56	36	E75L / 271	70	58	34	E75L / 307	71	57	36
A320 / 219	69	56	40	A320 / 244	69	56	38	A320 / 270	70	57	39	A320 / 277	73	59	39	A320 / 232	73	61	35	A320 / 238	74	60	39
B738 / 158	70	57	41	CRJ2 / 182	64	50	40	B738 / 224	70	56	40	B738 / 219	73	59	39	B738 / 170	73	60	38	B738 / 195	73	58	39

I – Noise Levels of Loudest SFO Aircraft Arrival Events*

Site A				Site B				Site C				Site D				Site E				Site F			
Aircraft / Date / Time	SEL (dB)	Lmax (dB)	Duration (s)	Aircraft / Date / Time	SEL (dB)	Lmax (dB)	Duration (s)	Aircraft / Date / Time	SEL (dB)	Lmax (dB)	Duration (s)	Aircraft / Date / Time	SEL (dB)	Lmax (dB)	Duration (s)	Aircraft / Date / Time	SEL (dB)	Lmax (dB)	Duration (s)	Aircraft / Date / Time	SEL (dB)	Lmax (dB)	Duration (s)
B748 / 12/16/2021 0:39	82	74	59	B748 / 12/16/2021 0:39	83	74	69	B748 / 12/16/2021 0:39	84	76	59	**B748 / 12/7/2021 11:56**	**86**	**74**	**48**	B748 / 12/12/2021 0:14	84	74	53	B748 / 12/16/2021 0:40	85	76	51
B748 / 12/7/2021 0:38	82	70	62	B748 / 12/7/2021 0:38	82	70	66	B748 / 12/12/2021 0:13	83	73	58	B748 / 12/12/2021 0:14	84	73	57	B744 / 12/15/2021 0:23	83	72	58	B763 / 12/9/2021 6:03	85	72	61
B748 / 12/12/2021 0:13	81	71	38	B748 / 12/12/2021 0:13	82	72	56	B744 / 12/9/2021 0:38	82	72	52	B748 / 12/16/2021 0:39	84	75	58	B748 / 12/16/2021 0:40	83	74	44	B744 / 12/14/2021 9:03	84	72	61

*Noise events in **BOLD** were made up of simultaneous aircraft noise and community noise.

J – Comparison of Existing and GLS Approach Procedures (Boeing 737 MAX 8 on comparable approaches)

		Site A			Site B			Site C			Site D			Site E			Site F		
Approach Type	Number of Arrivals	Avg SEL / Lmax (dB)	Avg Altitude (ft)	Avg Speed (kts)	Avg SEL / Lmax (dB)	Avg Altitude (ft)	Avg Speed (kts)	Avg SEL / Lmax (dB)	Avg Altitude (ft)	Avg Speed (kts)	Avg SEL / Lmax (dB)	Avg Altitude (ft)	Avg Speed (kts)	Avg SEL / Lmax (dB)	Avg Altitude (ft)	Avg Speed (kts)	Avg SEL / Lmax (dB)	Avg Altitude (ft)	Avg Speed (kts)
Non-GLS Approaches	5	71/58	6,206	236	72/59	5,957	236	72/60	5,656	236	75/64	5,062	219	75/63	4,827	214	75/63	4,231	201
Test RNAV Approaches	4	68/56	5,900	252	68/55	5,799	253	68/55	5,505	254	71/59	4,912	251	71/59	4,673	245	75/62	4,174	229
Test GLS Approaches	3	66/54	5,883	252	67/54	5,833	251	67/54	5,625	253	72/57	5,199	238	72/57	5,010	232	69/56	4,472	229

As a reference, the modeled (estimated) GLS Innovative Approach noise levels are listed on **Table K**. The modeled noise levels are calculated by the FAA Aviation Environmental Design Tool (AEDT) based on annual average atmospheric parameters (inversions, wind direction, wind speed, temperature and humidity effects). Short-term noise measurements do not adequately represent annual atmospheric conditions. Short-term measurements are a snapshot in time and may be useful for a simple in-the-field checks, comparison of aircraft to ambient levels, and a tool to identify needs for longer term measurements, but not to validate noise modeling.

K – Modeled 737 MAX 8 GLS Innovative Approach

		Site A			Site B			Site C			Site D			Site E			Site F		
Approach Type	Number of Arrivals	Avg SEL / Lmax (dB)	Avg Altitude (ft)	Avg Speed (kts)	Avg SEL / Lmax (dB)	Avg Altitude (ft)	Avg Speed (kts)	Avg SEL / Lmax (dB)	Avg Altitude (ft)	Avg Speed (kts)	Avg SEL / Lmax (dB)	Avg Altitude (ft)	Avg Speed (kts)	Avg SEL / Lmax (dB)	Avg Altitude (ft)	Avg Speed (kts)	Avg SEL / Lmax (dB)	Avg Altitude (ft)	Avg Speed (kts)
Modeled GLS Approach	3	66/54	6,195	250	67/54	5,879	247	67/55	5,673	244	68/56	5,241	236	69/56	5,062	233	69/57	4,551	228

Note: modeled altitudes are relative to Mean Sea Level (MSL).

5 Altitude Analysis

5.1 Gate Penetration Graphs

To evaluate aircraft altitude over the measurement sites, gates (2-dimentional cross-sections of airspace) were created over each site. **Figures 5-1 to 5-7** show six (6) gate locations and individual gate penetration graphs that show SFO arrival flight tracks that penetrated each gate during the measurement period. The gate penetration graphs help visualize the range of arrival altitudes Above Ground Level (AGL, 11 ft), the level of dispersion, and concentration of flight through each gate.

Figure 5-1 Gate Map

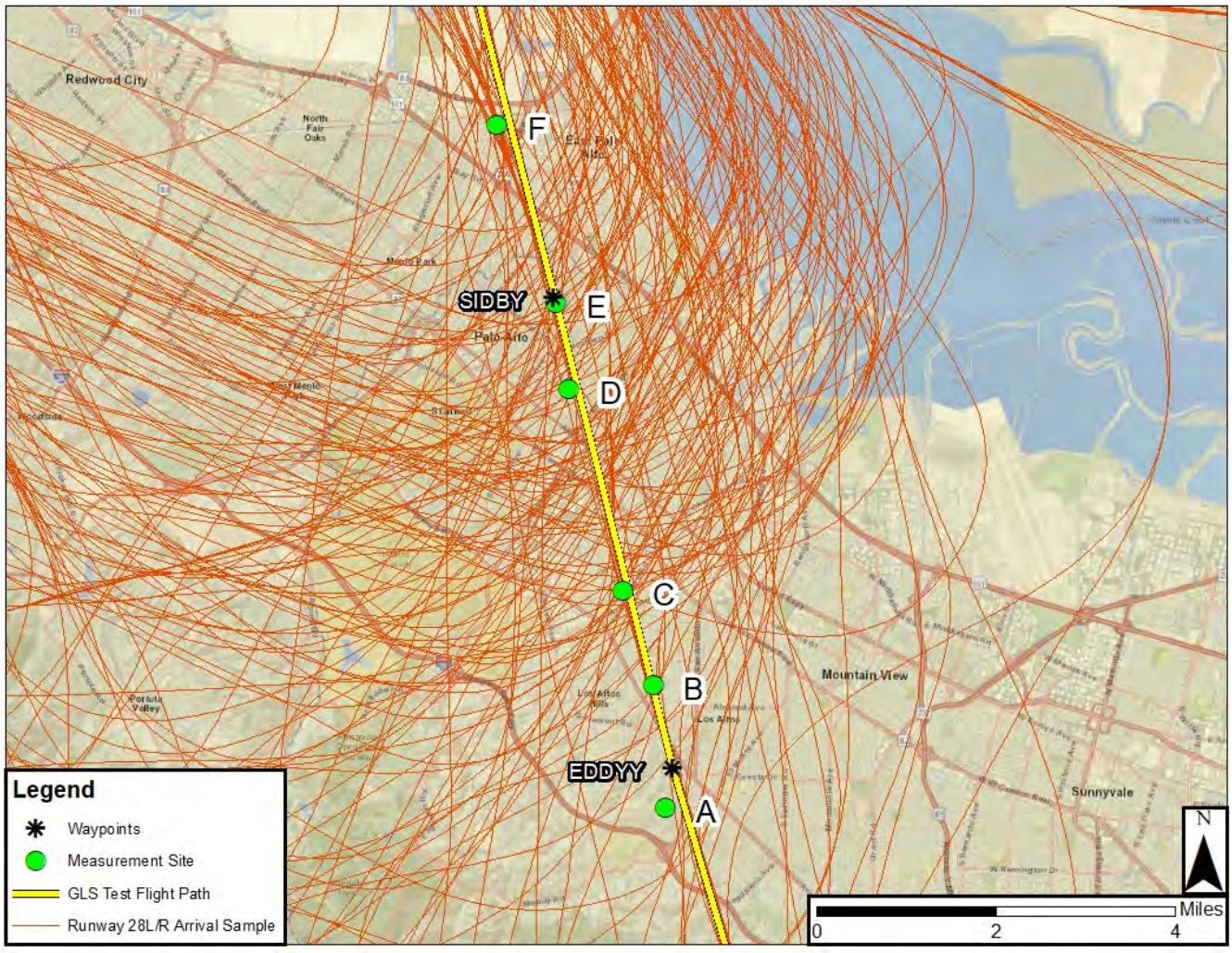


Figure 5-2 Site A Gate Penetration Graph

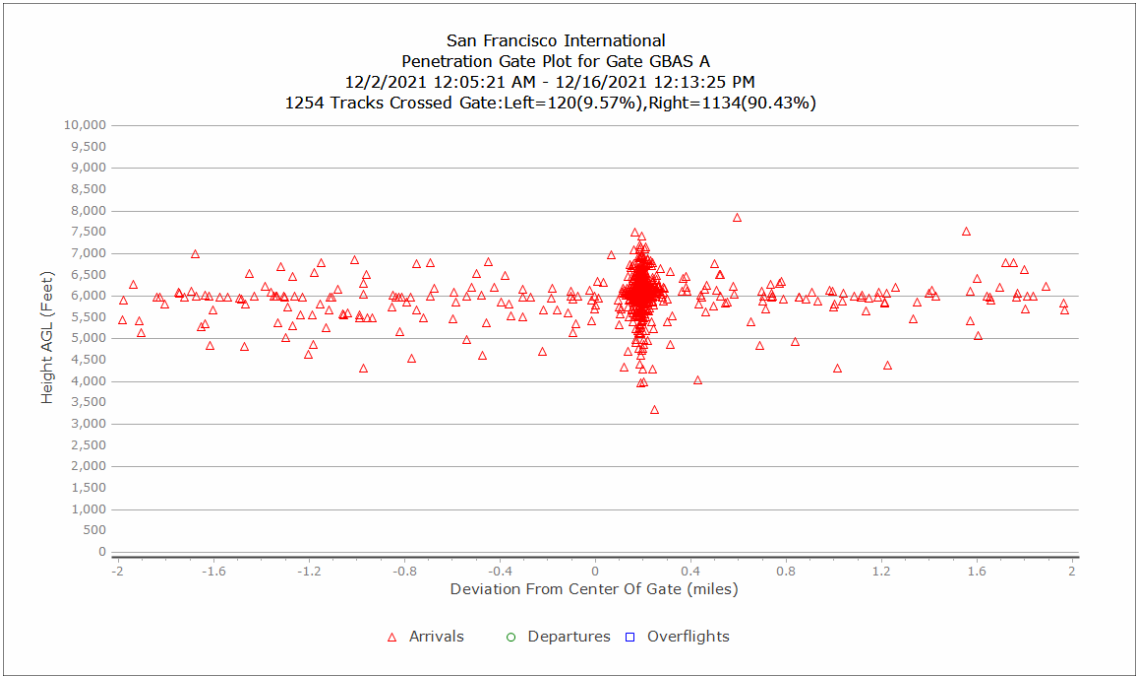


Figure 5-3 Site B Gate Penetration Graph

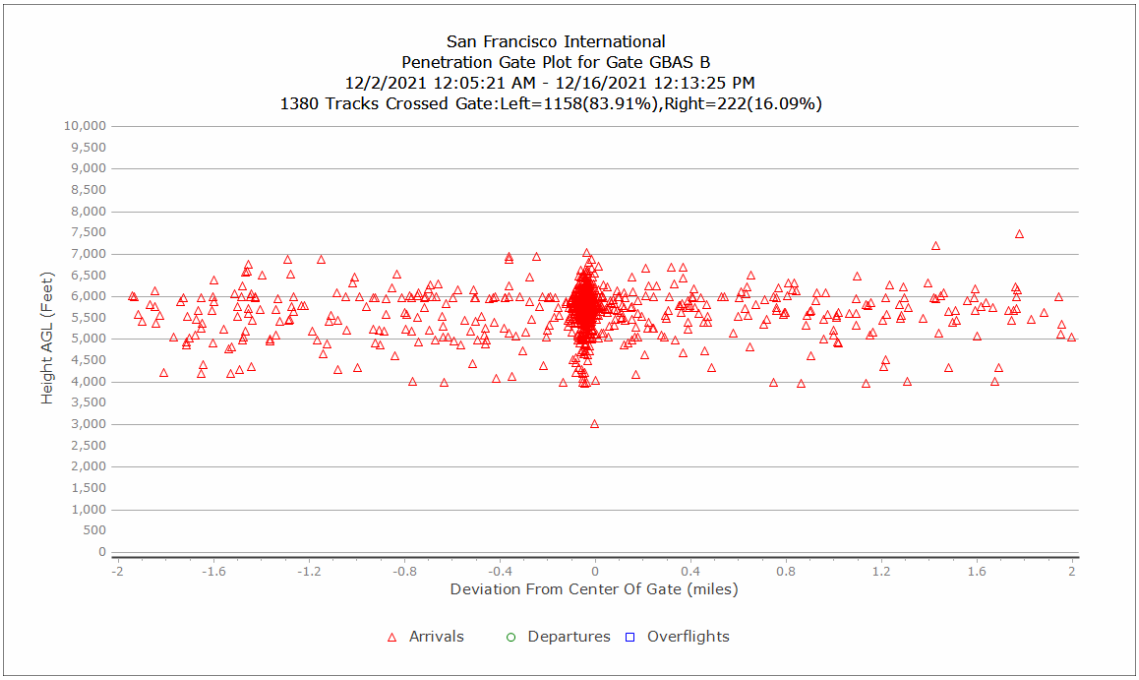


Figure 5-4 Site C Gate Penetration Graph

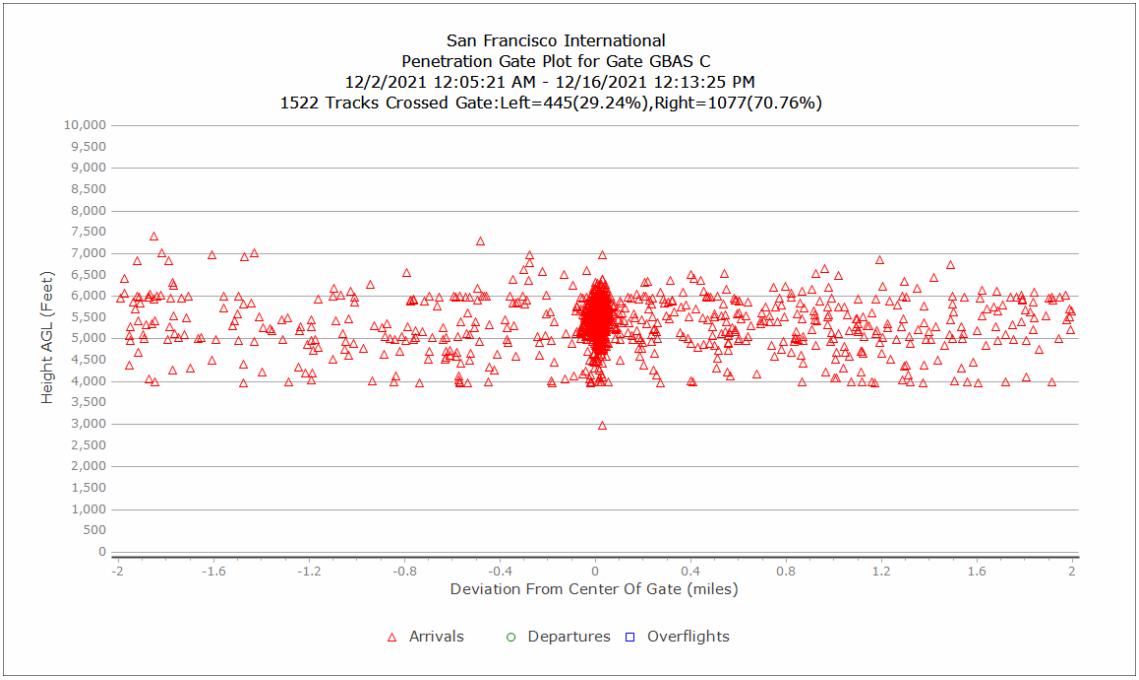


Figure 5-5 Site D Gate Penetration Graph

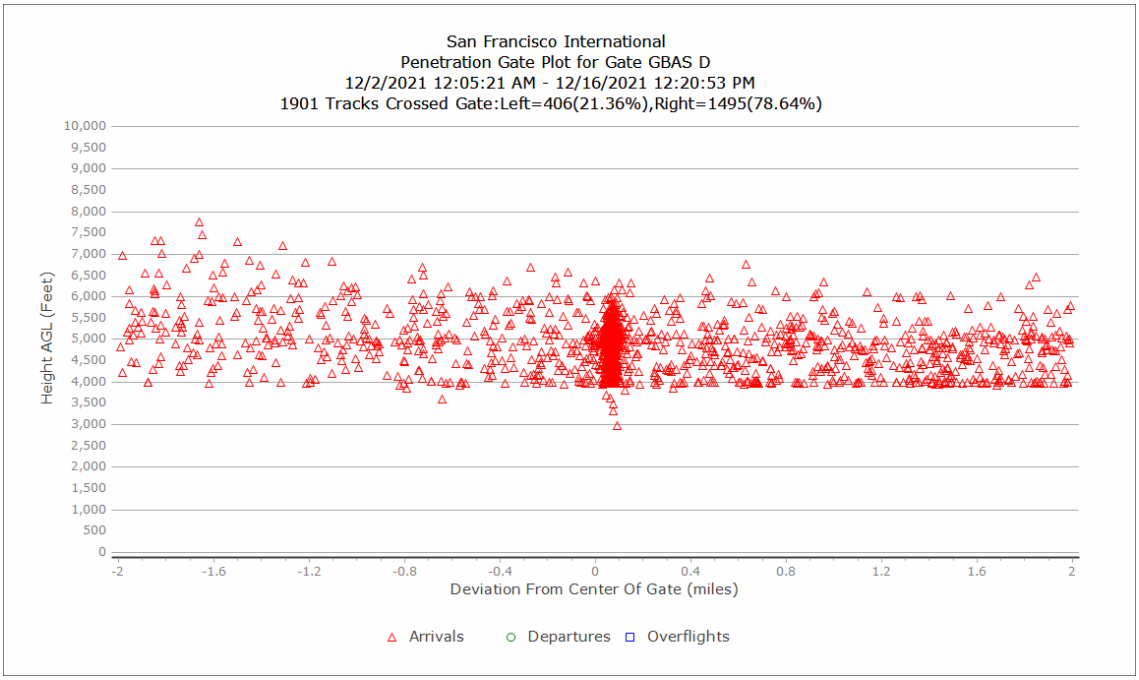


Figure 5-6 Site E Gate Penetration Graph

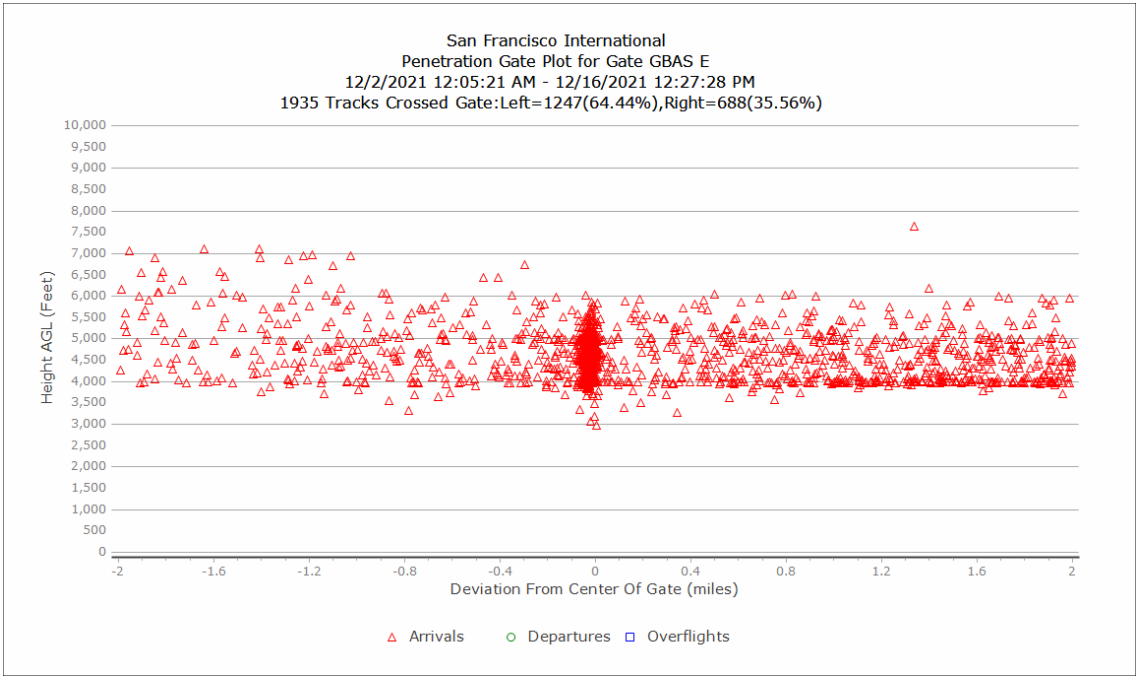
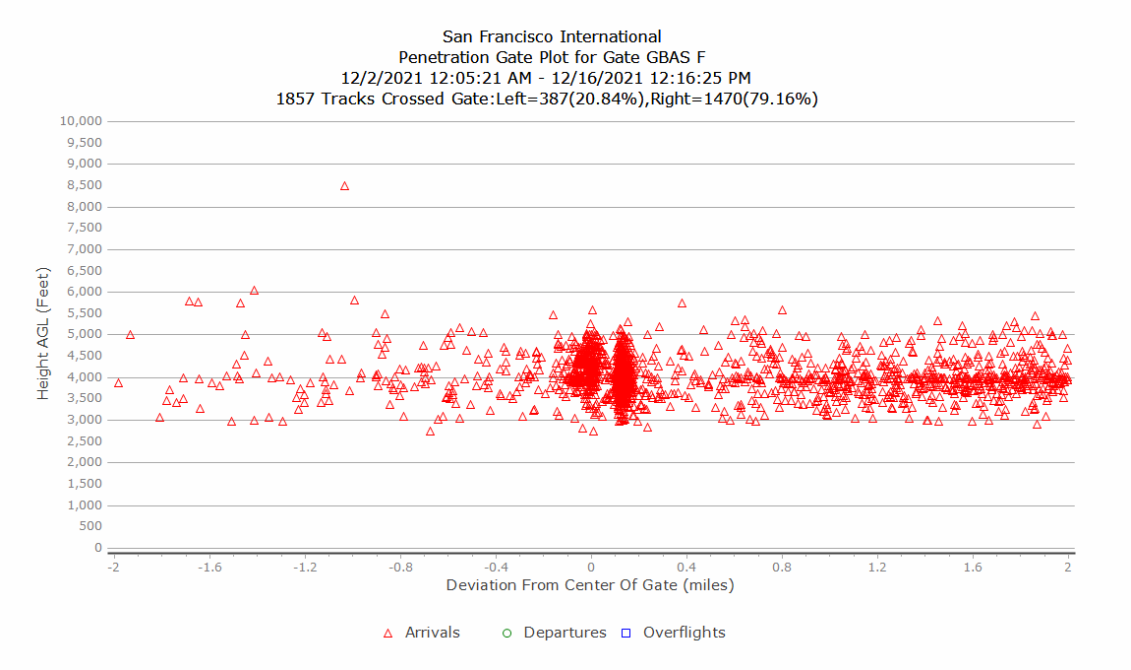


Figure 5-7 Site F Gate Penetration Graph



5.2 Point-of-Closest Approach Graph

Point-of-Closest Approach (PCA) graphs were developed to evaluate the frequency at which SFO arrivals flew within two (2) miles of each site at certain altitude intervals. **Figures 5-8 to 5-13** show the PCA altitude over each measurement site. Site elevation is shown in parenthesis.

Figure 5-8 Arrival PCA over Site A (380 ft.)

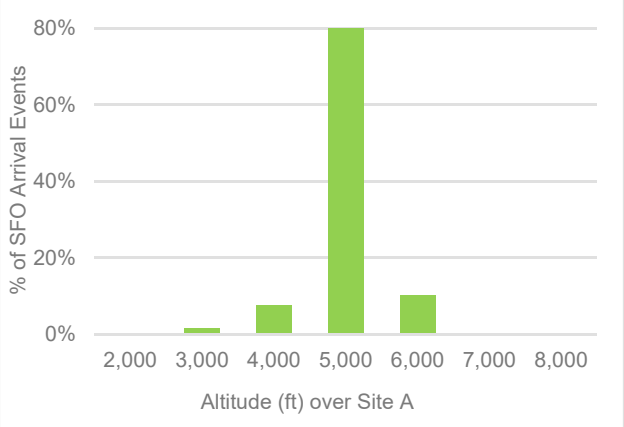


Figure 5-9 Arrival PCA over Site B (150 ft.)

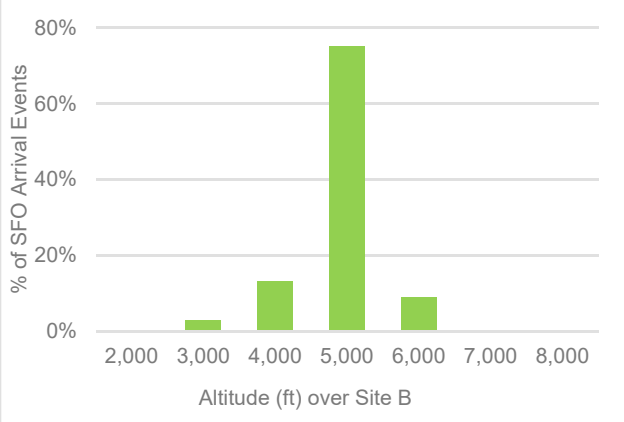


Figure 5-10 Arrival PCA over Site C (80 ft.)

Figure 5-11 Arrival PCA over Site D (30 ft.)

Figure 5-12 Arrival PCA over Site E (33 ft.)

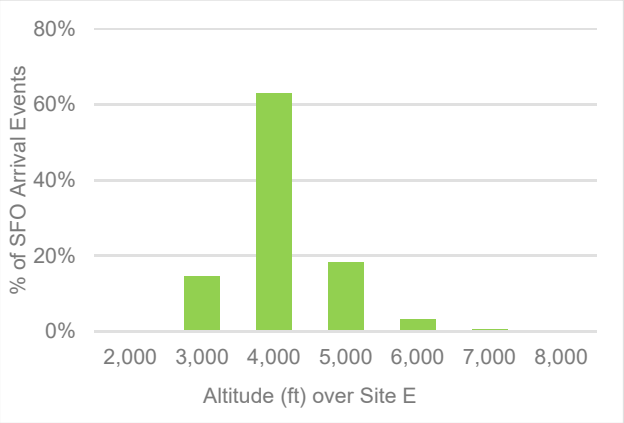
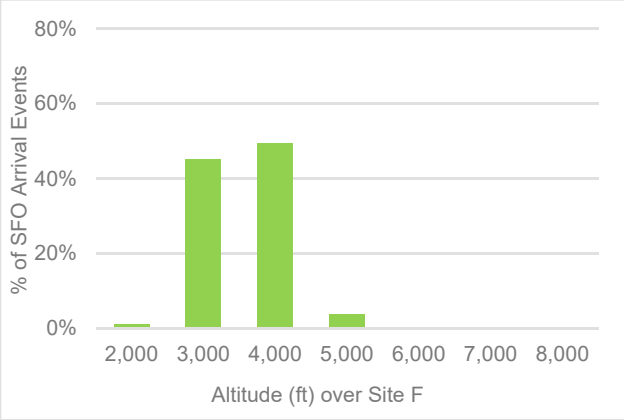


Figure 5-13 Arrival PCA over Site F (10 ft.)



Appendix A

Test Approach Noise Events					
Site	**Date/Time**	**Procedure**	**SEL (dB)**	**Lmax (dB)**	**Duration (s)**
A	12/2/2021 18:40	RNAV (GPS) RWY 28L	68.4	55	51
A	12/2/2021 18:57	GLS-A RWY 28L	65.4	52.7	37
A	12/2/2021 19:19	RNAV (GPS) Z RWY 28R	65	53.1	32
A	12/2/2021 19:38	GLS-A RWY 28R	65.8	52.9	57
A	12/16/2021 6:35	RNAV (RNP) Y RWY 28R	69.4	57.7	36
A	12/16/2021 6:53	RNAV (GPS) RWY 28L	69.3	58.7	31
A	12/16/2021 7:10	GLS-R RWY 28R	66.7	55.5	30
A	12/16/2021 7:28	GLS-A RWY 28L	67.6	55.9	41
B	12/2/2021 18:40	RNAV (GPS) RWY 28L	65.4	52	57
B	12/2/2021 18:57	GLS-A RWY 28L	65.4	51.3	56
B	12/2/2021 19:19	RNAV (GPS) Z RWY 28R	64.1	50.9	35
B	12/2/2021 19:39	GLS-A RWY 28R	64.9	51.6	57
B	12/16/2021 6:35	RNAV (RNP) Y RWY 28R	69.5	58.5	36
B	12/16/2021 6:54	RNAV (GPS) RWY 28L	69.3	57.7	32
B	12/16/2021 7:10	GLS-R RWY 28R	69.9	57.7	42
B	12/16/2021 7:28	GLS-A RWY 28L	68.4	55.5	53
C	12/2/2021 18:40	RNAV (GPS) RWY 28L	64.7	52.6	44
C	12/2/2021 18:57	GLS-A RWY 28L	64.3	51.1	61
C	12/2/2021 19:19	RNAV (GPS) Z RWY 28R	64.9	51.8	49
C	12/2/2021 19:39	GLS-A RWY 28R	64.2	51.5	48
C	12/16/2021 6:35	RNAV (RNP) Y RWY 28R	68.2	57.5	28
C	12/16/2021 6:54	RNAV (GPS) RWY 28L	70.1	58.4	33
C	12/16/2021 7:10	GLS-R RWY 28R	70.4	59.3	34
C	12/16/2021 7:28	GLS-A RWY 28L	68.8	57.6	35
D	12/2/2021 18:41	RNAV (GPS) RWY 28L	68.6	58.3	33
D	12/2/2021 18:57	GLS-A RWY 28L	65.3	52.2	45
D	12/2/2021 19:19	RNAV (GPS) Z RWY 28R	70.1	57.2	46
D	12/2/2021 19:39	GLS-A RWY 28R	65.2	52.7	45
D	12/16/2021 6:36	RNAV (RNP) Y RWY 28R	70.5	59.5	32
D	12/16/2021 6:54	RNAV (GPS) RWY 28L	72.1	60.7	32
D	12/16/2021 7:11	GLS-R RWY 28R	75.8	65.2	35
D	12/16/2021 7:29	GLS-A RWY 28L	70.1	56.1	54
E	12/2/2021 18:41	RNAV (GPS) RWY 28L	66.4	55.5	29
E	12/2/2021 18:58	GLS-A RWY 28L	65.1	53	26
E	12/2/2021 19:20	RNAV (GPS) Z RWY 28R	72.8	63.6	34
E	12/2/2021 19:40	GLS-A RWY 28R	64.5	53.1	26
E	12/16/2021 6:36	RNAV (RNP) Y RWY 28R	70.5	58.1	31

E	12/16/2021 6:54	RNAV (GPS) RWY 28L	72.8	60.7	41
E	12/16/2021 7:11	GLS-R RWY 28R	76.7	64.8	38
E	12/16/2021 7:29	GLS-A RWY 28L	71.6	60.8	39
F	12/2/2021 18:41	RNAV (GPS) RWY 28L	69.1	57	40
F	12/2/2021 18:58	GLS-A RWY 28L	66.4	54	35
F	12/2/2021 19:20	RNAV (GPS) Z RWY 28R	75.8	64.2	44
F	12/2/2021 19:40	GLS-A RWY 28R	67.4	53.7	51
F	12/16/2021 6:36	RNAV (RNP) Y RWY 28R	72.8	58.7	63
F	12/16/2021 6:55	RNAV (GPS) RWY 28L	78.4	67.3	46
F	12/16/2021 7:11	GLS-R RWY 28R	72.2	61	50
F	12/16/2021 7:30	GLS-A RWY 28L	75.7	61.9	49

Appendix B

This Appendix describes the sections of the noise monitoring report and a glossary of terms.

Parts A & C – Community Noise Equivalent Levels (CNEL) produced by all SFO and non-SFO aircraft at each measurement site and CNELs produced by Community (non-aircraft) sources.

Parts B & D – Average Sound Exposure Level (SEL) produced by SFO Runways 28 L/R arrival aircraft at each measurement site and average SEL produced by Community (non-aircraft) noise events.

Part E – SFO Aircraft Daily Noise Event Averages lists the number of noise events registered at each noise monitoring site by SFO Runways 28 L/R arrival aircraft during each day of the noise measurement period. The noise event levels are expressed as average Sound Exposure Level (SEL), average peak noise level (Lmax) and Community ambient noise (L_{90}).

Part F – SFO Aircraft Noise Events by Time of Day lists the daily minimum, maximum, average SEL, average Lmax, and the number of SFO Runways 28 L/R arrival aircraft noise events during the Daytime (7am to 7pm), Evening (7pm to 10pm), and Nighttime (10pm to 7am).

Part G – UAL Test Flight lists each United Airlines (UAL) test approach procedure, the applied flap setting, the speed brake deployment, and the landing gear position over Site E**.**

Part H – Noise Levels of the Most Frequent Aircraft shows the number of noise events and percentage of all noise events, average Lmax, average SEL, and average duration of noise events registered by the three aircraft types with the most SFO Runways 28 L/R noise events during the measurement period.

Part I – Noise Levels of the Loudest SFO Aircraft Events shows the time of arrival, average Lmax, average SEL, and average duration of noise events registered by the three loudest SFO Runways 28 L/R arrival aircraft noise events during the measurement period.

Part J – Comparison of Existing and GLS Innovative Approach Procedures compares the average SEL, average Lmax, average altitude, and average speed of the Boeing 737 MAX 8 aircraft relative to the non-GLS approaches, the test RNAV and GLS approaches to SFO Runways 28 L/R.

Part K – Modeled 737 MAX 8 GLS Innovative Approach lists the modeled (estimated) GLS Innovative Approach average noise level, altitude, and speed of the Boeing 737 MAX 8 at each measurement site. The noise model used was the FAA Aviation Environmental Design Tool (AEDT 3d).

Glossary

A-Weighted Decibel, dBA – The most common unit used for measuring environmental sound levels. The human ear does not respond equally to different frequencies of sound. An A-weight adjusts the frequency components of sound to conform to your ear's normal response at conversational levels. The FAA and State of the California have adopted the A-weighted sound level for environmental analysis. Sound level meters have an A-weighting network for measuring noise in A-weighted decibels.

Community Noise Equivalent Level (CNEL) – A noise metric required by the California Airport Noise Standards for use by airport proprietors to measure aircraft noise levels. CNEL includes an additional weighting for each event occurring during the evening (7:00 p.m. – 9:59 p.m.) and nighttime (10:00 p.m. – 6:59 a.m.) periods to account for increased sensitivity to noise during these periods. Evening events are treated as though there were three and nighttime events are treated as though there were ten. This results in a 4.77 and 10 decibel penalty for operations occurring in the evening and nighttime periods, respectively. For a more in-depth explanation of CNEL and other technical noise terms, please visit the Federal Aviation Administration (FAA) website. Below is a graphic illustrating types of metropolitan areas and their corresponding CNEL intervals.

Decibel (dB) – A unit used to measure the magnitude or intensity of sound. The decibel uses a logarithmic scale to cover the very large range of sound pressures that can be heard by the human ear. Decibels measure a scale

from the threshold of human hearing, 0 dB, upward towards the threshold of pain, about 120-140 dB. Because decibels are such a small measure, they are computed logarithmically and cannot be added arithmetically. A10 dB increase will be perceived by most people to be a doubling in loudness, i.e., 80 dB seems twice as loud as 70 dB. A-weighted decibels (dBA) adjust sound pressure towards the frequency range of human hearing.

Maximum Sound Level (Lmax) – The maximum a-weighted sound level, in dBA, for a given noise event. The peak noise level reached by a single aircraft event.

Noise Event (Threshold) – A Noise Event is the measured sound produced by a single source of noise over a duration of time above a given noise level threshold. The ANEEM correlation process uses a dynamic threshold based on L90 plus an offsert of 2 to 5 dB.

Sound Exposure Level (SEL) – SEL is a measure of a single aircraft noise event spread out over its entirety compressed into one second. It allows for a comparison of aircraft noise events of different durations and noise levels. For example, think of the moment you hear a plane from a quarter mile away; we measure from that moment, as the aircraft flies overhead, and until it can't be heard. This is the duration of sound we use and then compress it into one second for a measure. SEL measures noise energy above the threshold. This way, any ambient noise is separated out from the measurement.

GLS-A RWY 28L (EDDYY)

Revision 1

Changes: New

San Francisco International Airport (SFO) has identified several Innovative Approach (IA) procedures primarily designed for noise reduction. Each procedure is described in a Community Flight Procedure Package (CFPP) that provides information about the IA and compares aircraft noise and flight performance of the IA to a comparable existing procedure if applicable. Please note that 1) IA procedure design is limited to be within approximately 20 nautical miles (nm) from the airport, 2) the maximum expected number of arrivals to use an IA procedure is 30 per day, and 3) the estimated noise reduction – although small or imperceptible in some areas – is part of an incremental noise reduction process that begins with demonstrating procedure design viability with the objective to achieve significant noise reduction in the future.

The CFPP includes the following pages of information:

- Page 1 includes the name and description of the IA, a map of the IA flight path, and the project goals being met by the procedure. The altitudes shown along the flight path indicate the change in altitude on the IA flight path compared to the existing procedure.
- Page 2 compares the navigational charts of the existing approach procedure and the proposed IA, the percentage of aircraft at SFO that are currently capable of using the IA, and the types of weather and visibility conditions in which the IA could be used.
- Pages 3, 5, 7, and 9 include maps that illustrate the waypoints, flight path, and Sound Exposure Level (SEL) contours of the existing and IA procedures for two Narrowbody and two Widebody aircraft. The pages also list the altitude and SEL changes at sample points, and the potential changes in population impacted by the implementation of the IA. Please note that 1) aircraft noise levels below 60 decibels (dB) may be similar to urban ambient noise, and 2) changes in noise levels below 3 dB are generally not perceptible by the human ear. Therefore, the population within an area illustrated as a noise increase may not notice the actual noise increase.
- Pages 4, 6, 8, and 10 show graphs that compare how altitude, flap settings, net thrust, and ground speed change during the flights of the existing approach procedure and the proposed IA. This data was used in the FAA Aviation Environmental Design Tool (AEDT 3d) noise model to calculate the SEL information shown on pages 3, 5, 7 and 9 and reflects the project team's best efforts to model how each of the aircraft would fly the IA without using aerodynamic braking.
- Pages 11 and 12 show comparisons of the existing procedure to the IA relative to evaluation criteria for Narrowbody and Widebody aircraft.

The remaining pages describe information about noise exposure and terms used throughout the CFPP.

GLS-A RWY 28L (EDDYY)

Revision 1

Changes: New

GLS Instrument approach to runway 28L originating east of the airport, starting at the EDDYY waypoint.

The approach is laterally identical to the existing RNAV (GPS) Rwy 28L approach but is elevated by a vertical 3.18 Degree final approach with higher minimum altitudes along the remainder of the intermediate and initial approach segments until reaching EDDYY

Project Goals

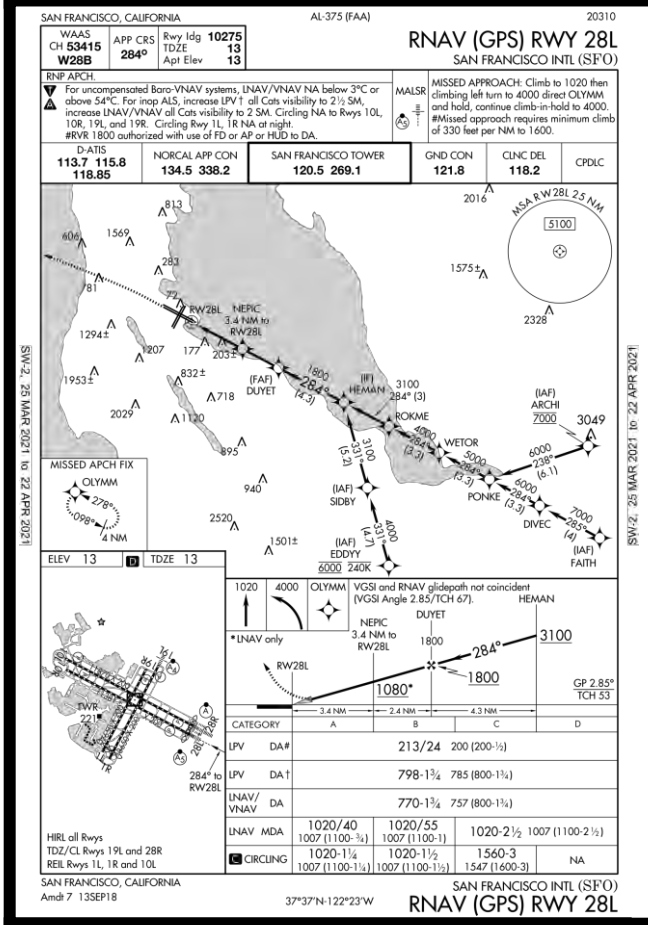
- ✓ Noise reduction
- ✓ ILS Redundancy
- ✓ Efficiency
- ❑ Reduce Delays

GLS-A RWY 28L (EDDYY)

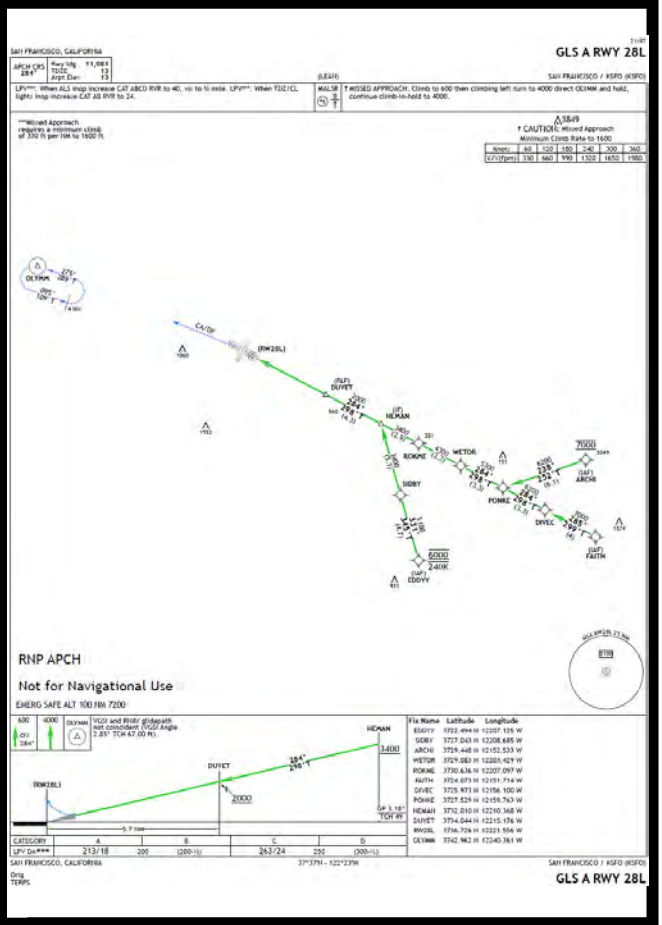
Revision 1

Changes: New

Existing Approach
RNAV (GPS) Rwy 28L



Preliminary Concept
GLS-A RWY 28L



Aircraft @ SFO Capable of Using This Procedure

Regional/BizJet < 1%

Narrowbody ~ 30%

Widebody ~ 30%

Narrowbody and widebody aircraft capable of using this approach into SFO are anticipated to <u>increase</u> over the next 5 years

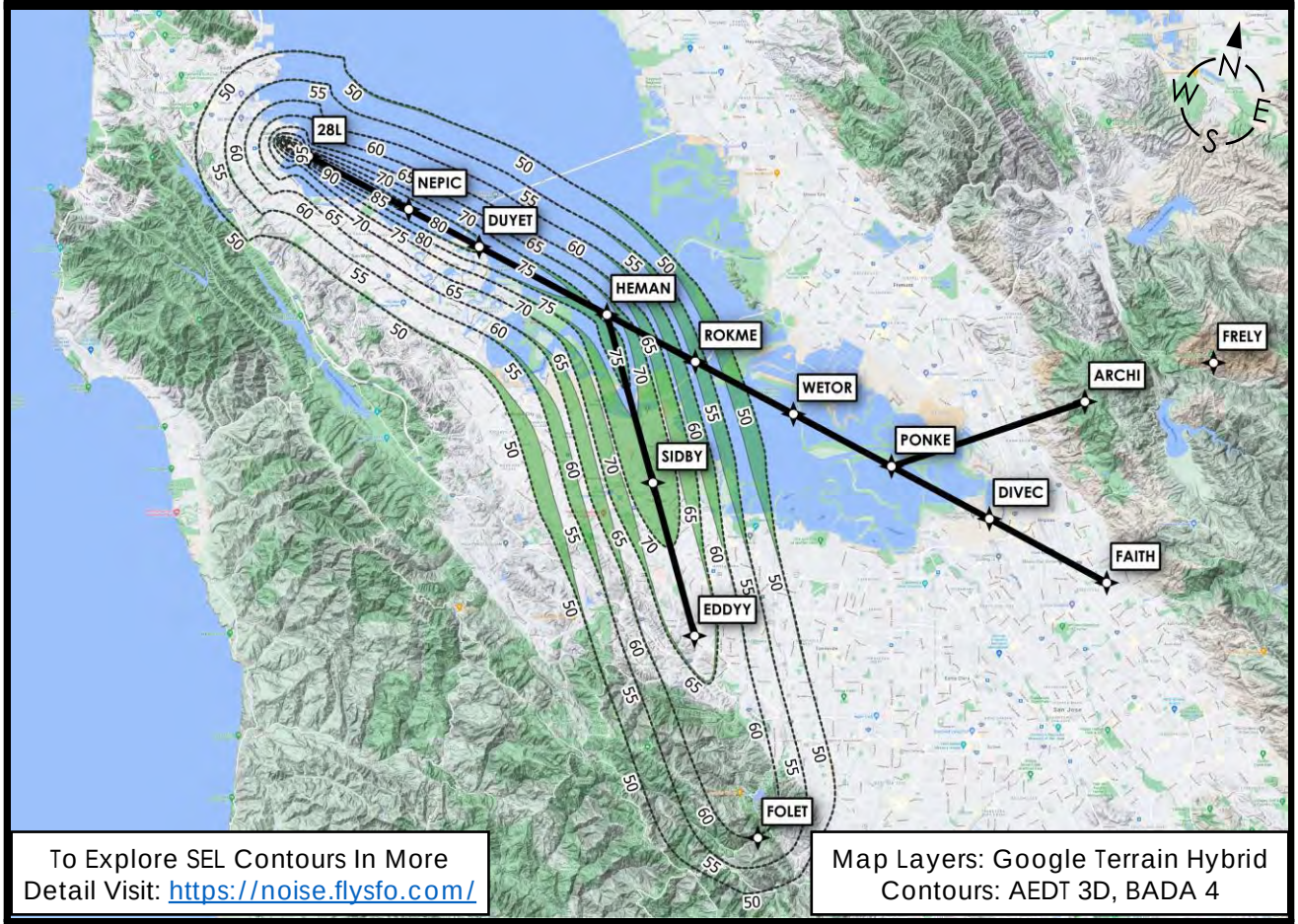
Weather Opportunity

VFR	✓	Day/Night Use
MVFR	✓	Day/Night Use
IFR	✓	Day/Night Use
LIFR	✓	CAT I Only

Narrowbody 1 SEL GLS-A RWY 28L

Revision 1

Changes: New



To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	67.01	66.62
SIDBY	4000	5100	73.76	68.55

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

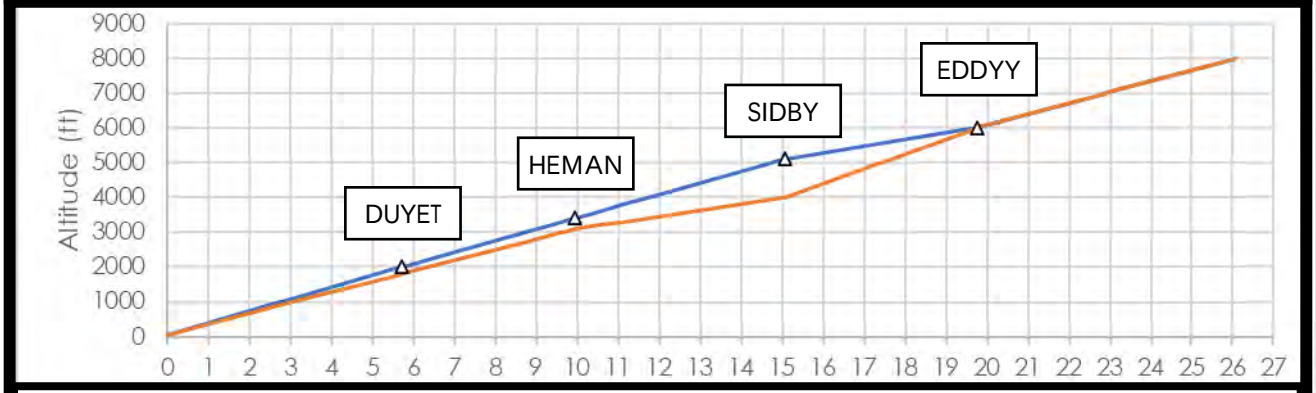
Potential Change In Population Effected	
SEL Contour (dBA)	2010 Population
50	-29307
55	-13195
60	-15824
65	-21787
70	-56649
75	-231
80	-777
85	-2
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Narrowbody 1 SEL GLS-A RWY 28L

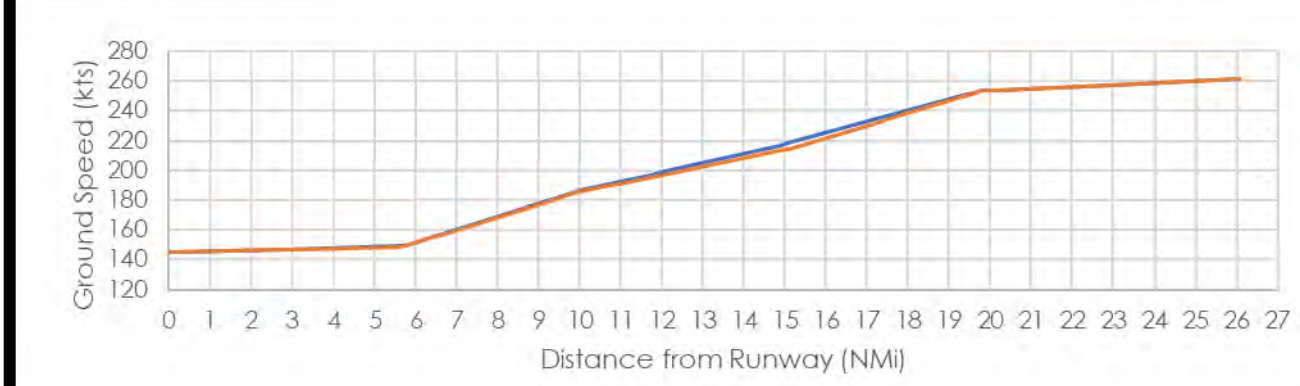
Revision 1

Changes: New



Simulated Flight Profile Characteristic for Existing Approach

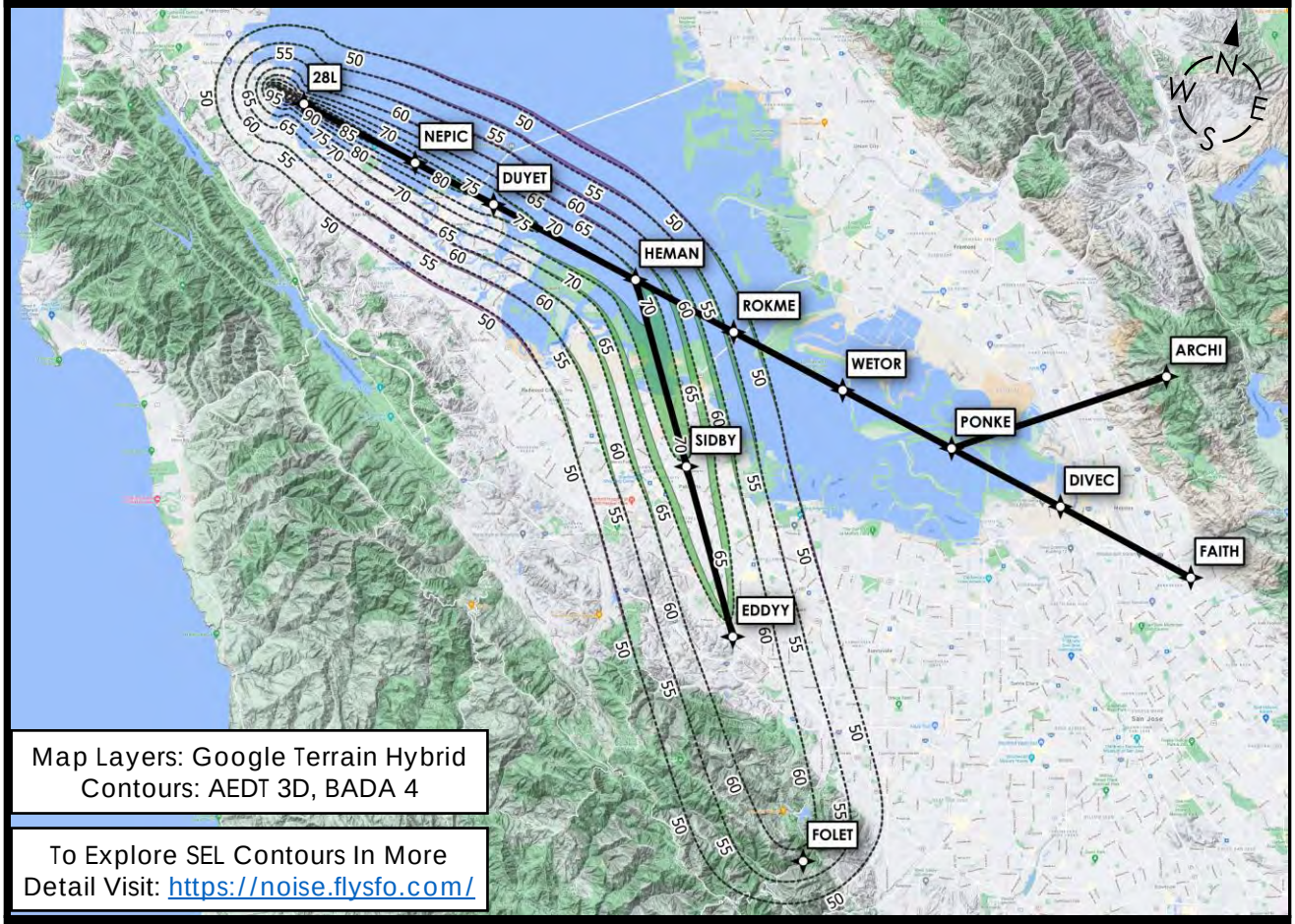
Simulated Flight Characteristic for Innovative Approach Concept



Narrowbody 2 SEL GLS-A RWY 28L

Revision 1

Changes: New



Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	64.59	64.49
SIDBY	4000	5100	69.47	66.66

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

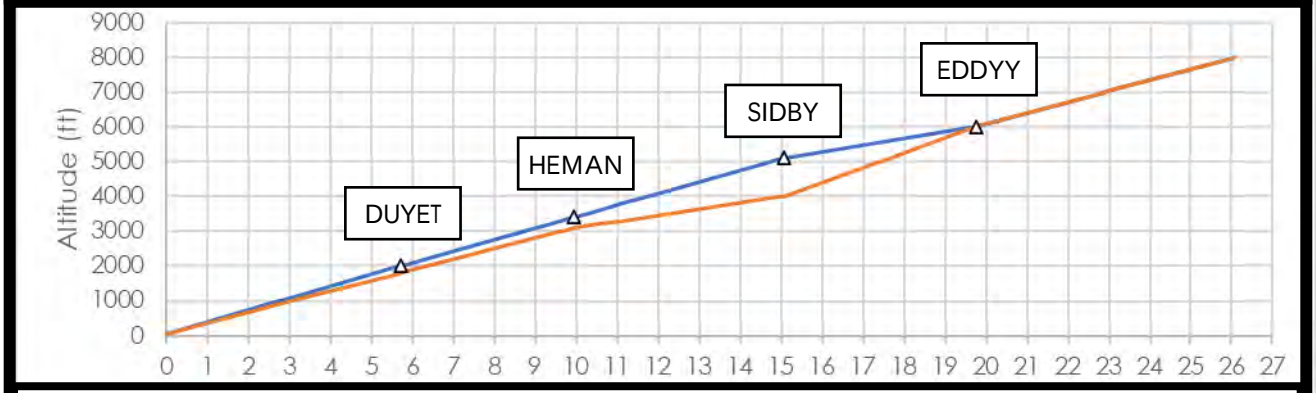
Potential Change In Population Effected	
SEL Contour (dBA)	2010 Population
50	1370
55	1227
60	-544
65	-21113
70	-15291
75	-116
80	0
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Narrowbody 2 SEL GLS-A RWY 28L

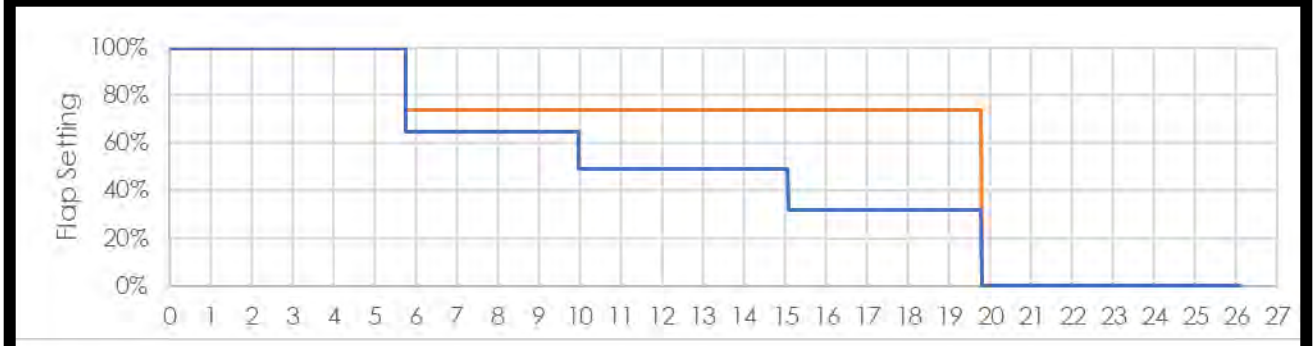
Revision 1

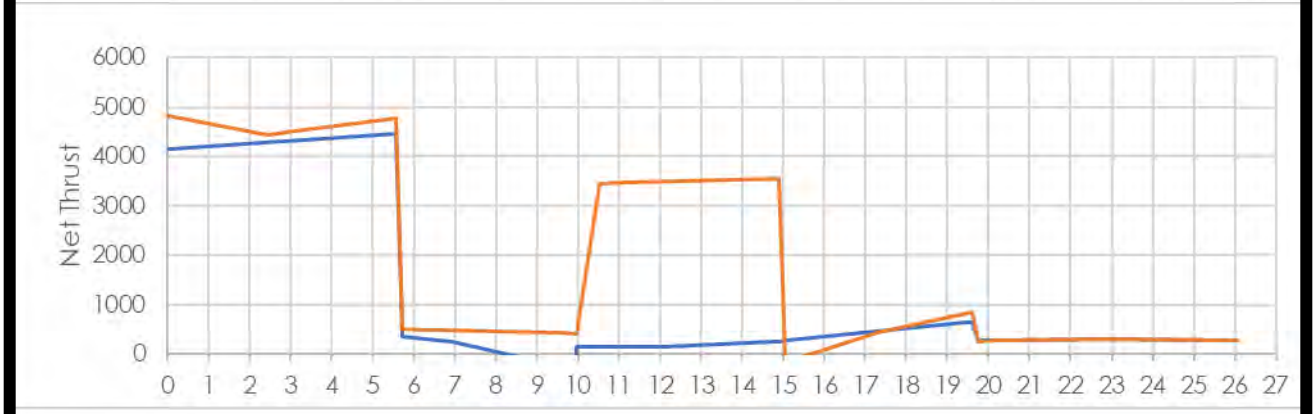
Changes: New

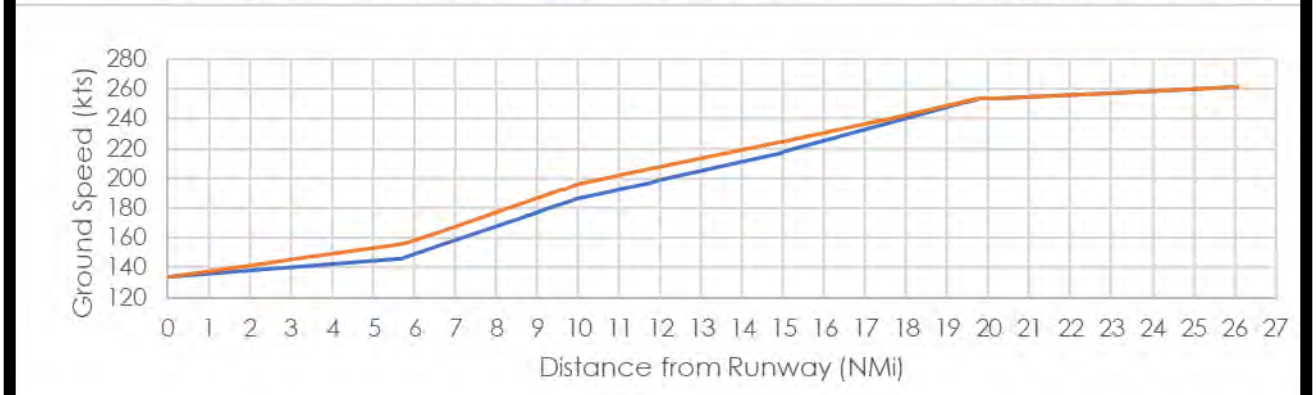


Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept



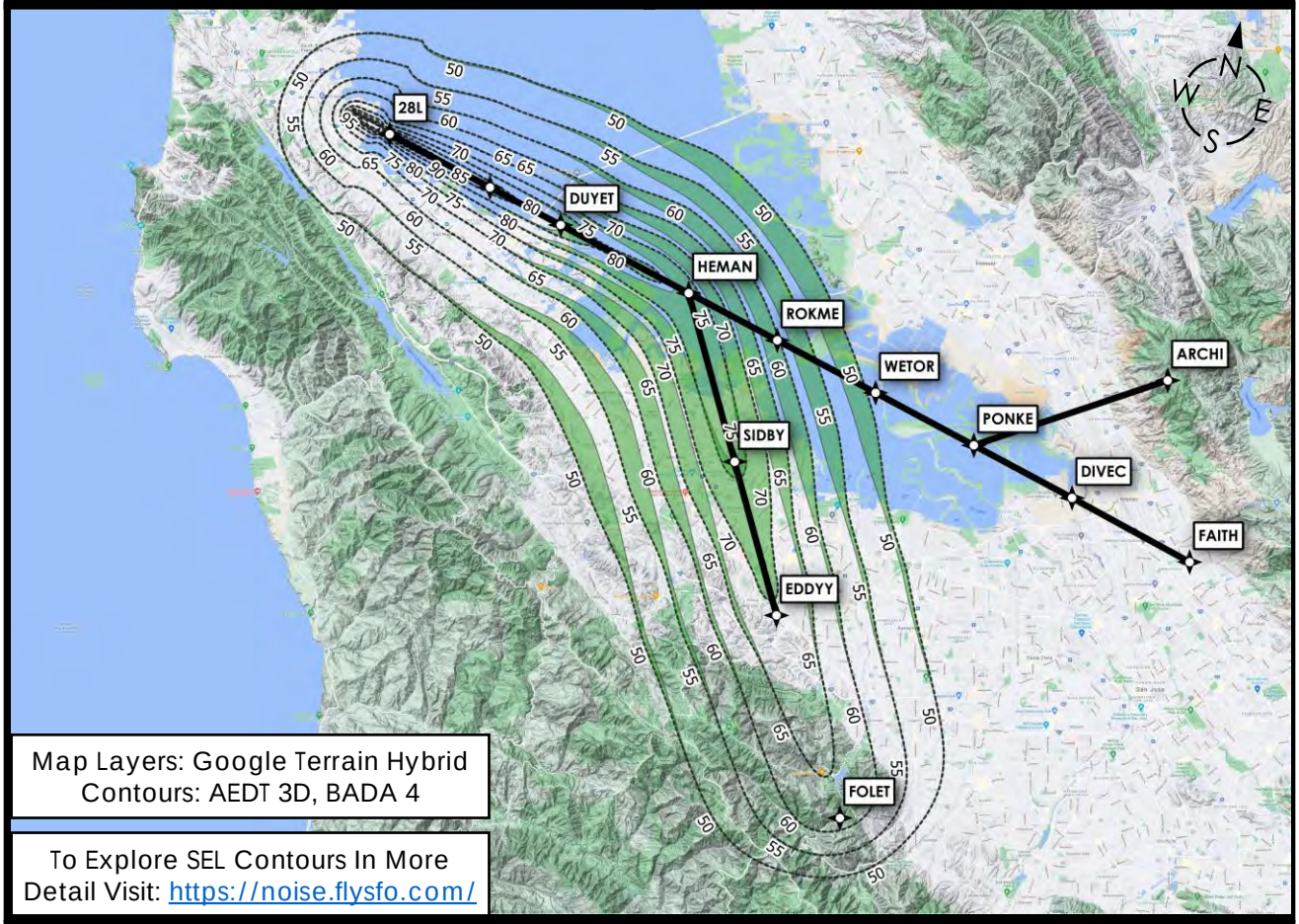




Widebody 1 SEL GLS-A RWY 28L

Revision 1

Changes: New



Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	69.3	68.37
SIDBY	4000	5100	75.85	70.06

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

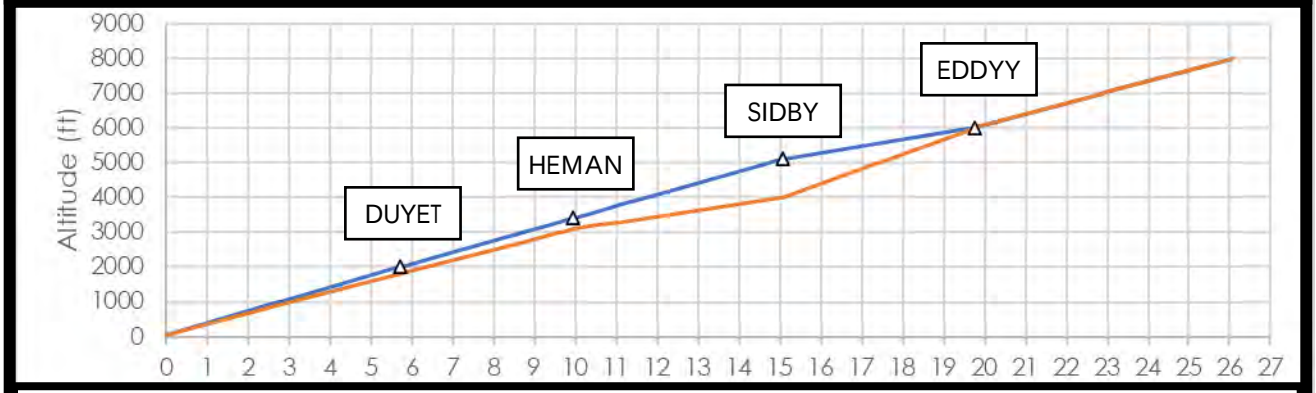
Potential Change In Population Effected	
SEL Contour (dBA)	2010 Population
50	-28008
55	-35434
60	-25512
65	-25256
70	-73829
75	-24301
80	-1354
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Widebody 1 SEL GLS-A RWY 28L

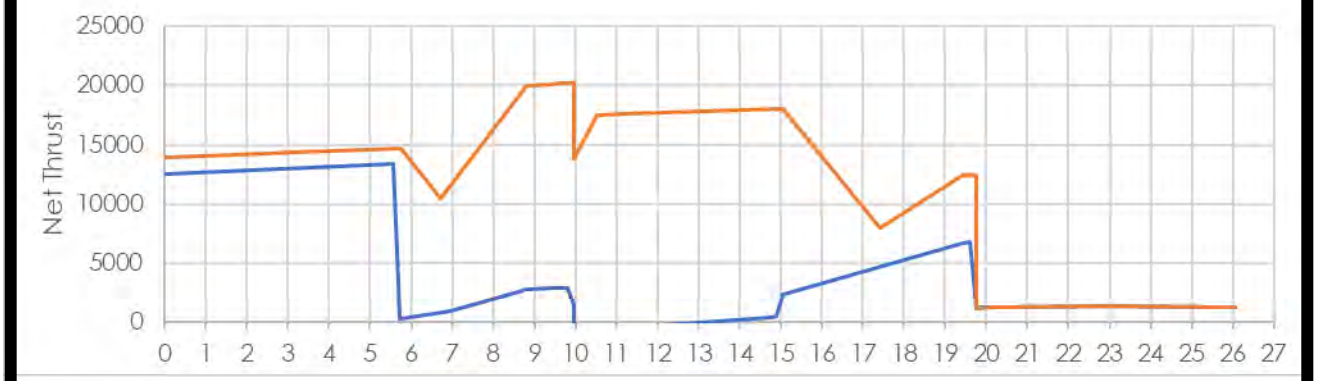
Revision 1

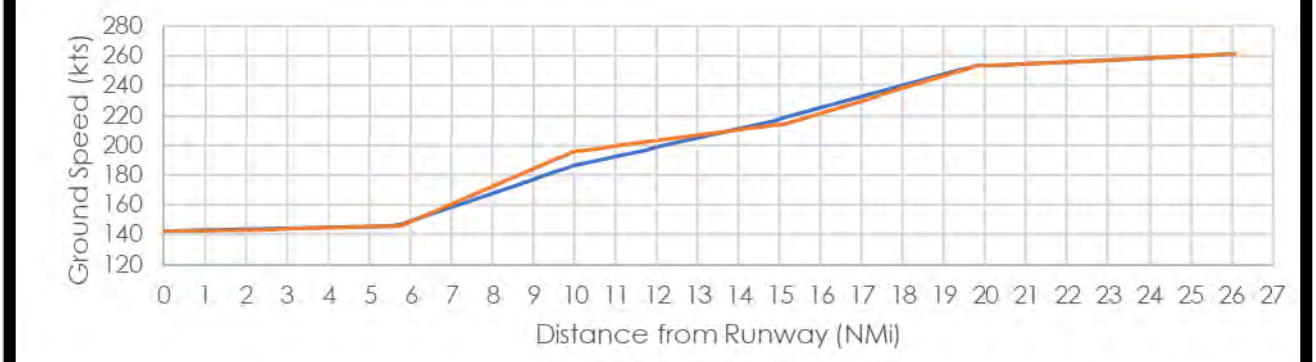
Changes: New



Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept

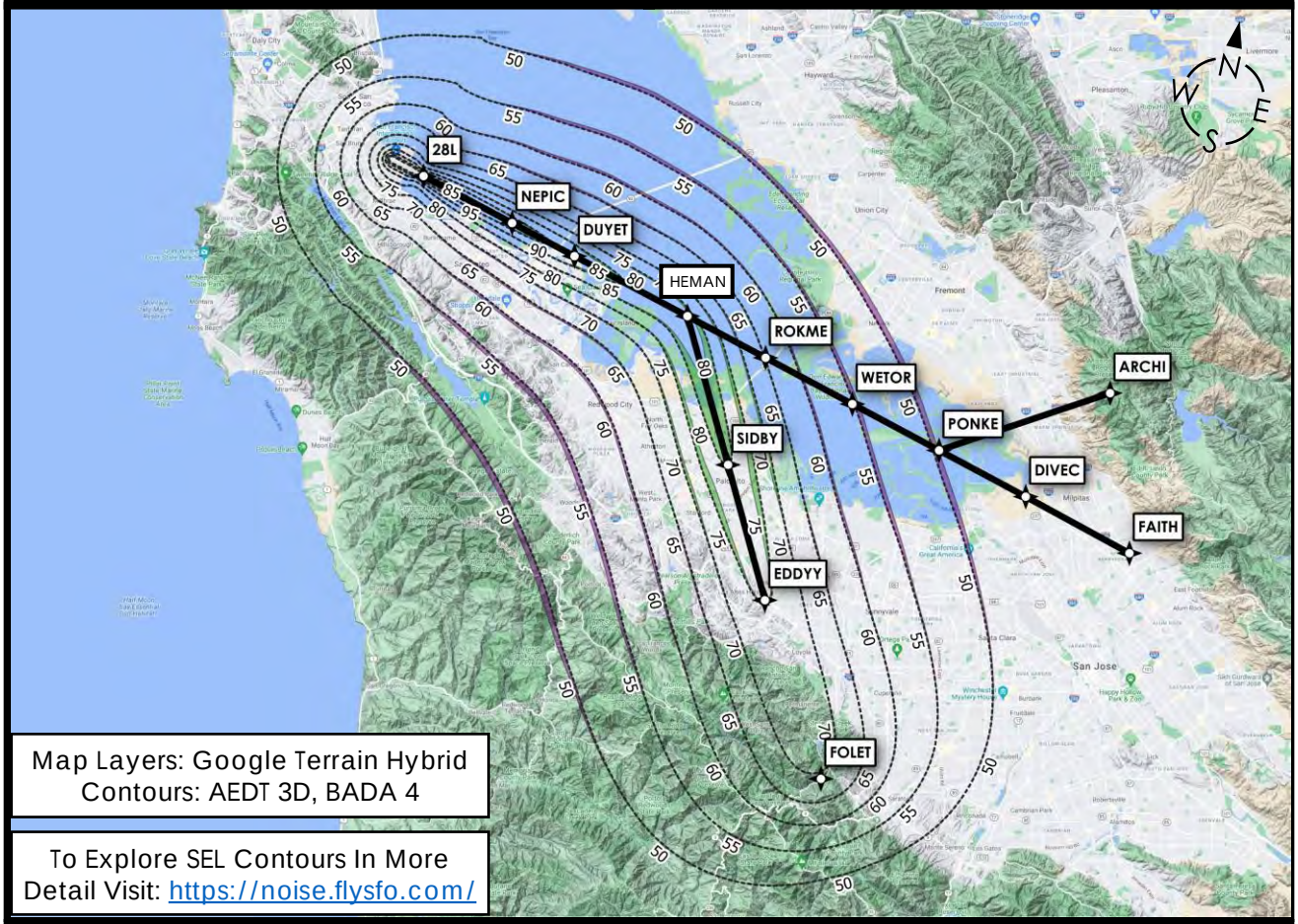




Widebody 2 SEL GLS-A RWY 28L

Revision 1

Changes: New



Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	75.19	75.08
SIDBY	4000	5100	80.04	77.26

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

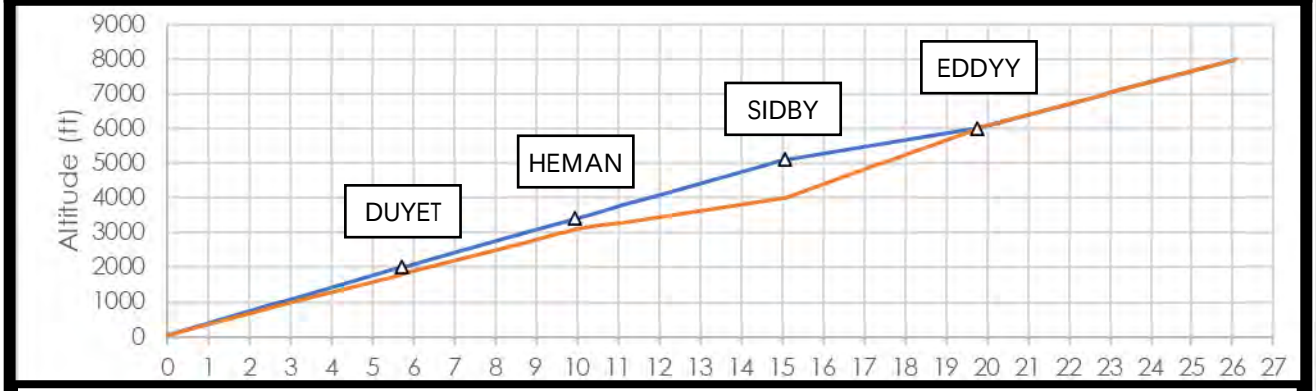
Potential Change In Population Effected	
SEL Contour (dBA)	2010 Population
50	8906
55	5736
60	9606
65	4499
70	946
75	-13696
80	-14846
85	-192
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Widebody 2 SEL GLS-A RWY 28L

Revision 1

Changes: New



Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept

GLS-A RWY 28L (EDDYY)

Revision 1

Changes: New

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - NARROWBODY 1

PROCEDURE: GLS A RWY 28L (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	ILS or LOC RWY 28L or RNAV (GPS) Rwy 28L	GLS A RWY 28L	DIFFERENCE	RANKING
Population within 60 dB SEL contour	255171	243071	-12100	
Population within 75 dB SEL contour	4273	4050	-223	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	4000	5100	1100	
SEL at Location EDDYY (dB)	67.01	66.62	-0.39	
SEL at Location SIDBY (dB)	73.76	68.55	-5.21	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	215	218	3	
Number of arrivals between 07:00 - 19:00	TBD	15 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - NARROWBODY 2

PROCEDURE: GLS A RWY 28L (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	ILS or LOC RWY 28L or RNAV (GPS) Rwy 28L	GLS A RWY 28L	DIFFERENCE	RANKING
Population within 60 dB SEL contour	195637	195093	-544	
Population within 75 dB SEL contour	4035	3919	-116	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	4000	5100	1100	
SEL at Location EDDYY (dB)	64.59	64.49	-0.1	
SEL at Location SIDBY (dB)	69.47	66.66	-2.81	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	226	211	-15	
Number of arrivals between 07:00 - 19:00	TBD	15 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

Disclaimer

The information provided in this CFPP is intended to assist members of the public to review the potential changes that might be experienced following the implementation of a proposed innovative approach procedure concept when compared to an existing instrument approach procedure.

All information contained in this presentation was prepared by the SFIA GBAS Project Team using industry best practices, insight provided by SFIA Flight Procedures Subcommittee participants and historical experience regarding flight operations into SFIA.

Information presented in this handout is a prediction of current and future aircraft operations and is subject to change. This includes potential changes in the number of aircraft and flight crews that can utilize GLS approaches, changes in air traffic control methods, changes in FAA instrument procedure design criteria, changes in the airspace surrounding SFO and other variables which may not have been modeled that can affect the potential altitude, flap, thrust, aerodynamic configuration and operating weight of the aircraft.

Any further regulatory review of these procedures, including assessment under the National Environmental Policy Act will require an independent noise analysis. The noise results presented in this document are for exploratory purposes only and rely on BADA4 aircraft performance inputs; which are restricted to research purposes only per the Eurocontrol and the FAA terms of use in AEDT.

GLS-A RWY 28L (EDDYY)

Revision 1

Changes: New

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - WIDEBODY 1

PROCEDURE: GLS A RWY 28L (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	ILS or LOC RWY 28L or RNAV (GPS) Rwy 28L	GLS A RWY 28L	DIFFERENCE	RANKING
Population within 60 dB SEL contour	322156	296638	-25518	
Population within 75 dB SEL contour	30978	6664	-24314	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	4000	5100	1100	
SEL at Location EDDYY (dB)	69.3	68.37	-0.93	
SEL at Location SIDBY (dB)	75.85	70.06	-5.79	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	215	218	3	
Number of arrivals between 07:00 - 19:00	TBD	15 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - WIDEBODY 2

PROCEDURE: GLS A RWY 28L (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	ILS or LOC RWY 28L or RNAV (GPS) Rwy 28L	GLS A RWY 28L	DIFFERENCE	RANKING
Population within 60 dB SEL contour	571424	581030	9606	
Population within 75 dB SEL contour	111161	97464	-13697	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	4000	5100	1100	
SEL at Location EDDYY (dB)	75.19	75.08	-0.11	
SEL at Location SIDBY (dB)	80.04	77.26	-2.78	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	224	218	-6	
Number of arrivals between 07:00 - 19:00	TBD	15 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

Disclaimer

The information provided in this CFPP is intended to assist members of the public to review the potential changes that might be experienced following the implementation of a proposed innovative approach procedure concept when compared to an existing instrument approach procedure.

All information contained in this presentation was prepared by the SFIA GBAS Project Team using industry best practices, insight provided by SFIA Flight Procedures Subcommittee participants and historical experience regarding flight operations into SFIA.

Information presented in this handout is a prediction of current and future aircraft operations and is subject to change. This includes potential changes in the number of aircraft and flight crews that can utilize GLS approaches, changes in air traffic control methods, changes in FAA instrument procedure design criteria, changes in the airspace surrounding SFO and other variables which may not have been modeled that can affect the potential altitude, flap, thrust, aerodynamic configuration and operating weight of the aircraft.

Any further regulatory review of these procedures, including assessment under the National Environmental Policy Act will require an independent noise analysis. The noise results presented in this document are for exploratory purposes only and rely on BADA4 aircraft performance inputs; which are restricted to research purposes only per the Eurocontrol and the FAA terms of use in AEDT.

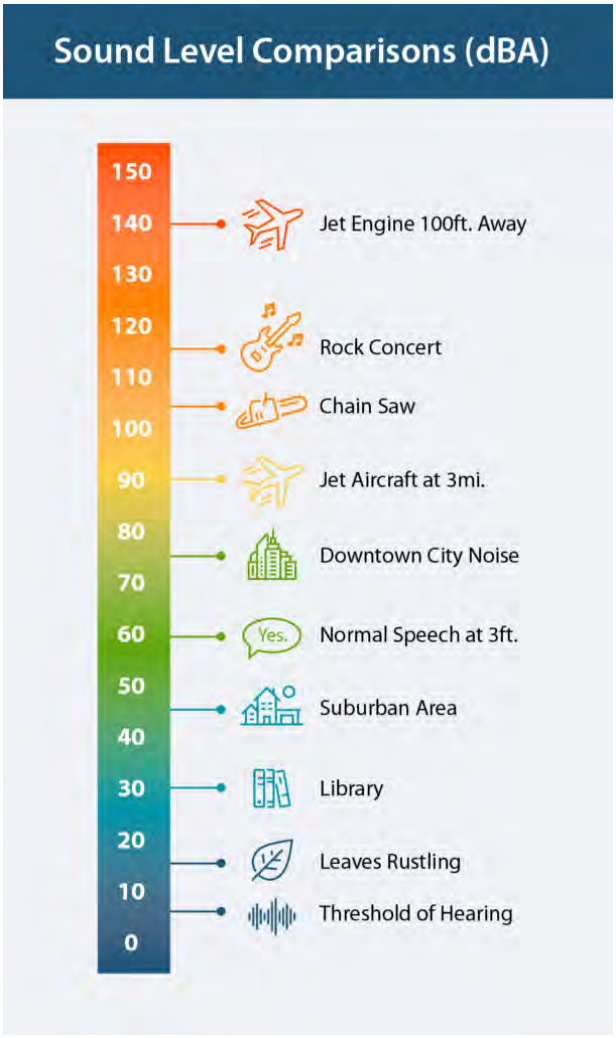
Information About SEL Contours

Revision 1

Changes: N/A

The Innovative Approach Evaluation Criteria, shown on the "Summary" page, use SEL 75 dB and 60 dB contours to compare the population counts impacted by each procedure. In reference to aircraft overflights, SEL is generally 10 dB above Lmax. The SEL 75 dB level was selected as part of the evaluation criteria due to its comparison to Lmax 65 dB, which is approximately the sound level of normal speech at a distance of 3 feet. The SEL 60 dB was selected due to its comparison to Lmax 50 dB, which is approximately the sound level of background noise at a quiet urban area.

Relative to sound level changes, an increase of 5 dBA is readily perceptible to the public and a 3 dBA increase is barely perceivable to the average healthy human ear.



Glossary

Revision 1

Changes: Updated

GBAS

Ground Based Augmentation System – A navigational aid, installed on the airport, that broadcasts a signal to aircraft that enhances ("augments") their existing GPS navigation capabilities enabling precision approaches to all runways at the airport.

GLS

GBAS Landing System (GLS) is the FAA's official term for a GBAS instrument approach procedure. A GLS approach is considered a "precision" approach procedure which means it provides precise navigational guidance similar to the Instrument Landing System (ILS) that have been used at SFO for over 50 years.

SEL

Sound Exposure Level – is a noise metric that represents all the acoustic energy (a.k.a. sound pressure) of an individual noise event as if that event had occurred within a one-second time period. SEL captures both the level (magnitude) and the duration of a sound event in a single numerical quantity, by "squeezing" all the noise energy from an event into one second. This provides a uniform way to make comparisons among noise events of various durations.

Lmax

Maximum Sound Level– is a noise metric that represents the maximum amount of acoustic energy (a.k.a. sound pressure) which occurs during an individual noise event regardless of its duration.

dB or dBA

Decibel (dB) or an "A-weighted" decibel - is the unit used to measure the intensity of a sound. The human ear hears sound pressures over a wide range. Decibels, which are measured on a logarithmic scale, correspond to the way our ears interpret sound pressures. The "A-weighted" scale most closely approximates the relative loudness of sounds in air as perceived by the human ear and provides a more useful way to evaluate the effect of noise exposure on humans by focusing on those parts of the frequency spectrum where we hear most. All noise results in this document use dBA.

MSL

Mean Sea Level (MSL), a tidal datum that is used to express geometric altitude above the earth. MSL references in this packet use imperial feet and can be thought of like a tapeline measurement from the ground to an object.

Glossary

Revision 1

Changes: Updated

ATC

Air Traffic Control, which represents a combination of human beings and technology responsible for aircraft separation from terrain, weather and other aircraft and aeronautical objects. At SFO, ATC is provided by a combination of individuals working locally in the tower and offsite with radar and voice communication capabilities.

Waypoint

Is a geographical location defined by a latitude/longitude geographic coordinate. These 5-letter waypoints, VHF intersections, 5-letter pronounceable DME fixes and 3-letter NAVAID IDs are published on various FAA aeronautical navigation products (IFR Enroute Charts, VFR charts, Terminal Procedures Publications, etc.).

RNAV or RNAV (GPS)

Area Navigation describes a navigation method used by aircraft which commonly utilize the Global Positioning System of satellites to determine information about their lateral position on earth. The GBAS sends an augmentation signal to aircraft using area navigation to increase the precision of the aircraft position, including additional information about the vertical location of the aircraft relative to the airport.

ILS

Instrument Landing System is the technology currently installed on 3 runways at SFO which sends an electronic signal along the final approach path which aircraft can detect and navigate within a fixed lateral and vertical corridor

RWY

Abbreviation for runway

Nmi

Nautical Mile – equal to 6,076 feet.

AEDT

Aviation Environmental Design Tool - AEDT is a software system that dynamically models aircraft performance in space and time to produce fuel burn, emissions and noise. Full flight gate-to-gate analyses are possible for study sizes ranging from a single flight at an airport to scenarios at the regional, national, and global levels.

Glossary

Revision 1

Changes: Updated

Waypoint

Is a geographical location defined by a latitude/longitude geographic coordinate. These 5-letter waypoints, VHF intersections, 5-letter pronounceable DME fixes and 3-letter NAVAID IDs are published on various FAA aeronautical navigation products (IFR Enroute Charts, VFR charts, Terminal Procedures Publications, etc.).

VFR

Visual Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is greater than 3,000 feet above ground level and the visibility is greater than five miles.

MVFR

Marginal Visual Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is between 1,000 - 3,000 feet above ground level and the visibility is between three and five miles.

IFR

Instrument Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is less than 1,000 feet above ground level and the visibility is less than three miles.

LIFR

Low Instrument Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is less than 500 feet above ground level and the visibility is less than 1/2 miles.

GLS-A RWY 28R (EDDYY)

Revision 2

Changes: New

San Francisco International Airport (SFO) has identified several Innovative Approach (IA) procedures primarily designed for noise reduction. Each procedure is described in a Community Flight Procedure Package (CFPP) that provides information about the IA and compares aircraft noise and flight performance of the IA to a comparable existing procedure if applicable. Please note that 1) IA procedure design is limited to be within approximately 20 nautical miles (nm) from the airport, 2) the maximum expected number of arrivals to use an IA procedure is 30 per day, and 3) the estimated noise reduction – although small or imperceptible in some areas – is part of an incremental noise reduction process that begins with demonstrating procedure design viability with the objective to achieve significant noise reduction in the future.

The CFPP includes the following pages of information:

- Page 1 includes the name and description of the IA, a map of the IA flight path, and the project goals being met by the procedure. The altitudes shown along the flight path indicate the change in altitude on the IA flight path compared to the existing procedure.
- Page 2 compares the navigational charts of the existing approach procedure and the proposed IA, the percentage of aircraft at SFO that are currently capable of using the IA, and the types of weather and visibility conditions in which the IA could be used.
- Pages 3, 5, 7, and 9 include maps that illustrate the waypoints, flight path, and Sound Exposure Level (SEL) contours of the existing and IA procedures for two Narrowbody and two Widebody aircraft. The pages also list the altitude and SEL changes at sample points, and the potential changes in population impacted by the implementation of the IA. Please note that 1) aircraft noise levels below 60 decibels (dB) may be similar to urban ambient noise, and 2) changes in noise levels below 3 dB are generally not perceptible by the human ear. Therefore, the population within an area illustrated as a noise increase may not notice the actual noise increase.
- Pages 4, 6, 8, and 10 show graphs that compare how altitude, flap settings, net thrust, and ground speed change during the flights of the existing approach procedure and the proposed IA. This data was used in the FAA Aviation Environmental Design Tool (AEDT 3d) noise model to calculate the SEL information shown on pages 3, 5, 7 and 9 and reflects the project team's best efforts to model how each of the aircraft would fly the IA without using aerodynamic braking.
- Pages 11 and 12 show comparisons of the existing procedure to the IA relative to evaluation criteria for Narrowbody and Widebody aircraft.

The remaining pages describe information about noise exposure and terms used throughout the CFPP.

GLS-A RWY 28R (EDDYY)

Revision 2

Changes: New

GLS Instrument approach to runway 28R originating southeast of the airport, starting at the EDDYY waypoint.

The approach is laterally identical to the existing RNAV (GPS) Y Rwy 28R approach but is elevated by a vertical 3.18 Degree final approach with higher minimum altitudes along the remainder of the intermediate and initial approach segments until reaching EDDYY.

Project Goals

- ✓ Noise reduction
- ✓ ILS Redundancy
- ✓ Efficiency
- ❑ Reduce Delays

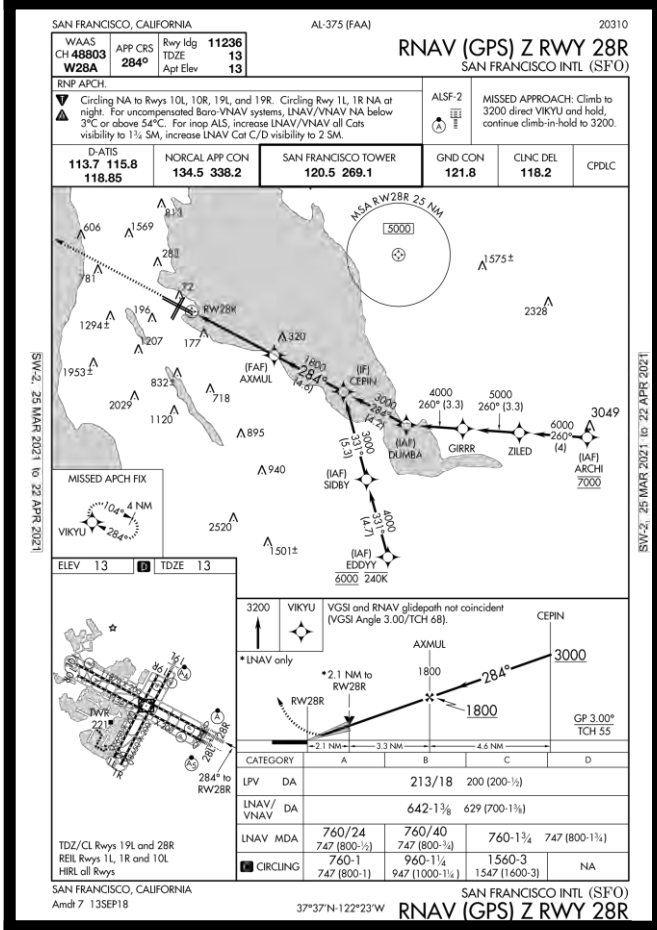
GLS-A RWY 28R (EDDYY)

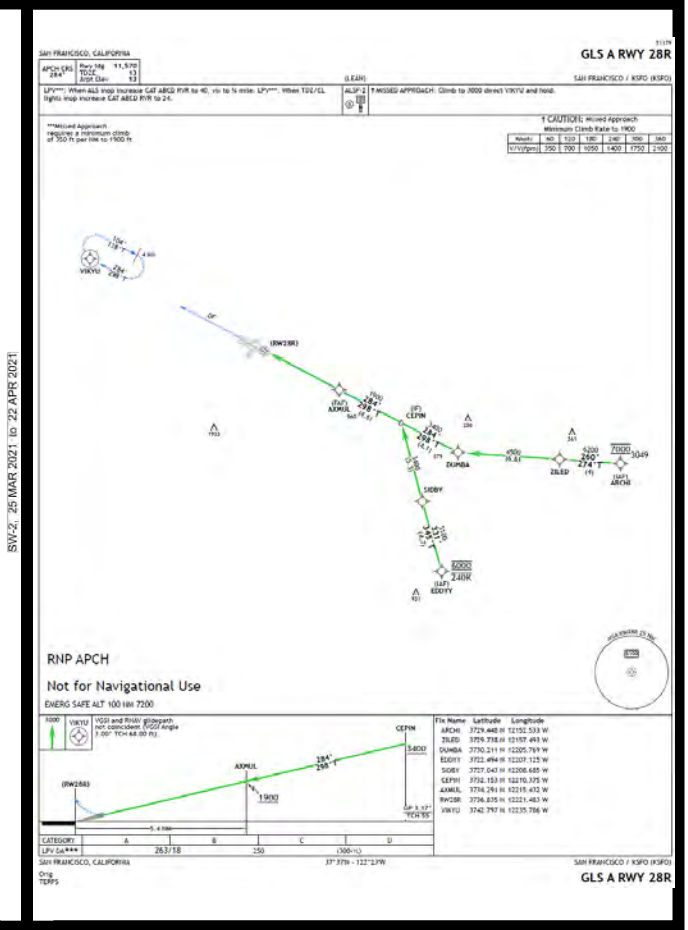
Revision 2

Changes: New

Existing Approach
RNAV (GPS) Z Rwy 28R

Preliminary Concept
GLS-A RWY 28R





Aircraft @ SFO Capable of Using This Procedure

Regional/BizJet < 1%

Narrowbody ~ 30%

Widebody ~ 30%

Narrowbody and widebody aircraft capable of using this approach into SFO are anticipated to <u>increase</u> over the next 5 years.

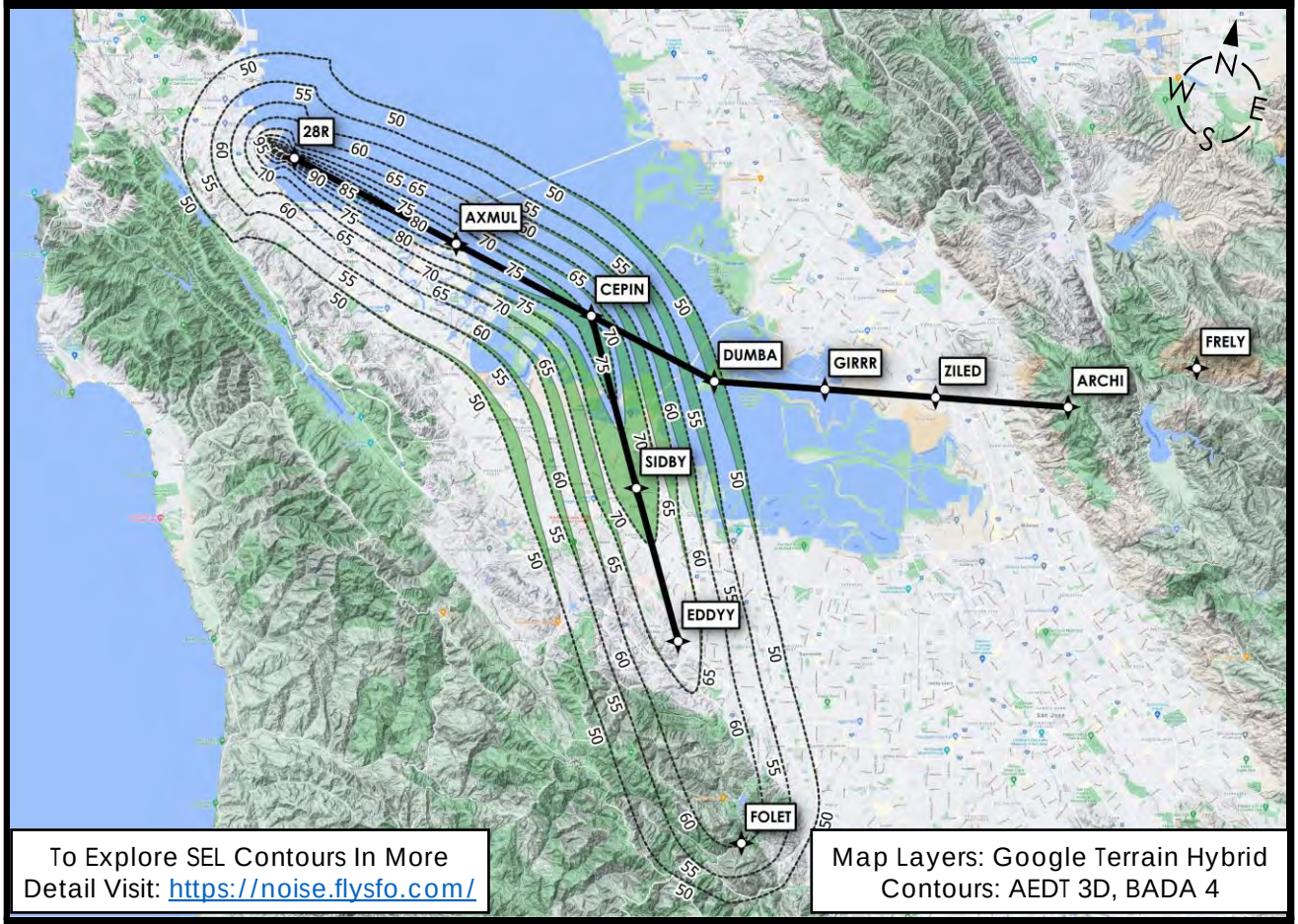
Weather Opportunity

VFR	✓	Day/Night Use
MVFR	✓	Day/Night Use
IFR	✓	Day/Night Use
LIFR	✓	CAT I Only

Narrowbody 1 SEL GLS-A RWY 28R

Revision 2

Changes: Updated



To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	67.11	66.77
SIDBY	4000	5100	73.4	69.15

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

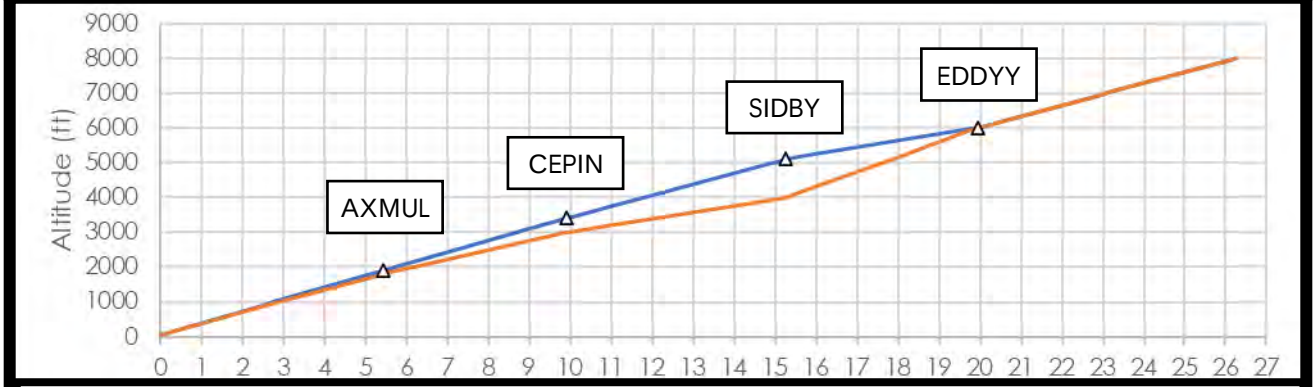
Potential Change In Population Effected	
SEL Contour (dBA)	2010 Population
50	-20176
55	-9777
60	-12100
65	-13822
70	-49601
75	-223
80	-343
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Narrowbody 1 SEL GLS-A RWY 28R

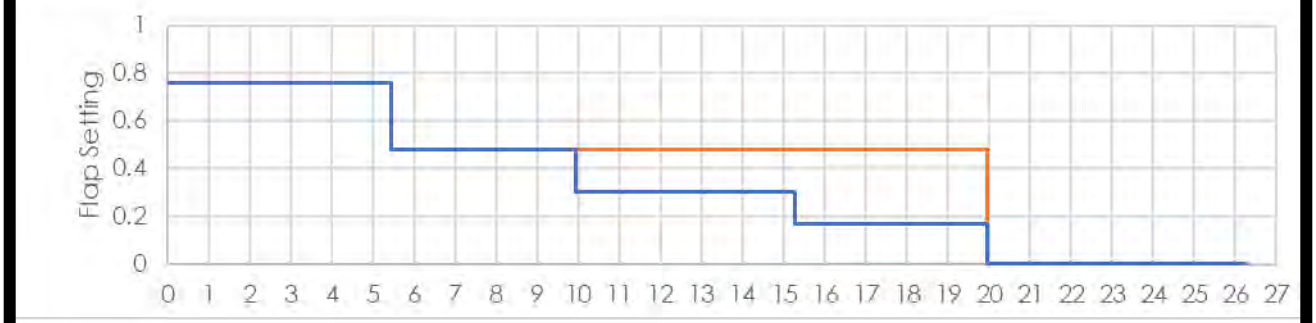
Revision 2

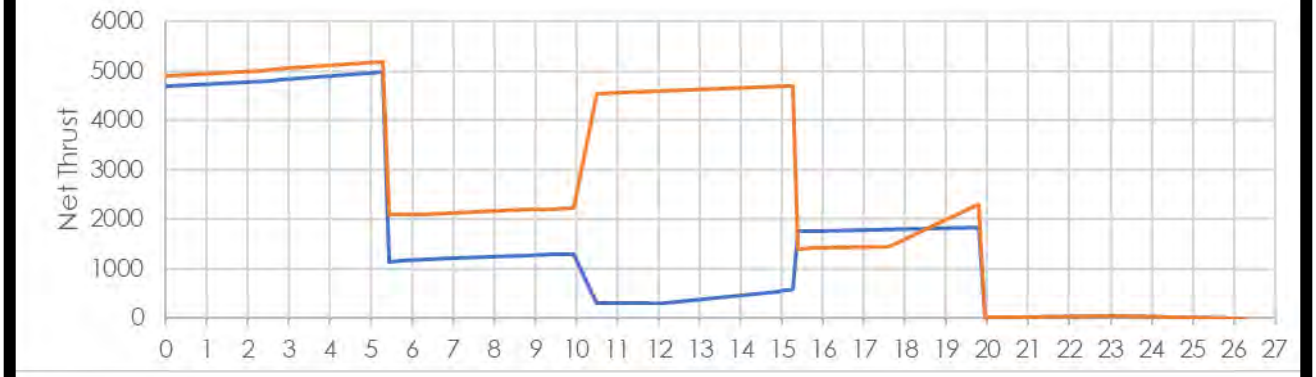
Changes: Updated

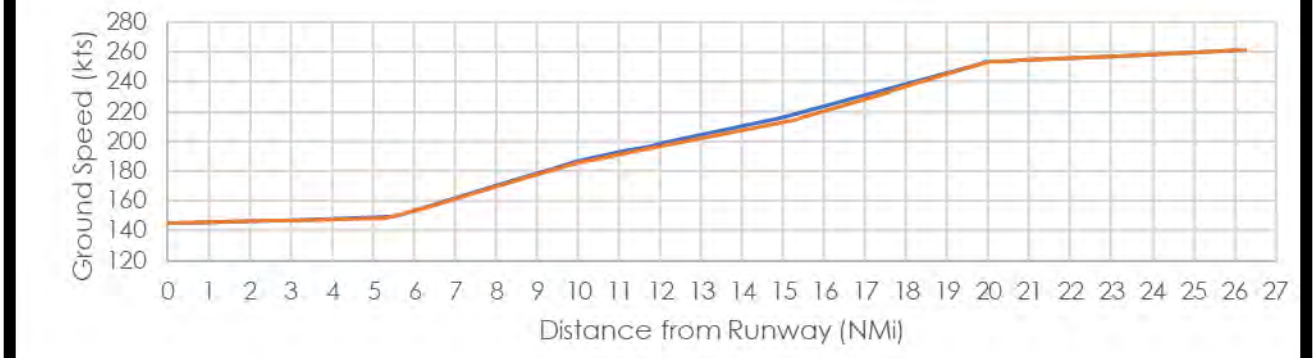


Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept



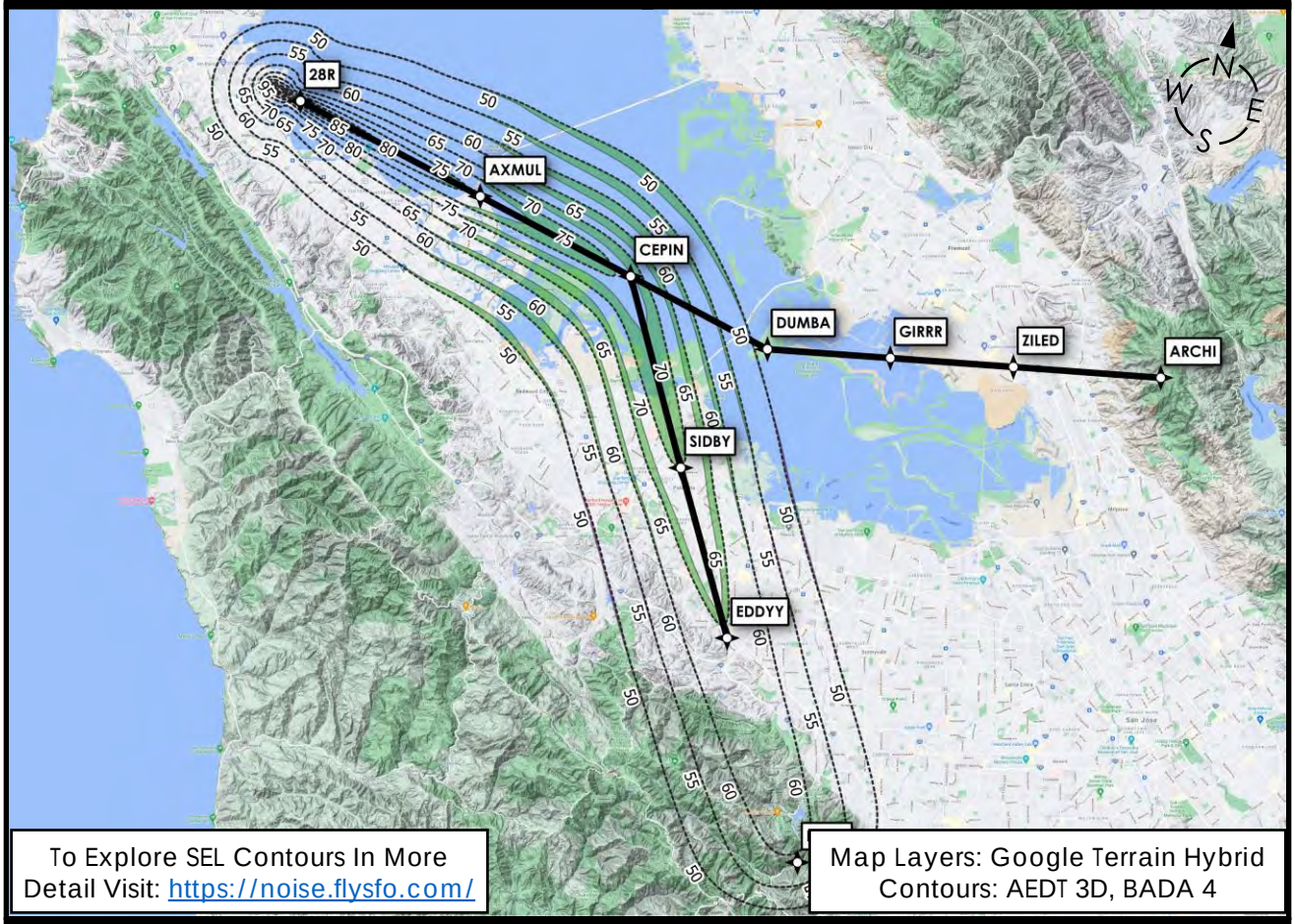




Narrowbody 2 SEL GLS-A RWY 28R

Revision 2

Changes: New



To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	64.71	64.57
SIDBY	4000	5100	69.9	67

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

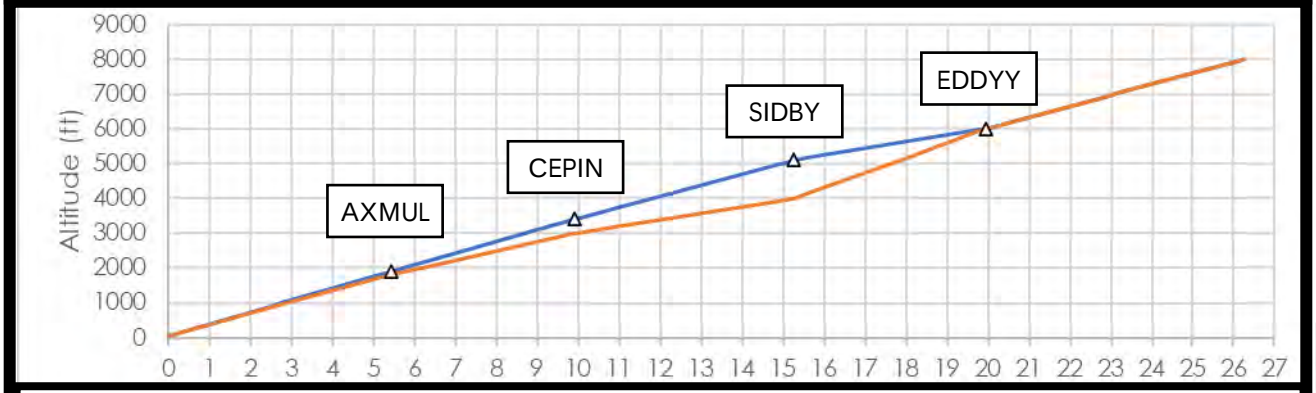
SEL Contour (dBA)	2010 Population
50	-2794
55	-3814
60	-5773
65	-23836
70	-16744
75	-1085
80	0
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Narrowbody 2 SEL GLS-A RWY 28R

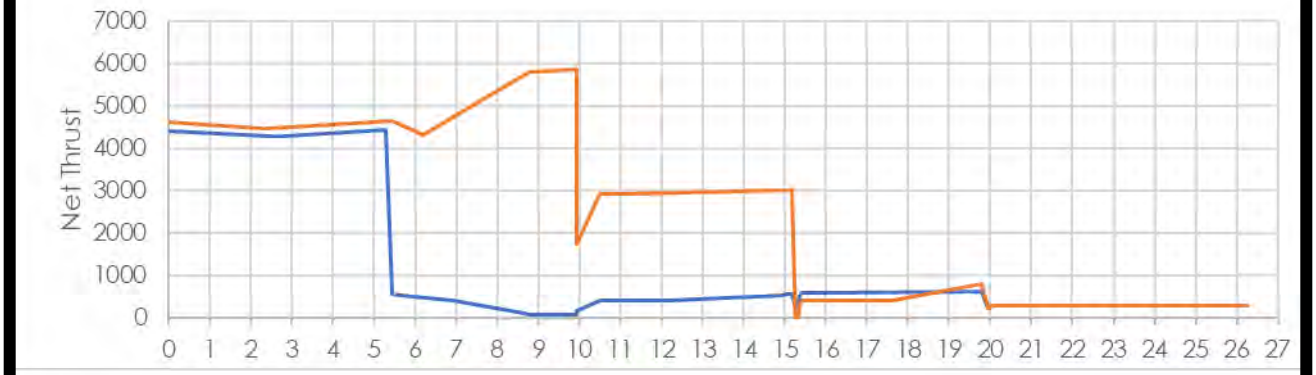
Revision 2

Changes: New



Simulated Flight Profile Characteristic for Existing Approach

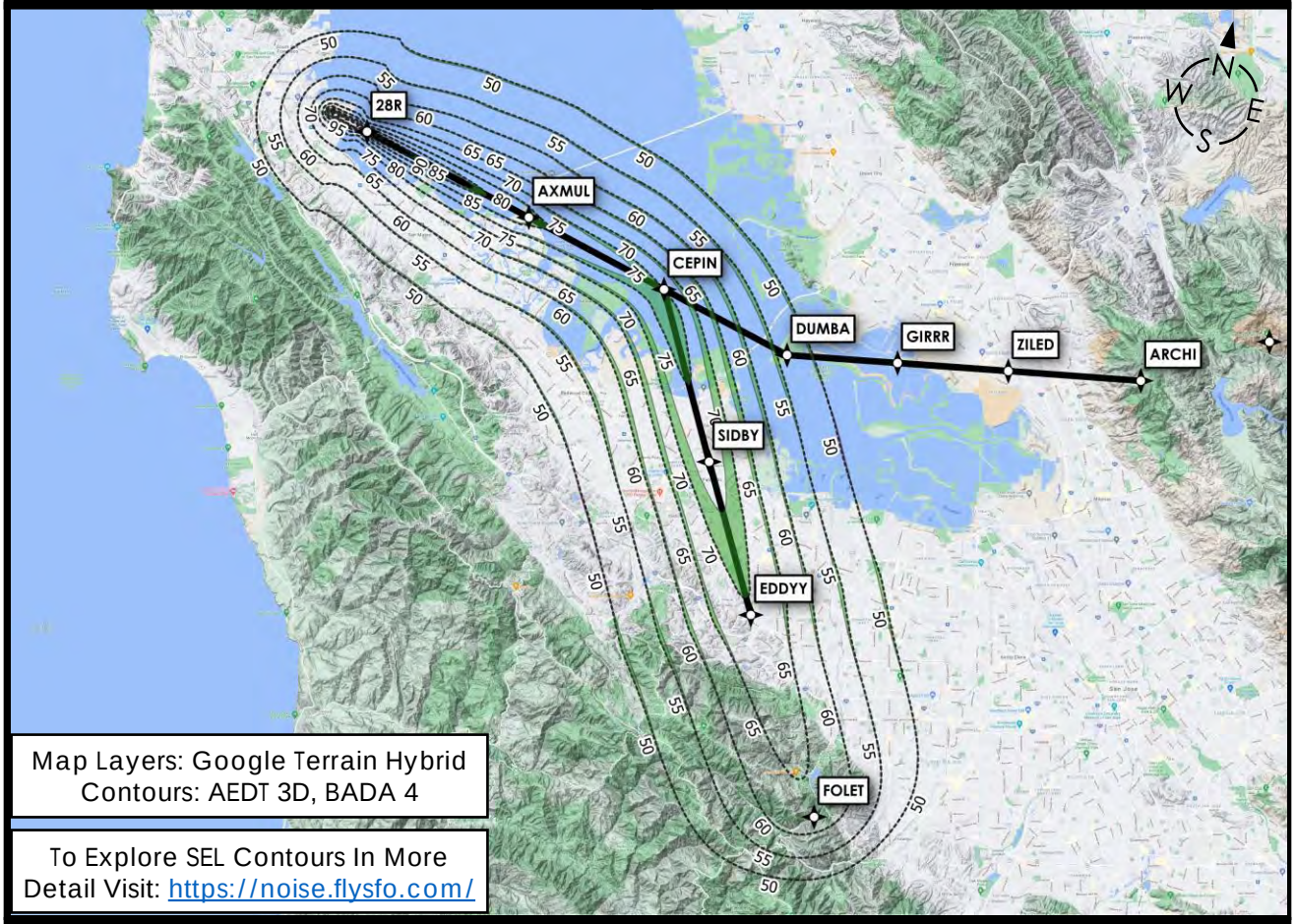
Simulated Flight Characteristic for Innovative Approach Concept



Widebody 1 SEL GLS-A RWY 28R

Revision 2

Changes: New



Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	69.42	68.51
SIDBY	4000	5100	73.73	70.88

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

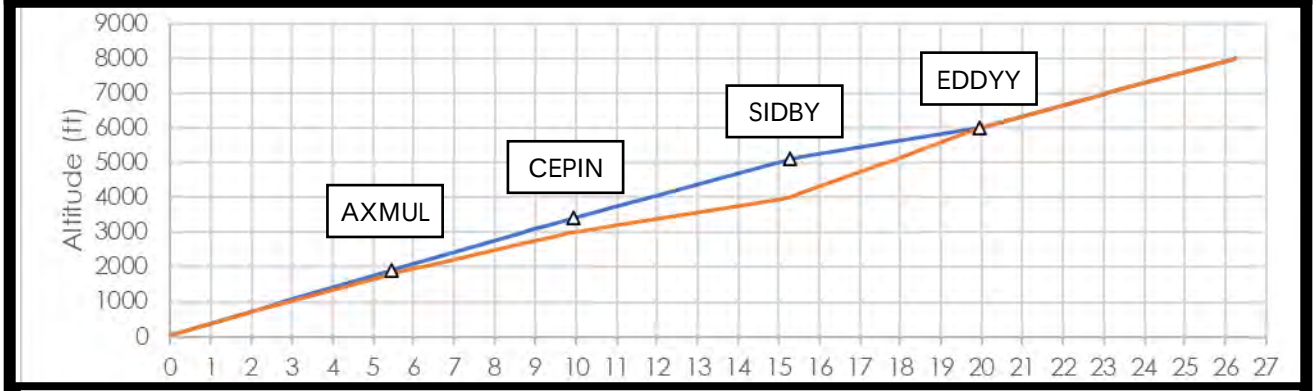
SEL Contour (dBA)	2010 Population
50	-5199
55	-8186
60	-8636
65	-9508
70	-41955
75	-375
80	-488
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Widebody 1 SEL GLS-A RWY 28R

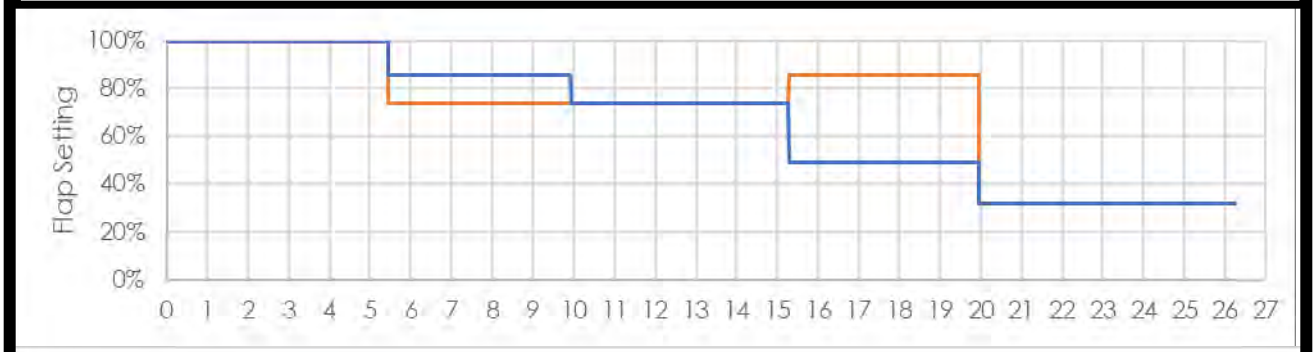
Revision 2

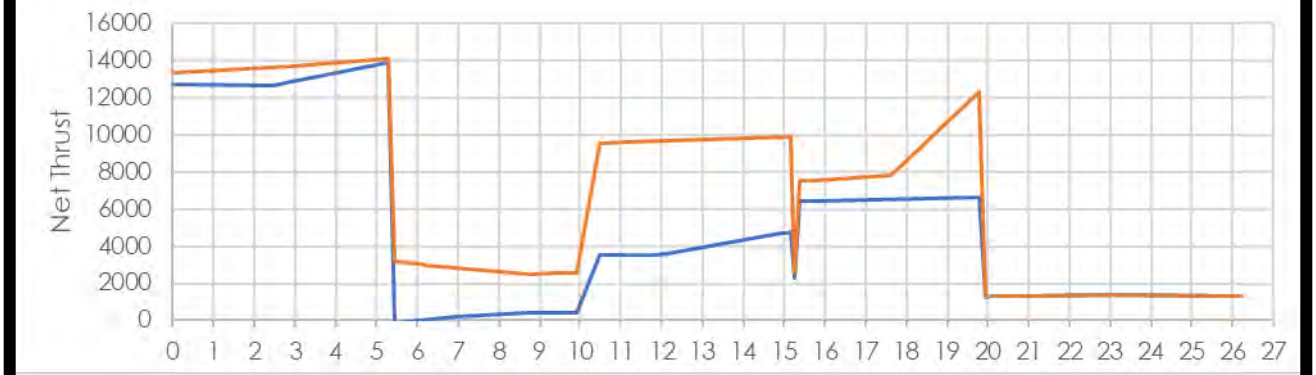
Changes: New

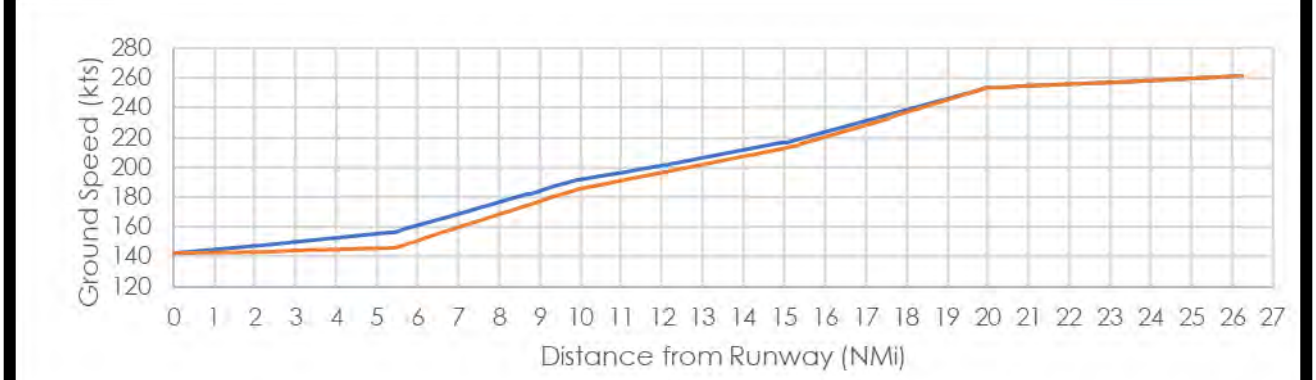


Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept



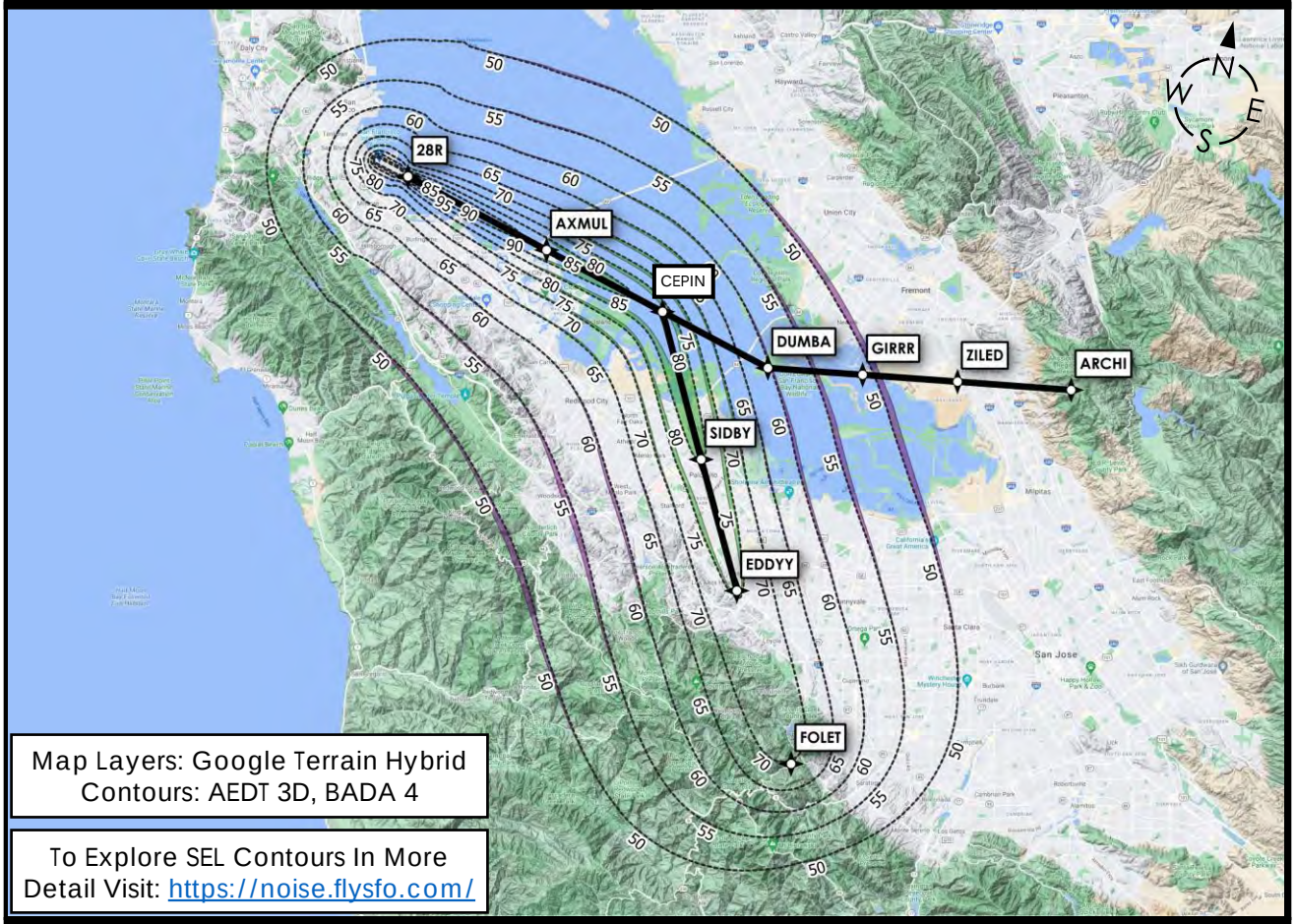




Widebody 2 SEL GLS-A RWY 28R

Revision 2

Changes: New



Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	75.18	75.07
SIDBY	4000	5100	80.05	77.57

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

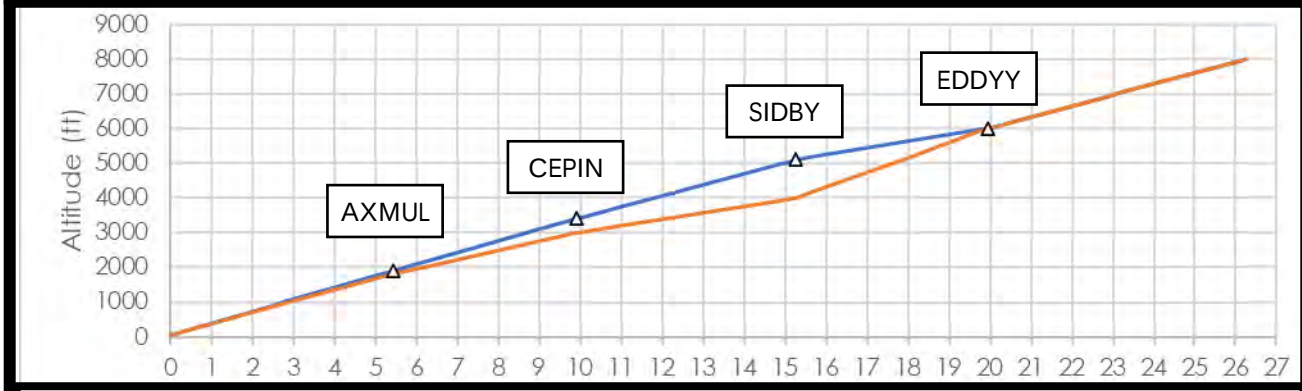
SEL Contour (dBA)	2010 Population
50	10166
55	4052
60	5850
65	1465
70	-1718
75	-14548
80	-16673
85	-768
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Widebody 2 SEL GLS-A RWY 28R

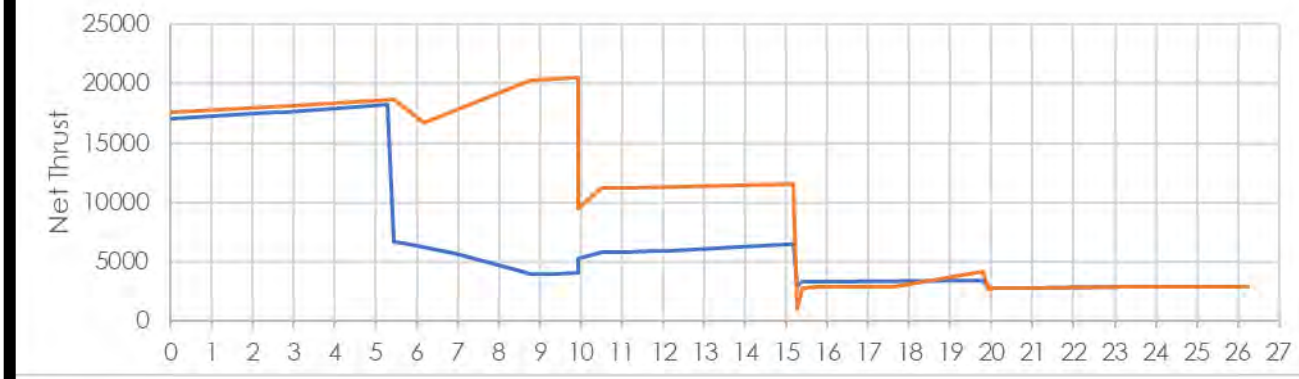
Revision 2

Changes: New



Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept



GLS-A RWY 28R (EDDYY)

Revision 2

Changes: Updated, Added Narrowbody 2

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - NARROWBODY 1

PROCEDURE: GLS A RWY 28R (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	ILS or LOC RWY 28R or RNAV (GPS) Z Rwy 28R	GLS A RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	255171	243071	-12100	
Population within 75 dB SEL contour	4273	4050	-223	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	4000	5100	1100	
SEL at Location EDDYY (dB)	67.11	66.77	-0.34	
SEL at Location SIDBY (dB)	73.4	69.15	-4.25	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	215	218	3	
Number of arrivals between 07:00 - 19:00	TBD	15 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - NARROWBODY 2

PROCEDURE: GLS A RWY 28R (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	ILS or LOC RWY 28R or RNAV (GPS) Z Rwy 28R	GLS A RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	190169	184396	-5773	
Population within 75 dB SEL contour	3464	2379	-1085	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	4000	5100	1100	
SEL at Location EDDYY (dB)	64.71	64.57	-0.14	
SEL at Location SIDBY (dB)	69.9	67	-2.9	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	224	216	-8	
Number of arrivals between 07:00 - 19:00	TBD	15 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

Disclaimer

The information provided in this CFPP is intended to assist members of the public to review the potential changes that might be experienced following the implementation of a proposed innovative approach procedure concept when compared to an existing instrument approach procedure.

All information contained in this presentation was prepared by the SFIA GBAS Project Team using industry best practices, insight provided by SFIA Flight Procedures Subcommittee participants and historical experience regarding flight operations into SFIA.

Information presented in this handout is a prediction of current and future aircraft operations and is subject to change. This includes potential changes in the number of aircraft and flight crews that can utilize GLS approaches, changes in air traffic control methods, changes in FAA instrument procedure design criteria, changes in the airspace surrounding SFO and other variables which may not have been modeled that can affect the potential altitude, flap, thrust, aerodynamic configuration and operating weight of the aircraft.

Any further regulatory review of these procedures, including assessment under the National Environmental Policy Act will require an independent noise analysis. The noise results presented in this document are for exploratory purposes only and rely on BADA4 aircraft performance inputs; which are restricted to research purposes only per the Eurocontrol and the FAA terms of use in AEDT.

GLS-A RWY 28R (EDDYY)

Revision 2

Changes: New

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - WIDEBODY 1

PROCEDURE: GLS A RWY 28R (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	ILS or LOC RWY 28R or RNAV (GPS) Z Rwy 28R	GLS A RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	295874	287260	-8614	
Population within 75 dB SEL contour	4639	4262	-377	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	4000	5100	1100	
SEL at Location EDDYY (dB)	69.42	68.51	-0.91	
SEL at Location SIDBY (dB)	73.73	70.88	-2.85	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	215	219	4	
Number of arrivals between 07:00 - 19:00	TBD	15 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - WIDEBODY 2

PROCEDURE: GLS A RWY 28R (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	ILS or LOC RWY 28R or RNAV (GPS) Z Rwy 28R	GLS A RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	562441	568291	5850	
Population within 75 dB SEL contour	105032	90464	-14568	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	4000	5100	1100	
SEL at Location EDDYY (dB)	75.18	75.07	-0.11	
SEL at Location SIDBY (dB)	80.05	77.57	-2.48	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	220	218	-2	
Number of arrivals between 07:00 - 19:00	TBD	15 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

Disclaimer

The information provided in this CFPP is intended to assist members of the public to review the potential changes that might be experienced following the implementation of a proposed innovative approach procedure concept when compared to an existing instrument approach procedure.

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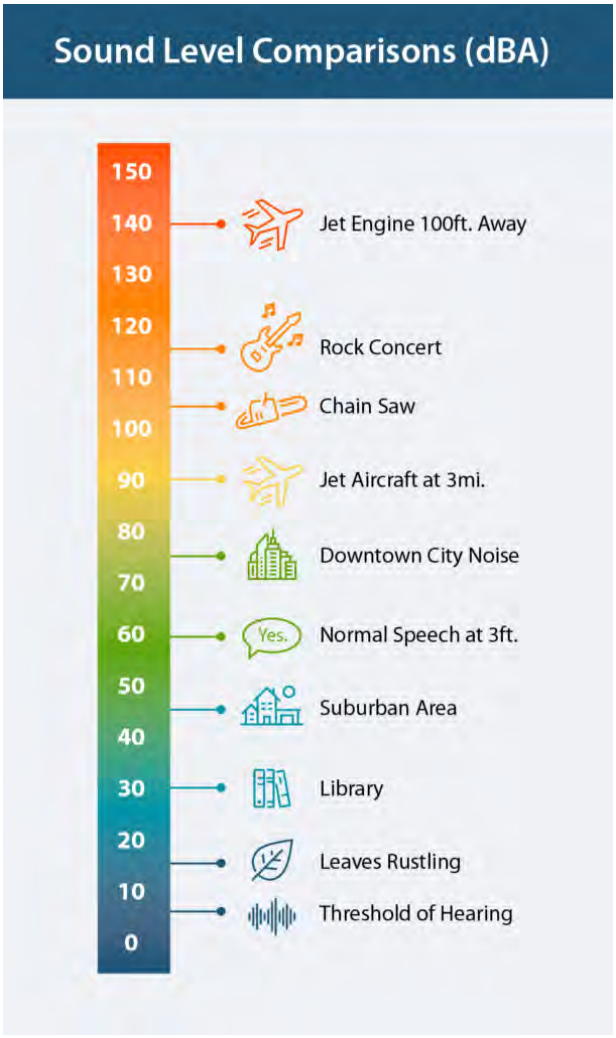
Information About SEL Contours

Revision 2

Changes: N/A

The Innovative Approach Evaluation Criteria, shown on the "Summary" page, use SEL 75 dB and 60 dB contours to compare the population counts impacted by each procedure. In reference to aircraft overflights, SEL is generally 10 dB above Lmax. The SEL 75 dB level was selected as part of the evaluation criteria due to its comparison to Lmax 65 dB, which is approximately the sound level of normal speech at a distance of 3 feet. The SEL 60 dB was selected due to its comparison to Lmax 50 dB, which is approximately the sound level of background noise at a quiet urban area.

Relative to sound level changes, an increase of 5 dBA is readily perceptible to the public and a 3 dBA increase is barely perceivable to the average healthy human ear.



Glossary

Revision 2

Changes: Updated

GBAS

Ground Based Augmentation System – A navigational aid, installed on the airport, that broadcasts a signal to aircraft that enhances ("augments") their existing GPS navigation capabilities enabling precision approaches to all runways at the airport.

GLS

GBAS Landing System (GLS) is the FAA's official term for a GBAS instrument approach procedure. A GLS approach is considered a "precision" approach procedure which means it provides precise navigational guidance similar to the Instrument Landing System (ILS) that have been used at SFO for over 50 years.

SEL

Sound Exposure Level – is a noise metric that represents all the acoustic energy (a.k.a. sound pressure) of an individual noise event as if that event had occurred within a one-second time period. SEL captures both the level (magnitude) and the duration of a sound event in a single numerical quantity, by "squeezing" all the noise energy from an event into one second. This provides a uniform way to make comparisons among noise events of various durations.

Lmax

Maximum Sound Level– is a noise metric that represents the maximum amount of acoustic energy (a.k.a. sound pressure) which occurs during an individual noise event regardless of its duration.

dB or dBA

Decibel (dB) or an "A-weighted" decibel - is the unit used to measure the intensity of a sound. The human ear hears sound pressures over a wide range. Decibels, which are measured on a logarithmic scale, correspond to the way our ears interpret sound pressures. The "A-weighted" scale most closely approximates the relative loudness of sounds in air as perceived by the human ear and provides a more useful way to evaluate the effect of noise exposure on humans by focusing on those parts of the frequency spectrum where we hear most. All noise results in this document use dBA.

MSL

Mean Sea Level (MSL), a tidal datum that is used to express geometric altitude above the earth. MSL references in this packet use imperial feet and can be thought of like a tapeline measurement from the ground to an object.

Glossary

Revision 2

Changes: Updated

ATC

Air Traffic Control, which represents a combination of human beings and technology responsible for aircraft separation from terrain, weather and other aircraft and aeronautical objects. At SFO, ATC is provided by a combination of individuals working locally in the tower and offsite with radar and voice communication capabilities.

Waypoint

Is a geographical location defined by a latitude/longitude geographic coordinate. These 5-letter waypoints, VHF intersections, 5-letter pronounceable DME fixes and 3-letter NAVAID IDs are published on various FAA aeronautical navigation products (IFR Enroute Charts, VFR charts, Terminal Procedures Publications, etc.).

RNAV or RNAV (GPS)

Area Navigation describes a navigation method used by aircraft which commonly utilize the Global Positioning System of satellites to determine information about their lateral position on earth. The GBAS sends an augmentation signal to aircraft using area navigation to increase the precision of the aircraft position, including additional information about the vertical location of the aircraft relative to the airport.

ILS

Instrument Landing System is the technology currently installed on 3 runways at SFO which sends an electronic signal along the final approach path which aircraft can detect and navigate within a fixed lateral and vertical corridor.

RWY

Abbreviation for runway.

Nmi

Nautical Mile – equal to 6,076 feet.

AEDT

Aviation Environmental Design Tool - AEDT is a software system that dynamically models aircraft performance in space and time to produce fuel burn, emissions and noise. Full flight gate-to-gate analyses are possible for study sizes ranging from a single flight at an airport to scenarios at the regional, national, and global levels.

Glossary

Revision 2

Changes: Updated

Waypoint

Is a geographical location defined by a latitude/longitude geographic coordinate. These 5-letter waypoints, VHF intersections, 5-letter pronounceable DME fixes and 3-letter NAVAID IDs are published on various FAA aeronautical navigation products (IFR Enroute Charts, VFR charts, Terminal Procedures Publications, etc.).

VFR

Visual Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is greater than 3,000 feet above ground level and the visibility is greater than five miles.

MVFR

Marginal Visual Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is between 1,000 - 3,000 feet above ground level and the visibility is between three and five miles.

IFR

Instrument Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is less than 1,000 feet above ground level and the visibility is less than three miles.

LIFR

Low Instrument Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is less than 500 feet above ground level and the visibility is less than 1/2 miles.

GLS-BVE RWY 28R (EDDYY)

Revision 1

Changes: New

San Francisco International Airport (SFO) has identified several Innovative Approach (IA) procedures primarily designed for noise reduction. Each procedure is described in a Community Flight Procedure Package (CFPP) that provides information about the IA and compares aircraft noise and flight performance of the IA to a comparable existing procedure if applicable. Please note that 1) IA procedure design is limited to be within approximately 20 nautical miles (nm) from the airport, 2) the maximum expected number of arrivals to use an IA procedure is 30 per day, and 3) the estimated noise reduction – although small or imperceptible in some areas – is part of an incremental noise reduction process that begins with demonstrating procedure design viability with the objective to achieve significant noise reduction in the future.

The CFPP includes the following pages of information:

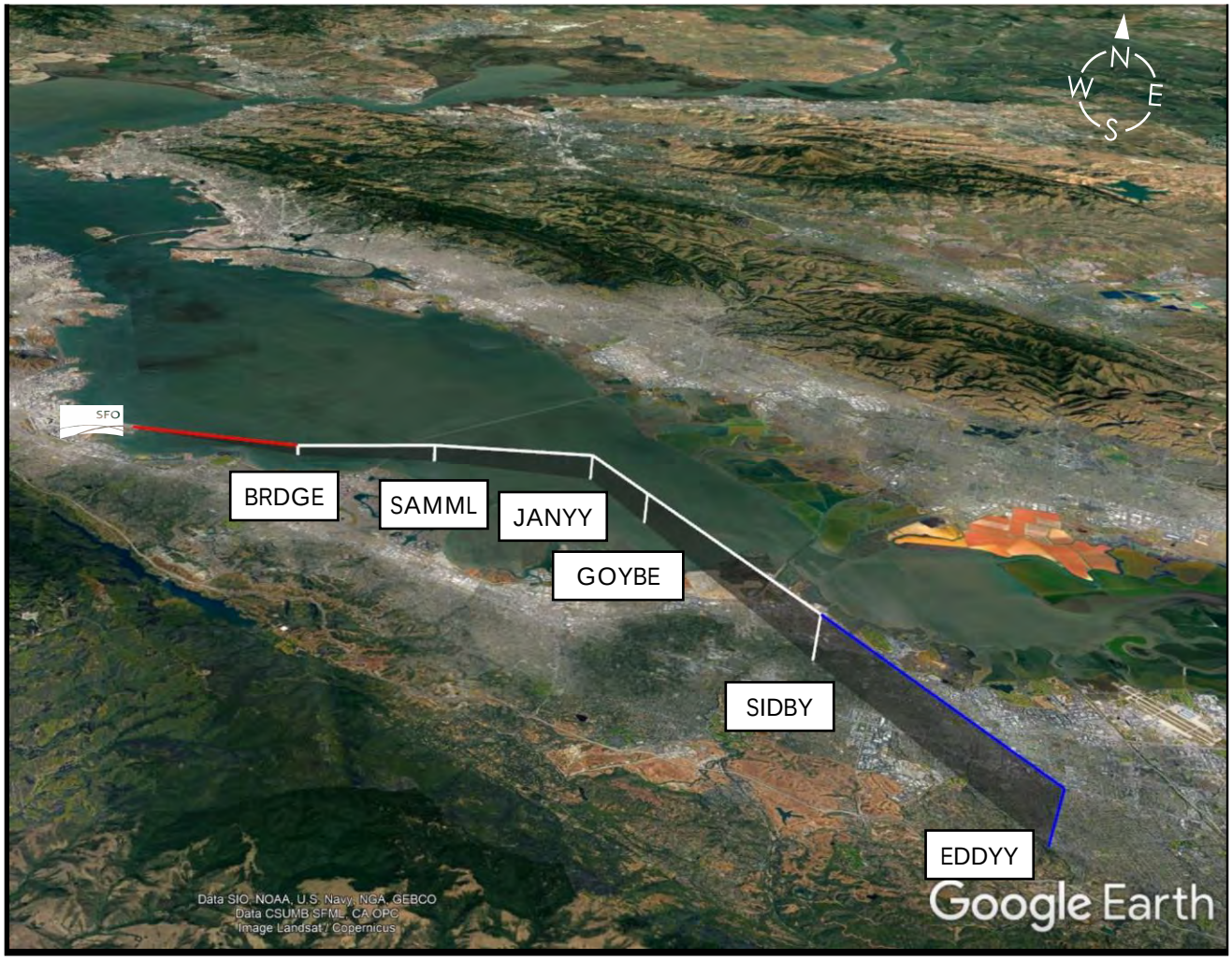
- Page 1 includes the name and description of the IA, a map of the IA flight path, and the project goals being met by the procedure. The altitudes shown along the flight path indicate the change in altitude on the IA flight path compared to the existing procedure.
- Page 2 compares the navigational charts of the existing approach procedure and the proposed IA, the percentage of aircraft at SFO that are currently capable of using the IA, and the types of weather and visibility conditions in which the IA could be used.
- Pages 3, 5, 7, and 9 include maps that illustrate the waypoints, flight path, and Sound Exposure Level (SEL) contours of the existing and IA procedures for two Narrowbody and two Widebody aircraft. The pages also list the altitude and SEL changes at sample points, and the potential changes in population impacted by the implementation of the IA. Please note that 1) aircraft noise levels below 60 decibels (dB) may be similar to urban ambient noise, and 2) changes in noise levels below 3 dB are generally not perceptible by the human ear. Therefore, the population within an area illustrated as a noise increase may not notice the actual noise increase.
- Pages 4, 6, 8, and 10 show graphs that compare how altitude, flap settings, net thrust, and ground speed change during the flights of the existing approach procedure and the proposed IA. This data was used in the FAA Aviation Environmental Design Tool (AEDT 3d) noise model to calculate the SEL information shown on pages 3, 5, 7 and 9 and reflects the project team's best efforts to model how each of the aircraft would fly the IA without using aerodynamic braking.
- Pages 11 and 12 show comparisons of the existing procedure to the IA relative to evaluation criteria for Narrowbody and Widebody aircraft.

The remaining pages describe information about noise exposure and terms used throughout the CFPP.

GLS-BVE RWY 28R (EDDYY)

Revision 1

Changes: New



GLS Instrument approach to runway 28R originating southeast of the airport, starting at EDDYY.

This approach is an identical overlay of the existing FMS Bridge Visual approach, in use today, under VFR conditions. The FMS Bridge Visual is a 3rd party (airline) created and maintained procedure and this concept would convert it into a public GLS approach procedure.

Project Goals

- ✓ Noise reduction
- ✓ ILS Redundancy
- ✓ Efficiency
- ✓ Reduce Delays

GLS-BVE RWY 28R (EDDYY)

Revision 1

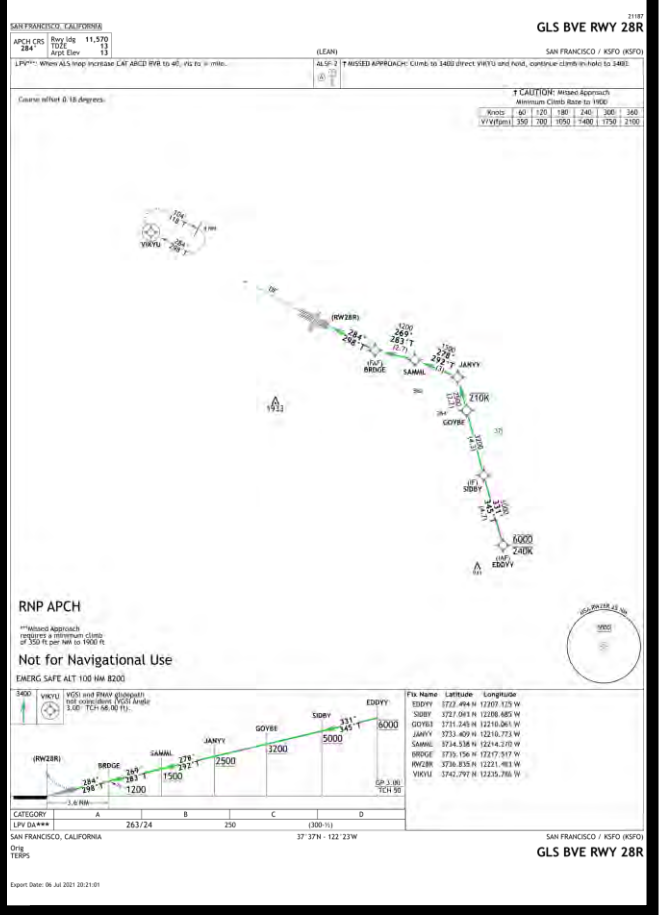
Changes: New

Existing Approach
FMS Bridge Visual RWY 28R

Existing FMS Bridge Visual approach is not maintained by FAA and must be requested by 14 CFR Part 121 or 129 aircraft operators in coordination with the lead air carrier.

Flight inspection graphics provided in all CFPPs are not suitable for navigation.

Preliminary Concept
GLS-BVE RWY 28R



Aircraft @ SFO Capable of Using This Procedure


Regional/BizJet < 1%


Narrowbody ~ 30%

Widebody ~ 30%

Narrowbody and widebody aircraft capable of using this approach into SFO are anticipated to increase over the next 5 years.

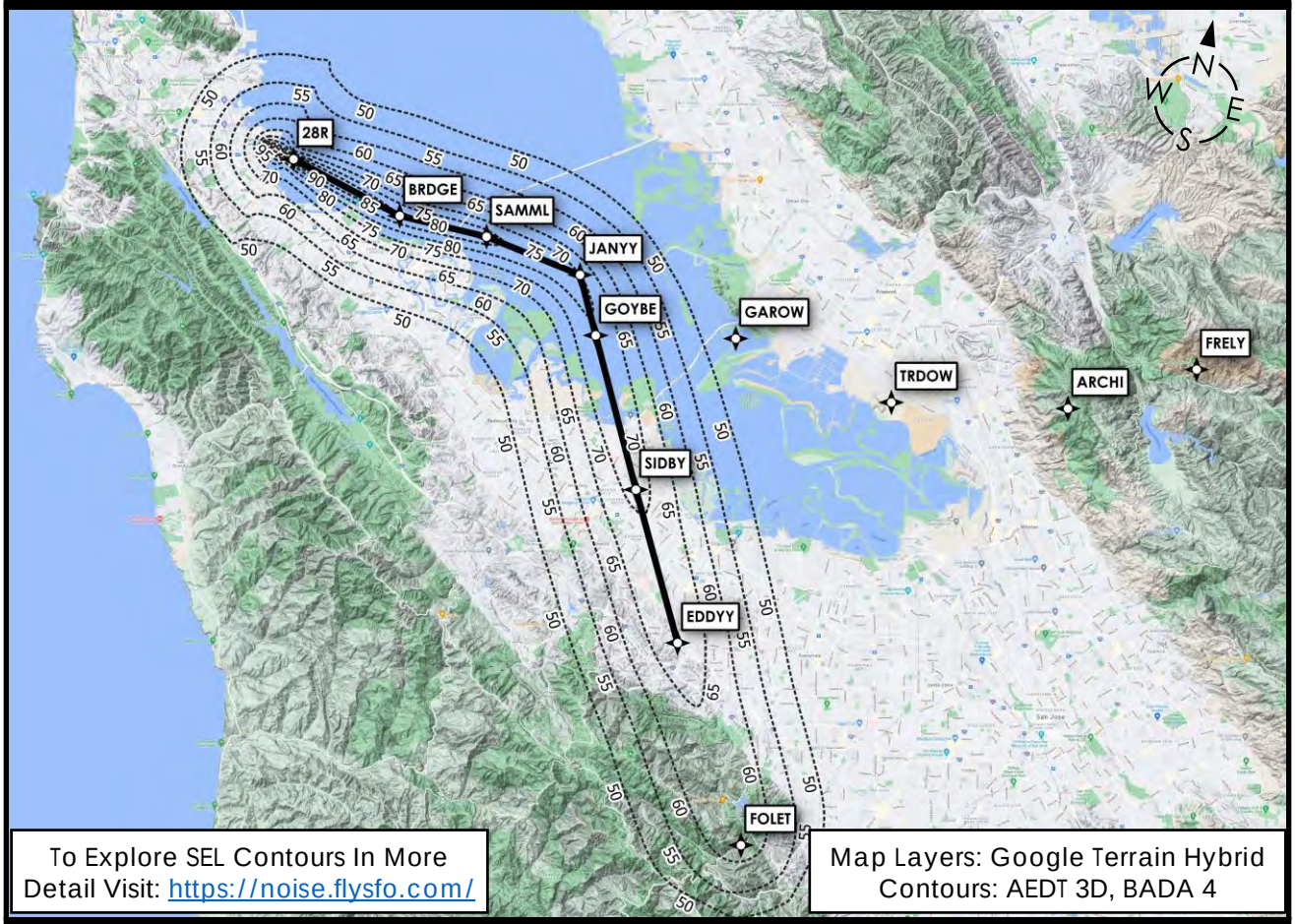
Weather Opportunity

VFR	✓	Day/Night Use
MVFR	✓	Day/Night Use
IFR	⊘	
LIFR	⊘	

Narrowbody 1 SEL GLS-BVE RWY 28R

Revision 1

Changes: New



To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	66.94	66.94
SIDBY	5000	5000	70.34	70.34

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

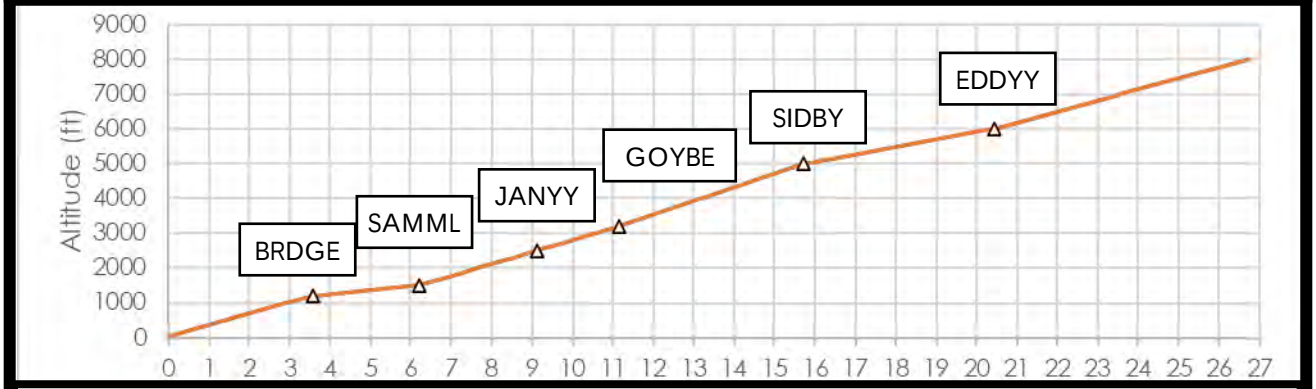
SEL Contour (dBA)	2010 Population
50	0
55	0
60	0
65	0
70	0
75	0
80	0
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Narrowbody 1 SEL GLS-BVE RWY 28R

Revision 1

Changes: New



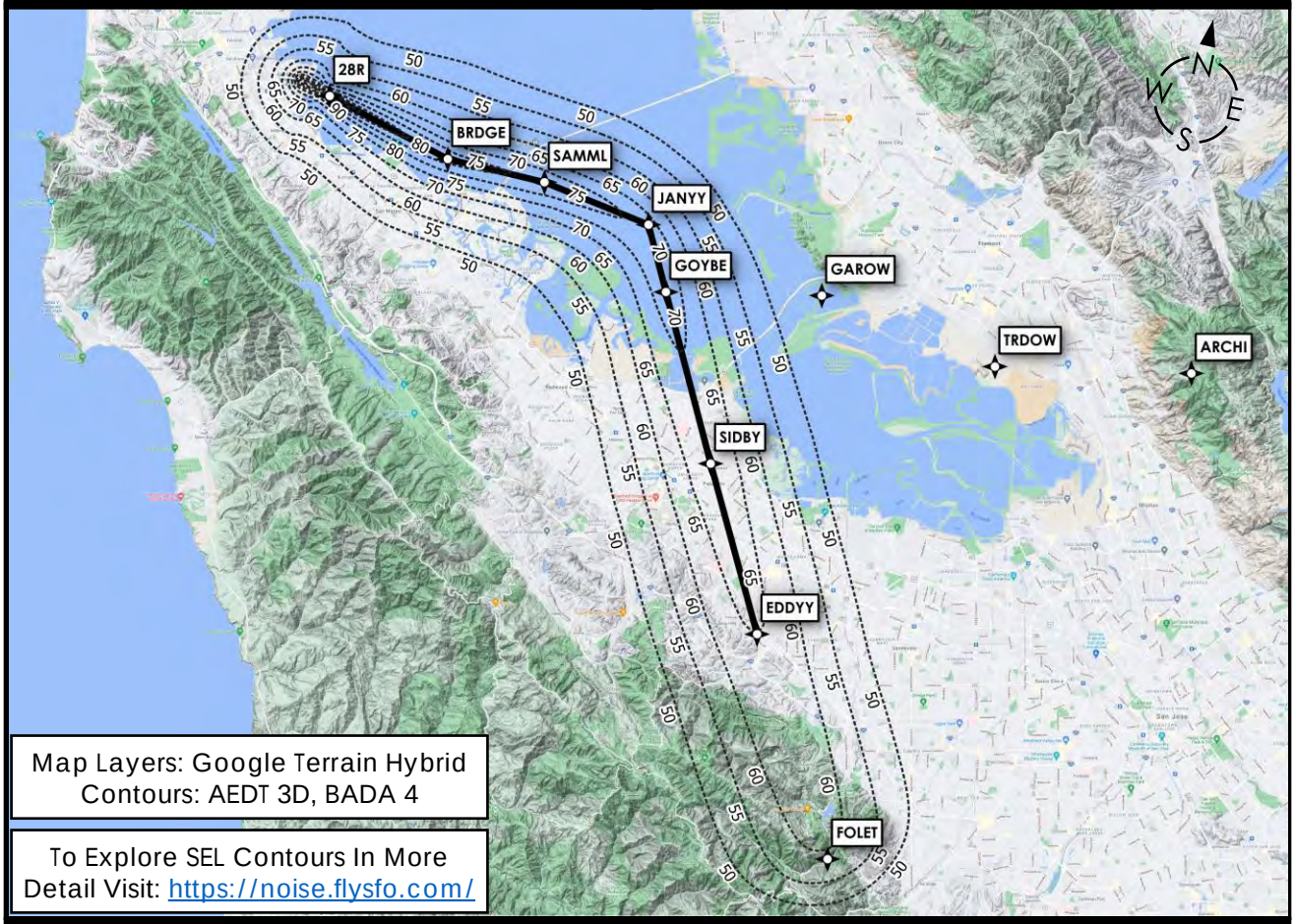
Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept

Narrowbody 2 SEL GLS-BVE RWY 28R

Revision 1

Changes: New



Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	64.91	64.91
SIDBY	5000	5000	67.32	67.32

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

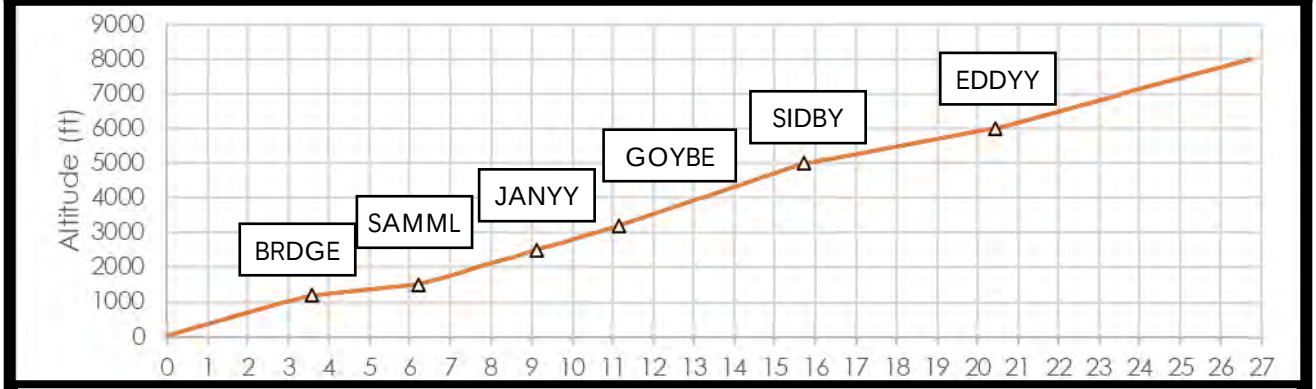
SEL Contour (dBA)	2010 Population
50	0
55	0
60	0
65	0
70	0
75	0
80	0
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Narrowbody 2 SEL GLS-BVE RWY 28R

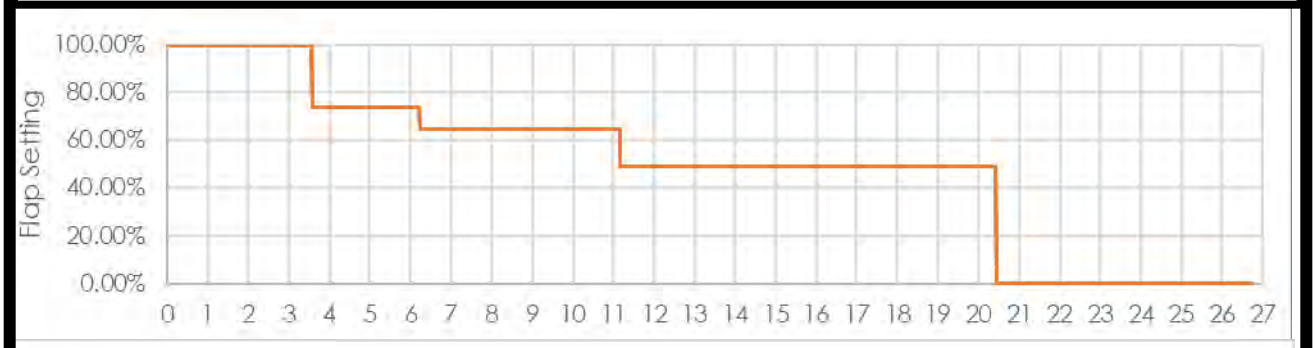
Revision 1

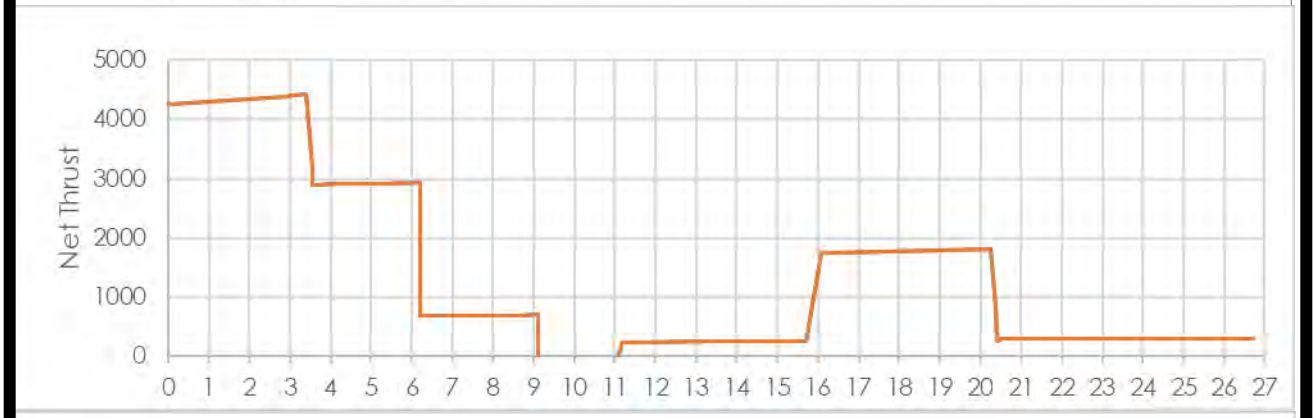
Changes: New



Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept

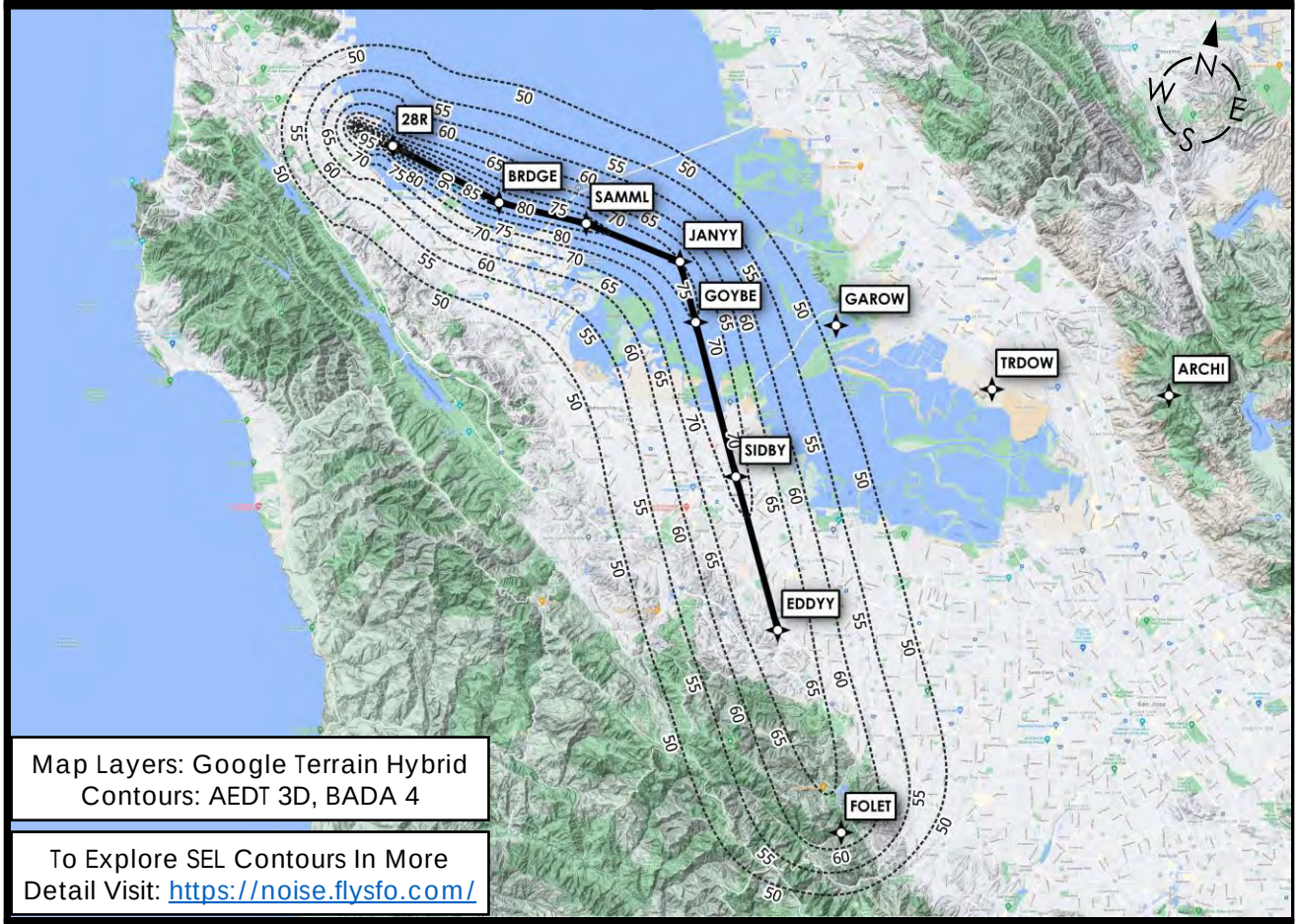




Widebody 1 SEL GLS-BVE RWY 28R

Revision 1

Changes: New



Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	68.31	68.31
SIDBY	5000	5000	70.62	70.62

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

SEL Contour (dBA)	2010 Population
50	0
55	0
60	0
65	0
70	0
75	0
80	0
85	0
90	0
95	0

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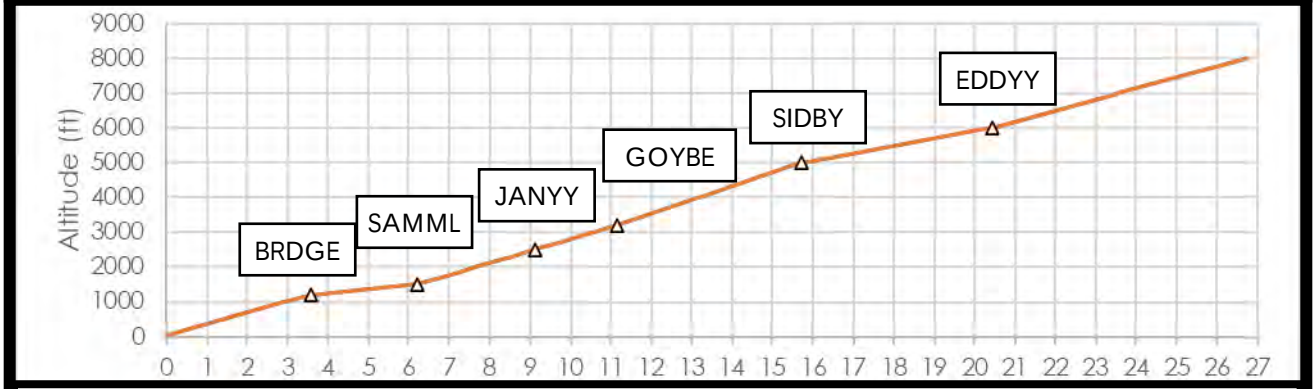
Widebody 1 SEL GLS-BVE RWY 28R

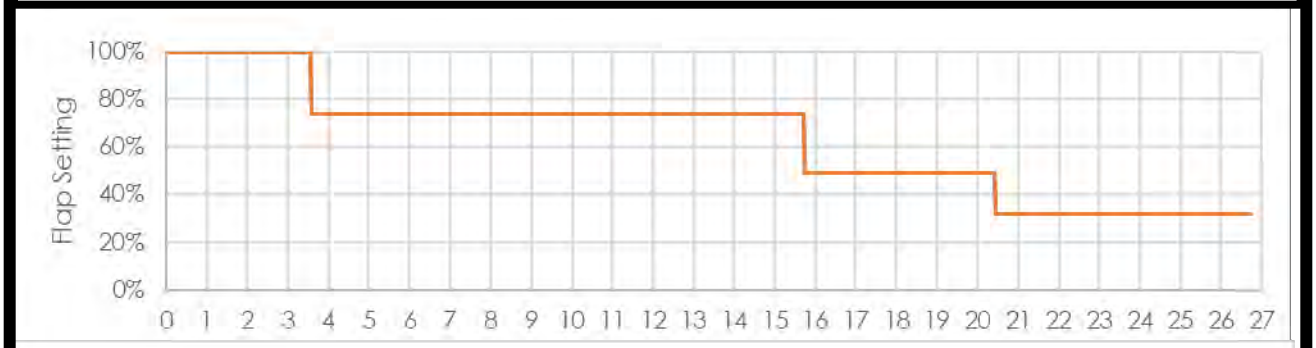
Revision 1

Changes: New



Simulated Flight Profile Characteristic for Existing Approach

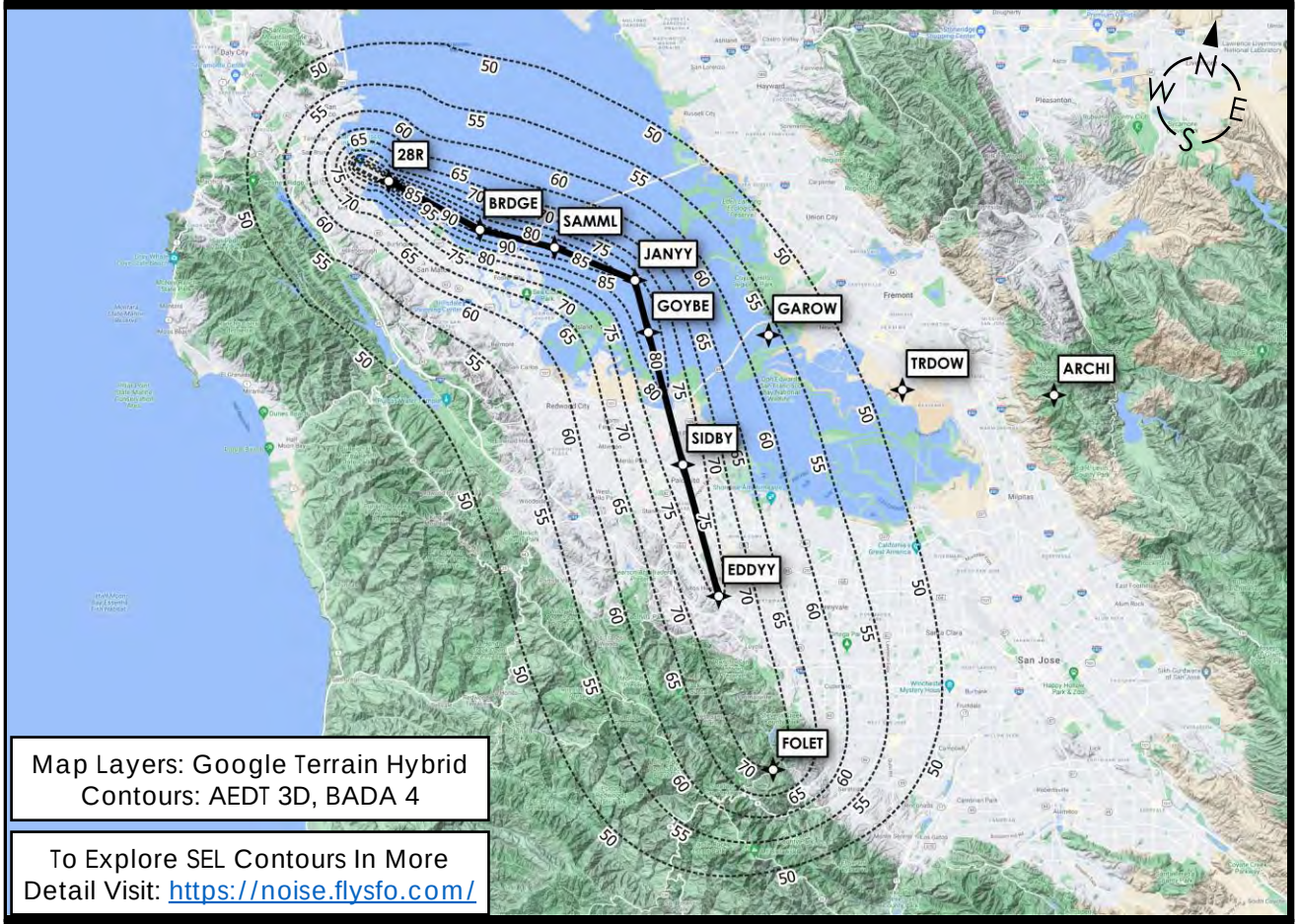
Simulated Flight Characteristic for Innovative Approach Concept



Widebody 2 SEL GLS-BVE RWY 28R

Revision 1

Changes: New



Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

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Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	75.08	75.08
SIDBY	5000	5000	77.64	77.64

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

SEL Contour (dBA)	2010 Population
50	0
55	0
60	0
65	0
70	0
75	0
80	0
85	0
90	0
95	0

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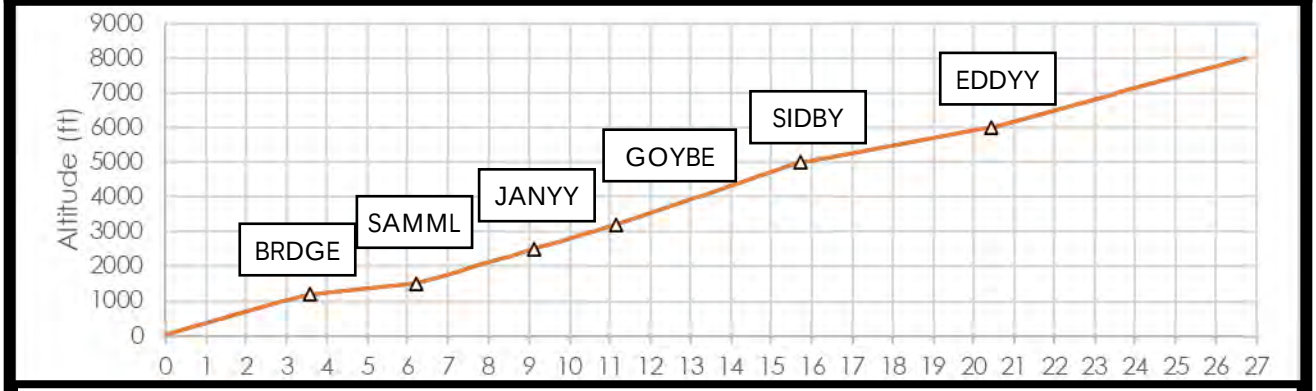
Widebody 2 SEL GLS-BVE RWY 28R

Revision 1

Changes: New



Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept

GLS BVE RWY 28R (EDDYY)

Revision 1

Changes: New

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - NARROWBODY 1

PROCEDURE: GLS BVE RWY 28R (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	RNAV (RNP) Y Rwy 28R	GLS R RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	230091	230091	0	
Population within 75 dB SEL contour	83	83	0	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	5000	5000	0	
SEL at Location EDDYY (dB)	66.94	66.94	0	
SEL at Location SIDBY (dB)	70.34	70.34	0	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	207	207	0	
Number of arrivals between 07:00 - 19:00	TBD	30 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - NARROWBODY 2

PROCEDURE: GLS BVE RWY 28R (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	RNAV (RNP) Y Rwy 28R	GLS R RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	171542	171542	0	
Population within 75 dB SEL contour	32	32	0	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	5000	5000	0	
SEL at Location EDDYY (dB)	64.91	64.91	0	
SEL at Location SIDBY (dB)	67.32	67.32	0	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	207	207	0	
Number of arrivals between 07:00 - 19:00	TBD	30 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

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GLS BVE RWY 28R (EDDYY)

Revision 1

Changes: New

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - WIDEBODY 1

PROCEDURE: GLS BVE RWY 28R (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	RNAV (RNP) Y Rwy 28R	GLS R RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	262109	262109	0	
Population within 75 dB SEL contour	137	137	0	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	5000	5000	0	
SEL at Location EDDYY (dB)	68.31	68.31	0	
SEL at Location SIDBY (dB)	70.62	70.62	0	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	207	207	0	
Number of arrivals between 07:00 - 19:00	TBD	30 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - WIDEBODY 2

PROCEDURE: GLS BVE RWY 28R (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	RNAV (RNP) Y Rwy 28R	GLS R RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	540479	540479	0	
Population within 75 dB SEL contour	81588	81588	0	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	5000	5000	0	
SEL at Location EDDYY (dB)	75.08	75.08	0	
SEL at Location SIDBY (dB)	77.64	77.64	0	
Speed at Location EDDYY (knts)	254	254	0	
Speed at Location SIDBY (knts)	212	212	0	
Number of arrivals between 07:00 - 19:00	TBD	30 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

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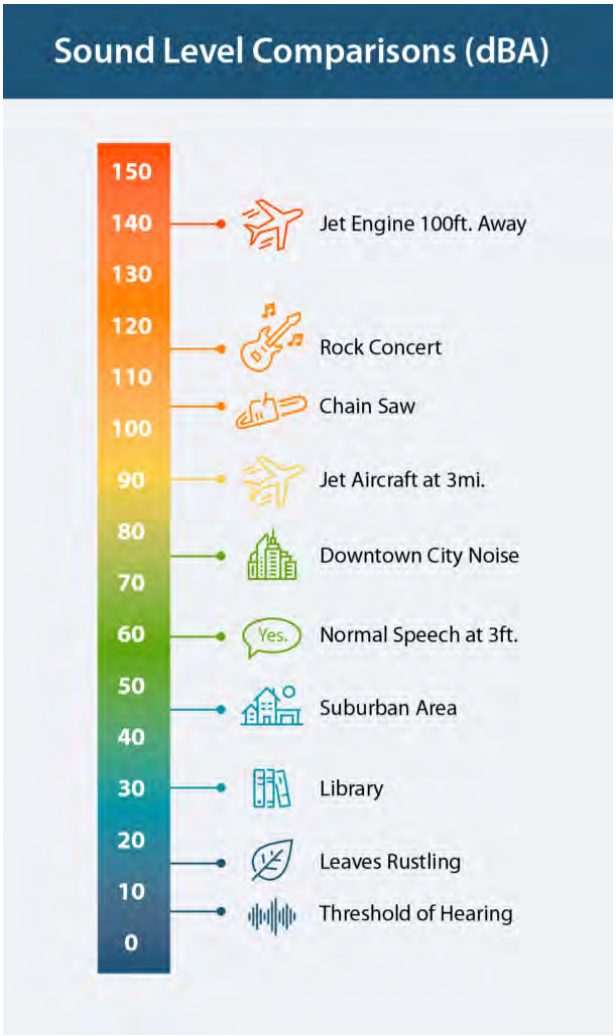
Information About SEL Contours

Revision 1

Changes: N/A

The Innovative Approach Evaluation Criteria, shown on the "Summary" page, use SEL 75 dB and 60 dB contours to compare the population counts impacted by each procedure. In reference to aircraft overflights, SEL is generally 10 dB above Lmax. The SEL 75 dB level was selected as part of the evaluation criteria due to its comparison to Lmax 65 dB, which is approximately the sound level of normal speech at a distance of 3 feet. The SEL 60 dB was selected due to its comparison to Lmax 50 dB, which is approximately the sound level of background noise at a quiet urban area.

Relative to sound level changes, an increase of 5 dBA is readily perceptible to the public and a 3 dBA increase is barely perceivable to the average healthy human ear.



Glossary

Revision 1

Changes: Updated

GBAS

Ground Based Augmentation System – A navigational aid, installed on the airport, that broadcasts a signal to aircraft that enhances ("augments") their existing GPS navigation capabilities enabling precision approaches to all runways at the airport.

GLS

GBAS Landing System (GLS) is the FAA's official term for a GBAS instrument approach procedure. A GLS approach is considered a "precision" approach procedure which means it provides precise navigational guidance similar to the Instrument Landing System (ILS) that have been used at SFO for over 50 years.

SEL

Sound Exposure Level – is a noise metric that represents all the acoustic energy (a.k.a. sound pressure) of an individual noise event as if that event had occurred within a one-second time period. SEL captures both the level (magnitude) and the duration of a sound event in a single numerical quantity, by "squeezing" all the noise energy from an event into one second. This provides a uniform way to make comparisons among noise events of various durations.

Lmax

Maximum Sound Level– is a noise metric that represents the maximum amount of acoustic energy (a.k.a. sound pressure) which occurs during an individual noise event regardless of its duration.

dB or dBA

Decibel (dB) or an "A-weighted" decibel - is the unit used to measure the intensity of a sound. The human ear hears sound pressures over a wide range. Decibels, which are measured on a logarithmic scale, correspond to the way our ears interpret sound pressures. The "A-weighted" scale most closely approximates the relative loudness of sounds in air as perceived by the human ear and provides a more useful way to evaluate the effect of noise exposure on humans by focusing on those parts of the frequency spectrum where we hear most. All noise results in this document use dBA.

MSL

Mean Sea Level (MSL), a tidal datum that is used to express geometric altitude above the earth. MSL references in this packet use imperial feet and can be thought of like a tapeline measurement from the ground to an object.

Glossary

Revision 1

Changes: Updated

ATC

Air Traffic Control, which represents a combination of human beings and technology responsible for aircraft separation from terrain, weather and other aircraft and aeronautical objects. At SFO, ATC is provided by a combination of individuals working locally in the tower and offsite with radar and voice communication capabilities.

Waypoint

Is a geographical location defined by a latitude/longitude geographic coordinate. These 5-letter waypoints, VHF intersections, 5-letter pronounceable DME fixes and 3-letter NAVAID IDs are published on various FAA aeronautical navigation products (IFR Enroute Charts, VFR charts, Terminal Procedures Publications, etc.).

RNAV or RNAV (GPS)

Area Navigation describes a navigation method used by aircraft which commonly utilize the Global Positioning System of satellites to determine information about their lateral position on earth. The GBAS sends an augmentation signal to aircraft using area navigation to increase the precision of the aircraft position, including additional information about the vertical location of the aircraft relative to the airport.

ILS

Instrument Landing System is the technology currently installed on 3 runways at SFO which sends an electronic signal along the final approach path which aircraft can detect and navigate within a fixed lateral and vertical corridor.

RWY

Abbreviation for runway.

Nmi

Nautical Mile – equal to 6,076 feet.

AEDT

Aviation Environmental Design Tool - AEDT is a software system that dynamically models aircraft performance in space and time to produce fuel burn, emissions and noise. Full flight gate-to-gate analyses are possible for study sizes ranging from a single flight at an airport to scenarios at the regional, national, and global levels.

Glossary

Revision 1

Changes: Updated

Waypoint

Is a geographical location defined by a latitude/longitude geographic coordinate. These 5-letter waypoints, VHF intersections, 5-letter pronounceable DME fixes and 3-letter NAVAID IDs are published on various FAA aeronautical navigation products (IFR Enroute Charts, VFR charts, Terminal Procedures Publications, etc.).

VFR

Visual Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is greater than 3,000 feet above ground level and the visibility is greater than five miles.

MVFR

Marginal Visual Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is between 1,000 - 3,000 feet above ground level and the visibility is between three and five miles.

IFR

Instrument Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is less than 1,000 feet above ground level and the visibility is less than three miles.

LIFR

Low Instrument Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is less than 500 feet above ground level and the visibility is less than 1/2 miles..

GLS-DB RWY 28R (DBAYY)

Revision 1

Changes: New

San Francisco International Airport (SFO) has identified several Innovative Approach (IA) procedures primarily designed for noise reduction. Each procedure is described in a Community Flight Procedure Package (CFPP) that provides information about the IA and compares aircraft noise and flight performance of the IA to a comparable existing procedure if applicable. Please note that 1) IA procedure design is limited to be within approximately 20 nautical miles (nm) from the airport, 2) the maximum expected number of arrivals to use an IA procedure is 30 per day, and 3) the estimated noise reduction – although small or imperceptible in some areas – is part of an incremental noise reduction process that begins with demonstrating procedure design viability with the objective to achieve significant noise reduction in the future.

The CFPP includes the following pages of information:

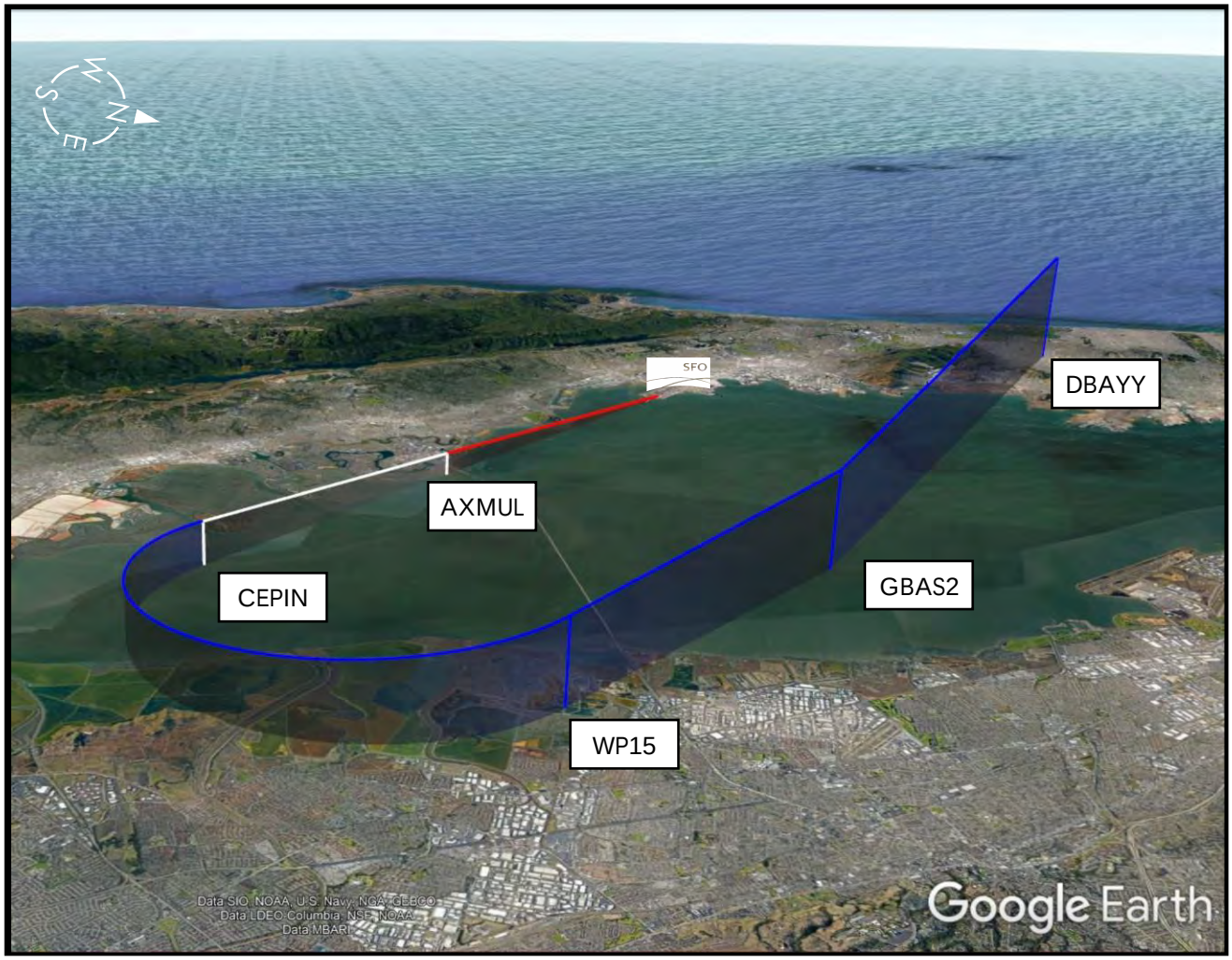
- Page 1 includes the name and description of the IA, a map of the IA flight path, and the project goals being met by the procedure. The altitudes shown along the flight path indicate the change in altitude on the IA flight path compared to the existing procedure.
- Page 2 compares the navigational charts of the existing approach procedure and the proposed IA, the percentage of aircraft at SFO that are currently capable of using the IA, and the types of weather and visibility conditions in which the IA could be used.
- Pages 3, 5, 7, and 9 include maps that illustrate the waypoints, flight path, and Sound Exposure Level (SEL) contours of the existing and IA procedures for two Narrowbody and two Widebody aircraft. The pages also list the altitude and SEL changes at sample points, and the potential changes in population impacted by the implementation of the IA. Please note that 1) aircraft noise levels below 60 decibels (dB) may be similar to urban ambient noise, and 2) changes in noise levels below 3 dB are generally not perceptible by the human ear. Therefore, the population within an area illustrated as a noise increase may not notice the actual noise increase.
- Pages 4, 6, 8, and 10 show graphs that compare how altitude, flap settings, net thrust, and ground speed change during the flights of the existing approach procedure and the proposed IA. This data was used in the FAA Aviation Environmental Design Tool (AEDT 3d) noise model to calculate the SEL information shown on pages 3, 5, 7 and 9 and reflects the project team's best efforts to model how each of the aircraft would fly the IA without using aerodynamic braking.
- Pages 11 and 12 show comparisons of the existing procedure to the IA relative to evaluation criteria for Narrowbody and Widebody aircraft.

The remaining pages describe information about noise exposure and terms used throughout the CFPP.

GLS-DB RWY 28R (DBAYY)

Revision 1

Changes: New



GLS Instrument approach to runway 28R originating northwest of the airport, starting at a new waypoint DBAYY at 11,000ft above sea level.

The approach is similar to an existing series of vectors issued by ATC which connect aircraft arriving from the North to the existing RNAV (GPS) Y Rwy 28R approach at CEPIN. This approach is identical to the GLS-A between CEPIN and Rwy 28R.

Project Goals

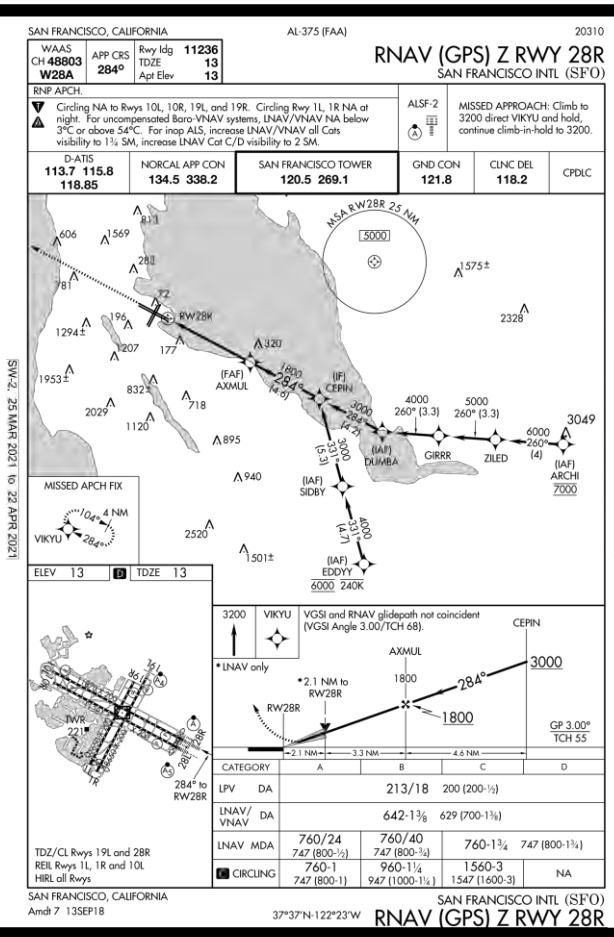
- ✓ Noise reduction
- ✓ ILS Redundancy
- ✓ Efficiency
- ✓ Reduce Delays

GLS-DB RWY 28R (DBAYY)

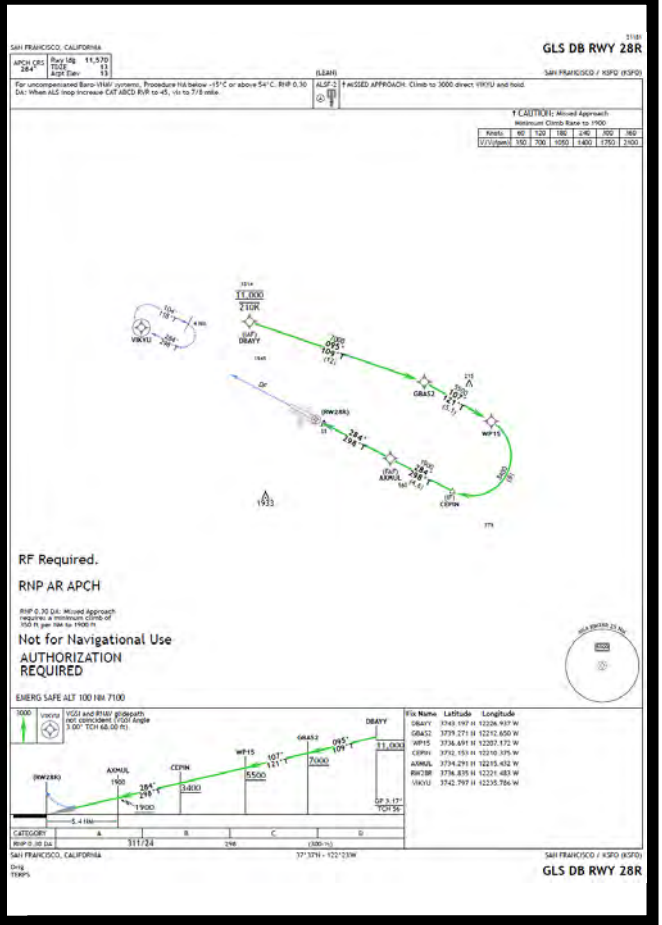
Revision 1

Changes: New

Existing Approach
RNAV (GPS) Z Rwy 28R



Preliminary Concept
GLS-DB RWY 28R



Aircraft @ SFO Capable of Using This Procedure

Regional/BizJet < 1%

Narrowbody ~ 30%

Widebody ~ 30%

Narrowbody and widebody aircraft capable of using this approach into SFO are anticipated to <u>increase</u> over the next 5 years.

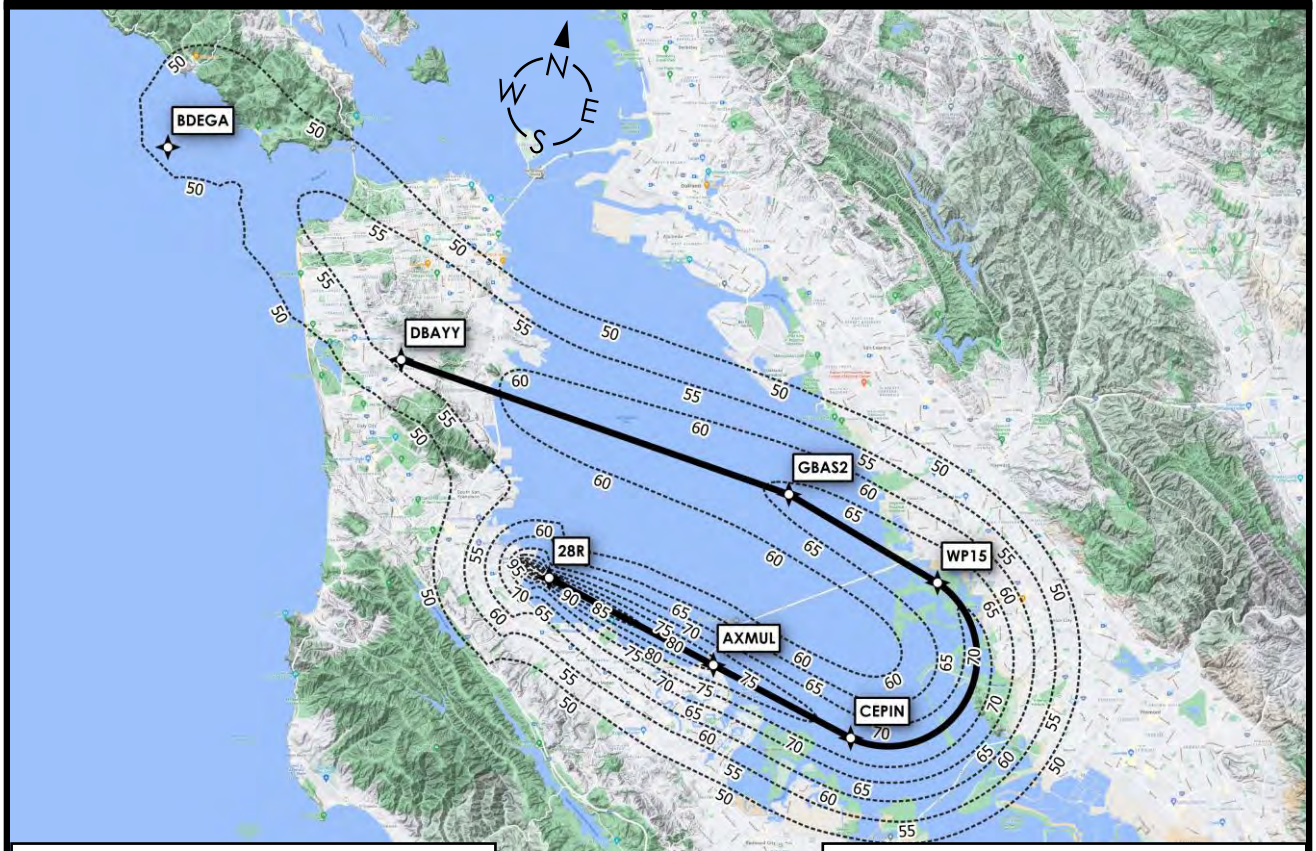
Weather Opportunity

VFR	✓	Day/Night Use
MVFR	✓	Day/Night Use
IFR	✓	Day/Night Use
LIFR	✓	CAT I Only

Narrowbody 1 SEL GLS-DB RWY 28R

Revision 1

Changes: New



To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
DBAYY	11000	11000	59.15	59.15
AXMUL	1800	1900	81.68	80.8

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

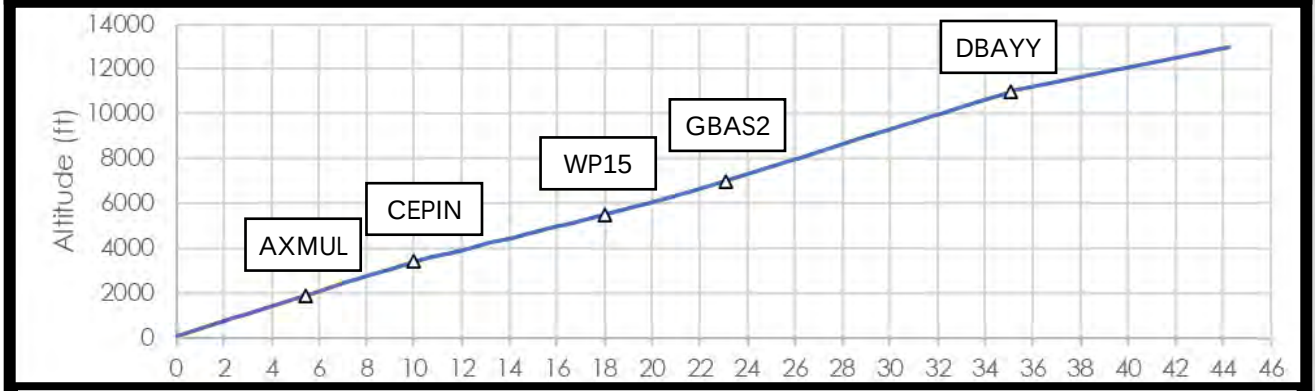
SEL Contour (dBA)	2010 Population
50	0
55	0
60	0
65	0
70	0
75	0
80	0
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Narrowbody 1 SEL GLS-DB RWY 28R

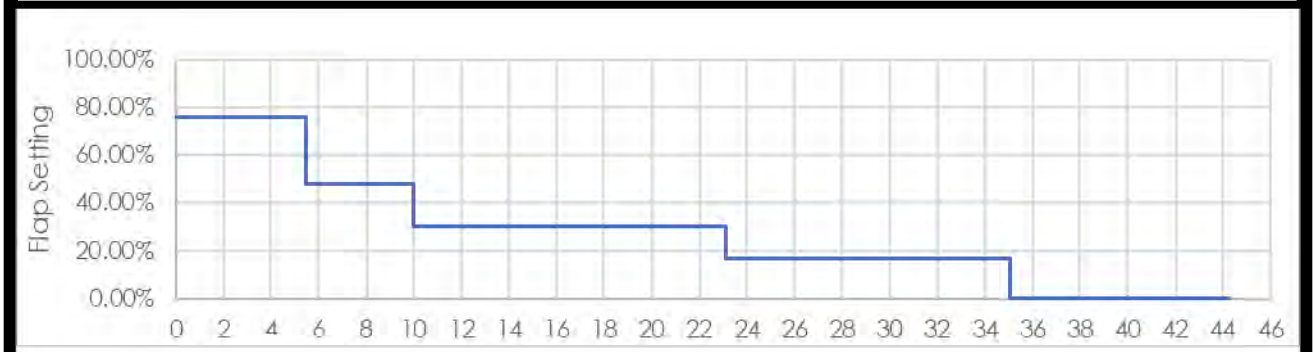
Revision 1

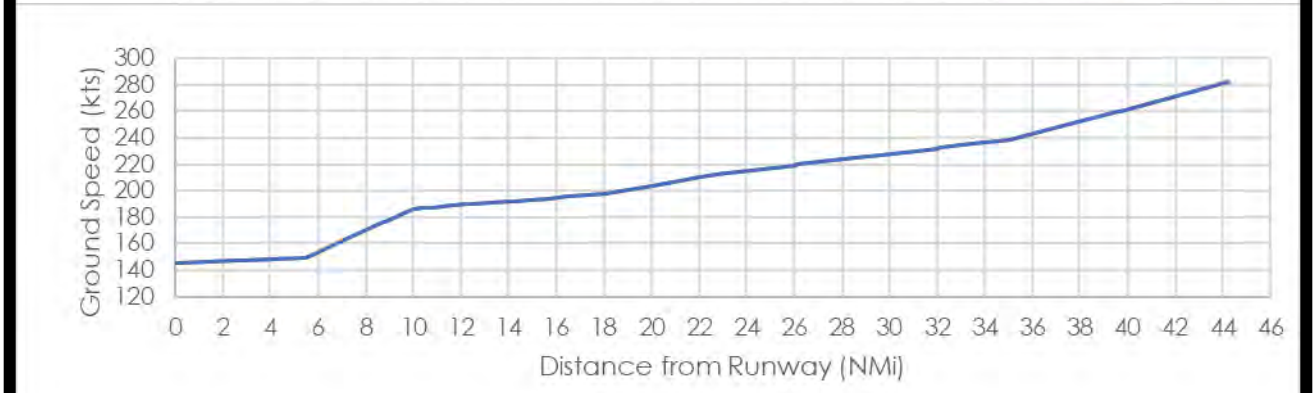
Changes: New



Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept

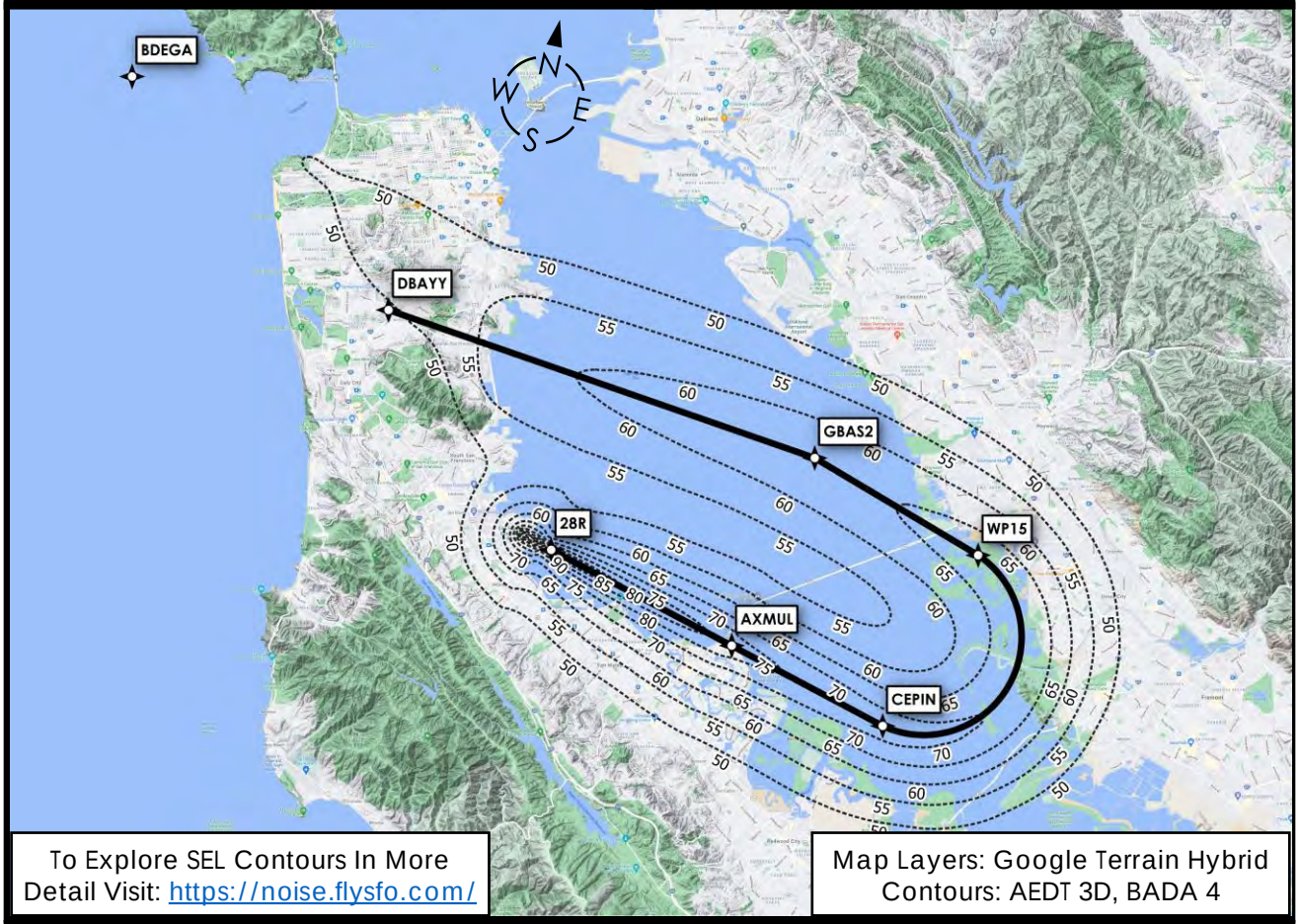




Narrowbody 2 SEL GLS-DB RWY 28R

Revision 1

Changes: New



To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
DBAYY	11000	11000	54.83	54.83
AXMUL	1800	1900	78.6	77.99

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

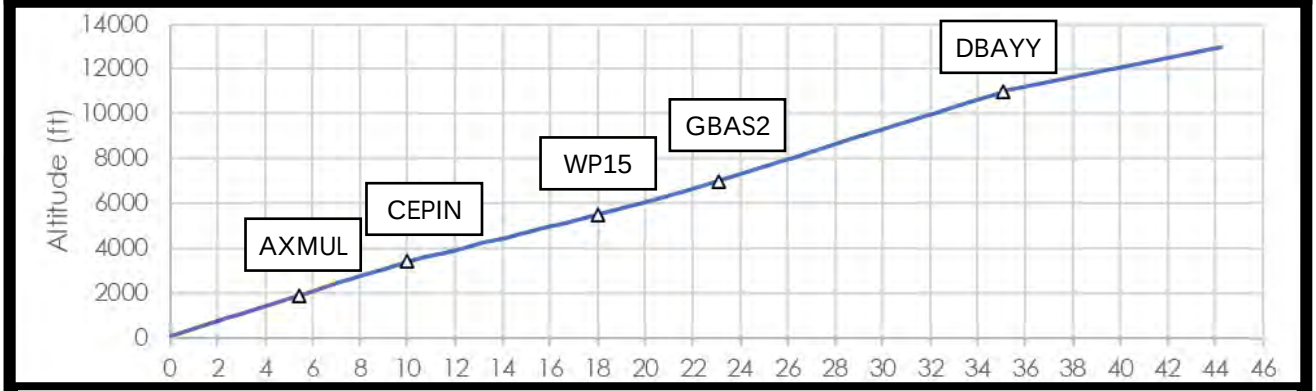
SEL Contour (dBA)	2010 Population
50	0
55	0
60	0
65	0
70	0
75	0
80	0
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Narrowbody 2 SEL GLS-DB RWY 28R

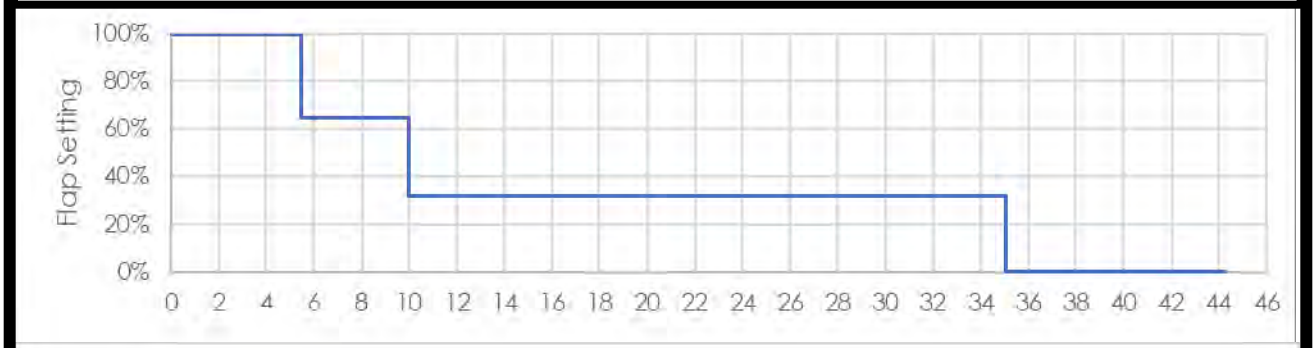
Revision 1

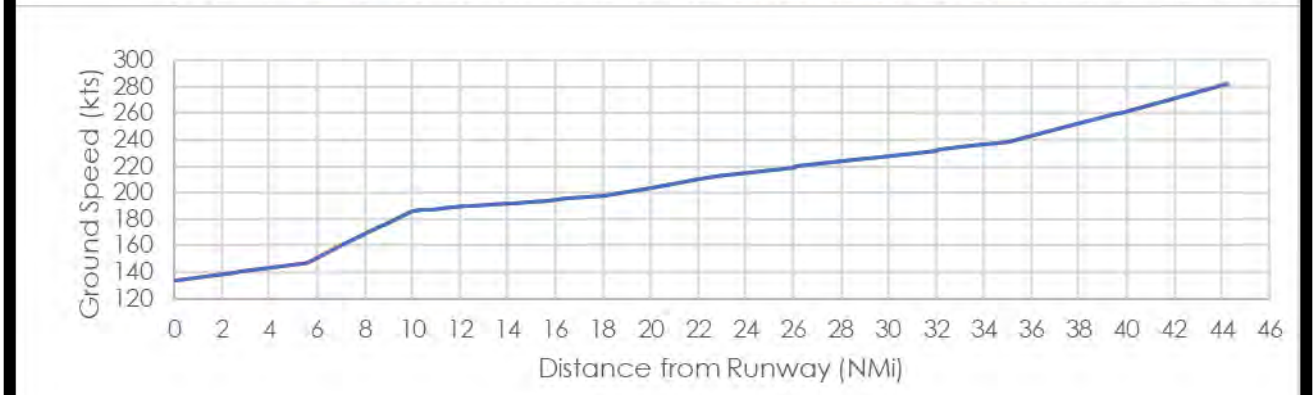
Changes: New



Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept

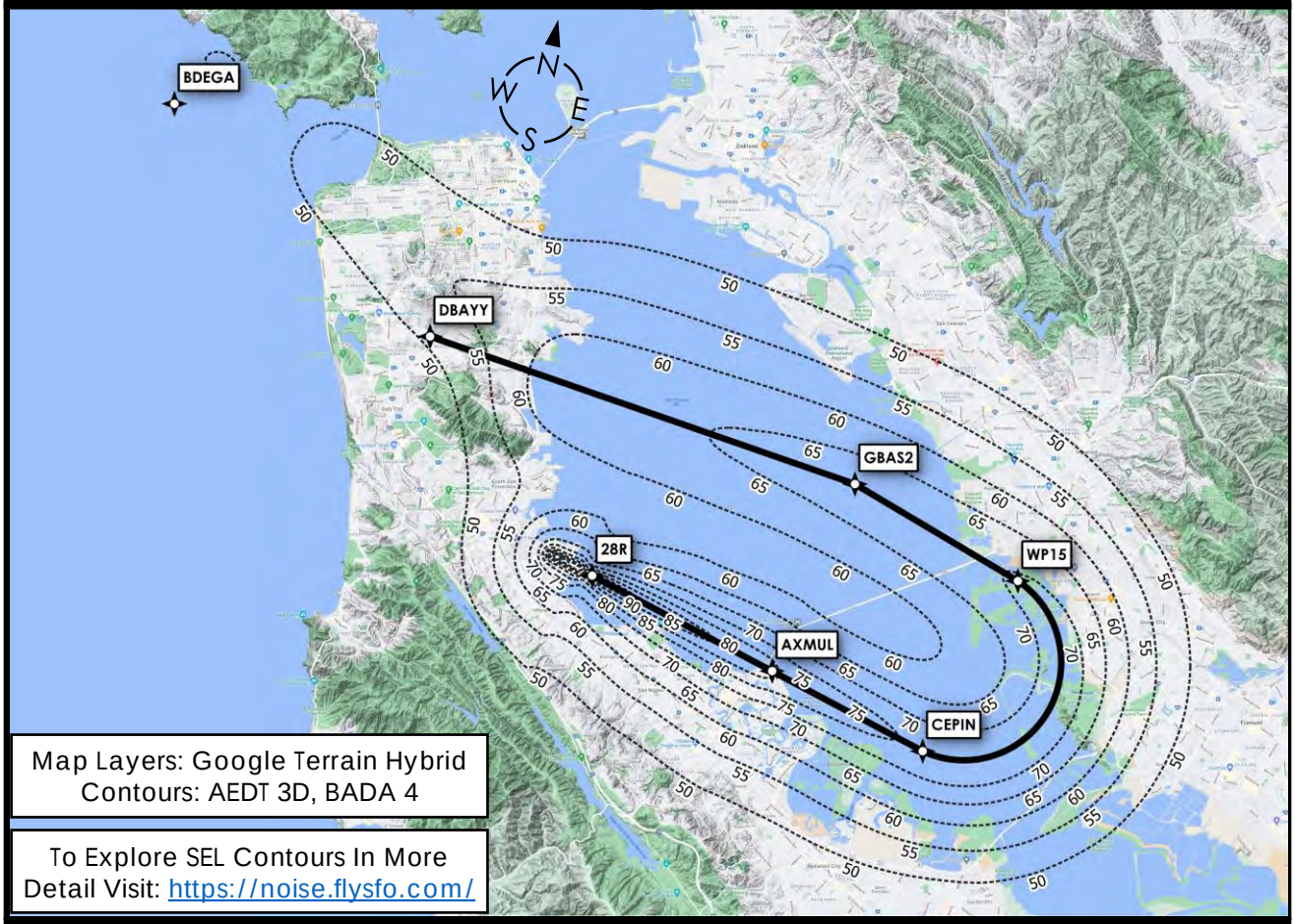




Widebody 1 SEL GLS-DB RWY 28R

Revision 1

Changes: New



Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
DBAYY	11000	11000	58.51	58.51
AXMUL	1800	1900	81.74	81.13

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

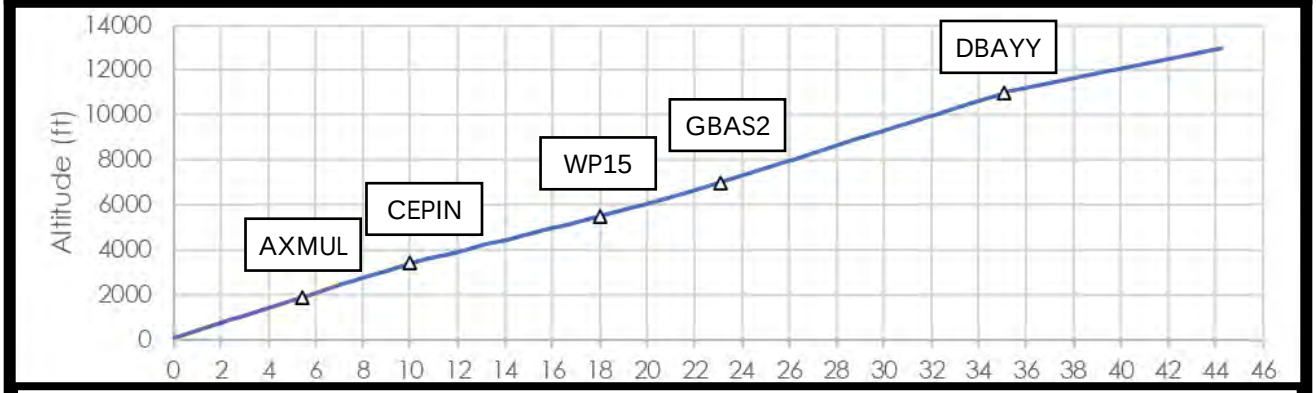
SEL Contour (dBA)	2010 Population
50	0
55	0
60	0
65	0
70	0
75	0
80	0
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Widebody 1 SEL GLS-DB RWY 28R

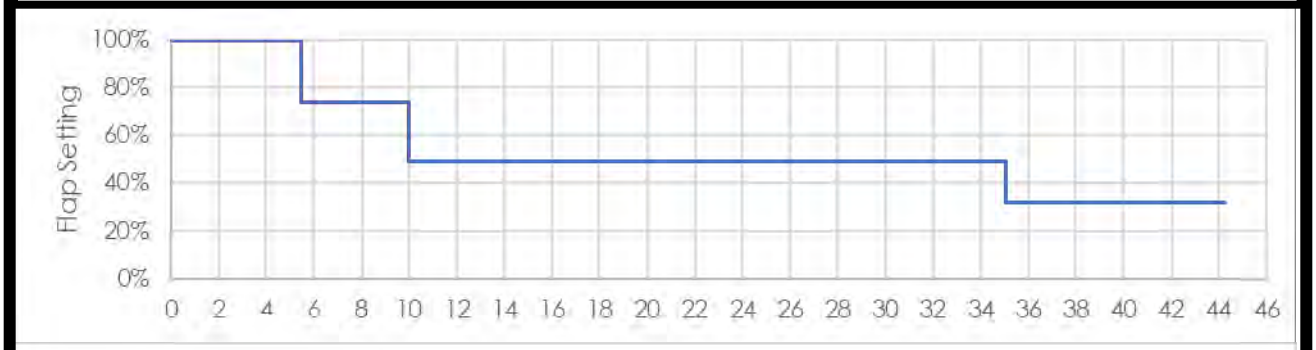
Revision 1

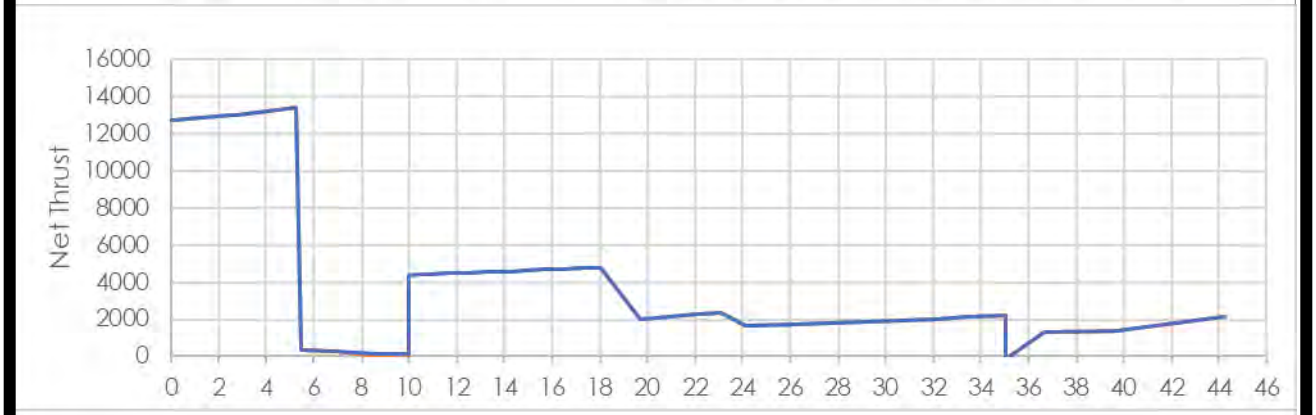
Changes: New



Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept

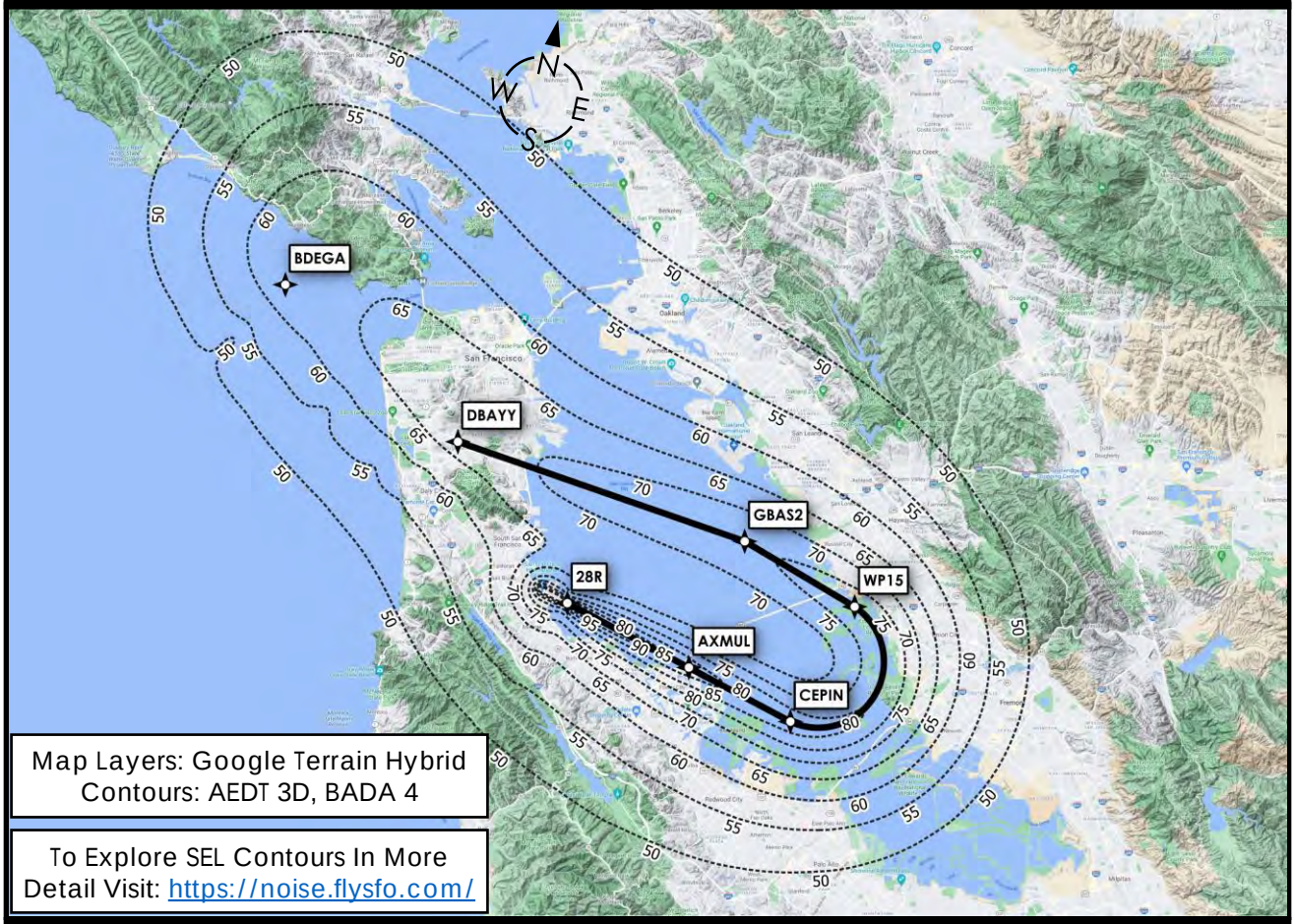




Widebody 2 SEL GLS-DB RWY 28R

Revision 1

Changes: New



Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
DBAYY	11000	11000	69.16	69.16
AXMUL	1800	1900	88.51	87.9

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

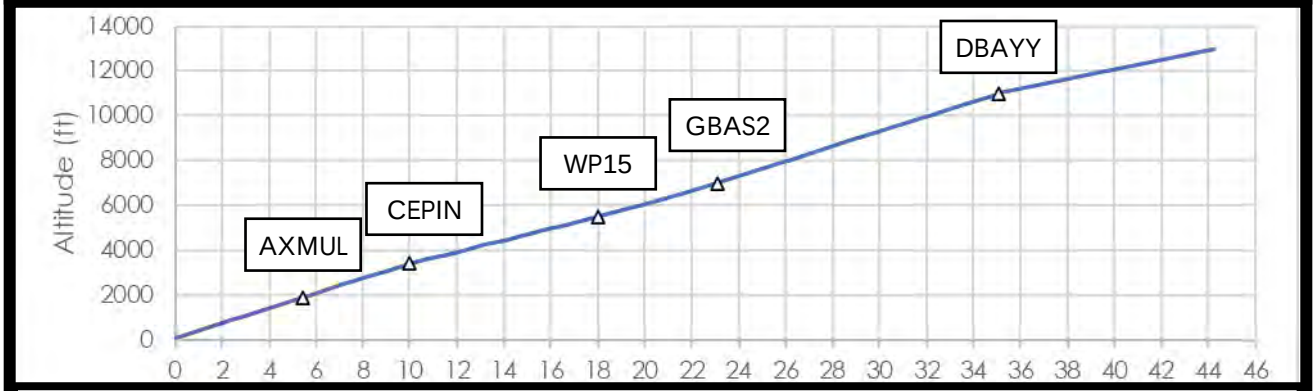
SEL Contour (dBA)	2010 Population
50	0
55	0
60	0
65	0
70	0
75	0
80	0
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Widebody 2 SEL GLS-DB RWY 28R

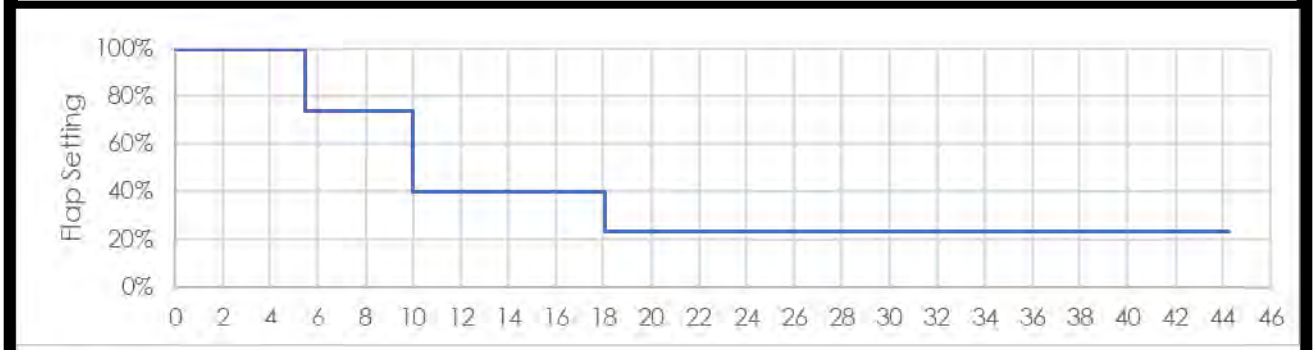
Revision 1

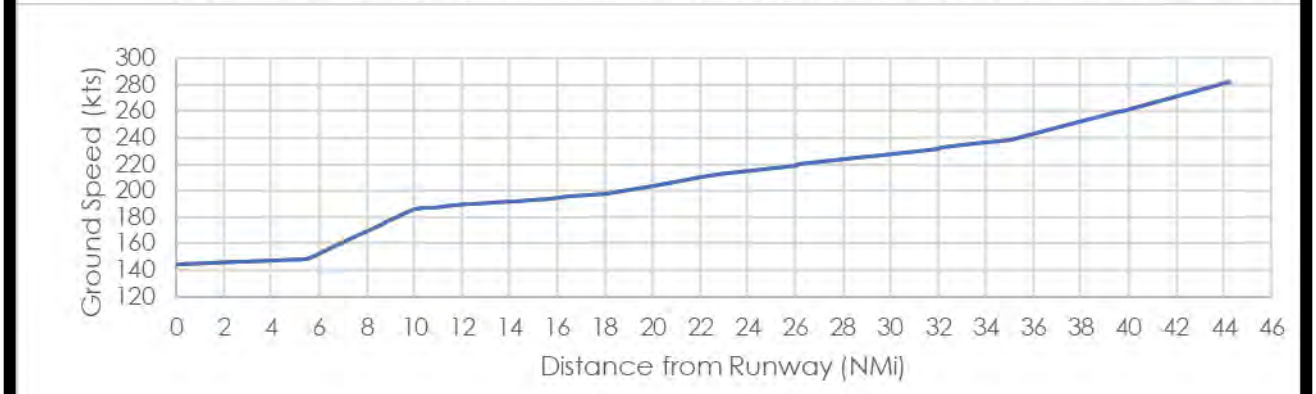
Changes: New



Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept





GLS-DB RWY 28R (DBAYY)

Revision 1

Changes: New

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - NARROWBODY 1

PROCEDURE: GLS DB RWY 28R (DBAYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	ATC Vectors	GLS DB RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	114666	114666	0	
Population within 75 dB SEL contour	4075	4075	0	
Altitude at Location DBAYY (MSL, ft)	11000	11000	0	
Altitude at Location AXMUL (MSL, ft)	1800	1900	100	
SEL at Location NM 23 (dB)	59.15	59.15	0	
SEL at Location AXMUL (dB)	81.68	80.8	-0.88	
Speed at Location DBAYY (knts)	239	239	0	
Speed at Location AXMUL (knts)	150	150	0	
Number of arrivals between 07:00 - 19:00	TBD	30 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - NARROWBODY 2

PROCEDURE: GLS DB RWY 28R (DBAYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	ATC Vectors	GLS DB RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	67654	67654	0	
Population within 75 dB SEL contour	2377	2377	0	
Altitude at Location DBAYY (MSL, ft)	11000	11000	0	
Altitude at Location AXMUL (MSL, ft)	1800	1900	100	
SEL at Location NM 23 (dB)	54.83	54.83	0	
SEL at Location AXMUL (dB)	78.6	77.99	-0.61	
Speed at Location DBAYY (knts)	239	239	0	
Speed at Location AXMUL (knts)	150	150	0	
Number of arrivals between 07:00 - 19:00	TBD	30 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

Disclaimer

The information provided in this CFPP is intended to assist members of the public to review the potential changes that might be experienced following the implementation of a proposed innovative approach procedure concept when compared to an existing instrument approach procedure.

All information contained in this presentation was prepared by the SFIA GBAS Project Team using industry best practices, insight provided by SFIA Flight Procedures Subcommittee participants and historical experience regarding flight operations into SFIA.

Information presented in this handout is a prediction of current and future aircraft operations and is subject to change. This includes potential changes in the number of aircraft and flight crews that can utilize GLS approaches, changes in air traffic control methods, changes in FAA instrument procedure design criteria, changes in the airspace surrounding SFO and other variables which may not have been modeled that can affect the potential altitude, flap, thrust, aerodynamic configuration and operating weight of the aircraft.

Any further regulatory review of these procedures, including assessment under the National Environmental Policy Act will require an independent noise analysis. The noise results presented in this document are for exploratory purposes only and rely on BADA4 aircraft performance inputs; which are restricted to research purposes only per the Eurocontrol and the FAA terms of use in AEDT.

GLS-DB RWY 28R (DBAYY)

Revision 1

Changes: New

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - WIDEBODY 1

PROCEDURE: GLS DB RWY 28R (DBAYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	ATC Vectors	GLS DB RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	133242	133242	0	
Population within 75 dB SEL contour	4418	4418	0	
Altitude at Location DBAYY (MSL, ft)	11000	11000	0	
Altitude at Location AXMUL (MSL, ft)	1800	1900	100	
SEL at Location NM 23 (dB)	58.51	58.51	0	
SEL at Location AXMUL (dB)	81.74	81.13	-0.61	
Speed at Location DBAYY (knts)	239	239	0	
Speed at Location AXMUL (knts)	146	146	0	
Number of arrivals between 07:00 - 19:00	TBD	30 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - WIDEBODY 2

PROCEDURE: GLS DB RWY 28R (DBAYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	ATC Vectors	GLS DB RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	1312421	1312421	0	
Population within 75 dB SEL contour	22728	22728	0	
Altitude at Location DBAYY (MSL, ft)	11000	11000	0	
Altitude at Location AXMUL (MSL, ft)	1800	1900	100	
SEL at Location NM 23 (dB)	69.16	69.16	0	
SEL at Location AXMUL (dB)	88.51	87.9	-0.61	
Speed at Location DBAYY (knts)	239	239	0	
Speed at Location AXMUL (knts)	151	151	0	
Number of arrivals between 07:00 - 19:00	TBD	30 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

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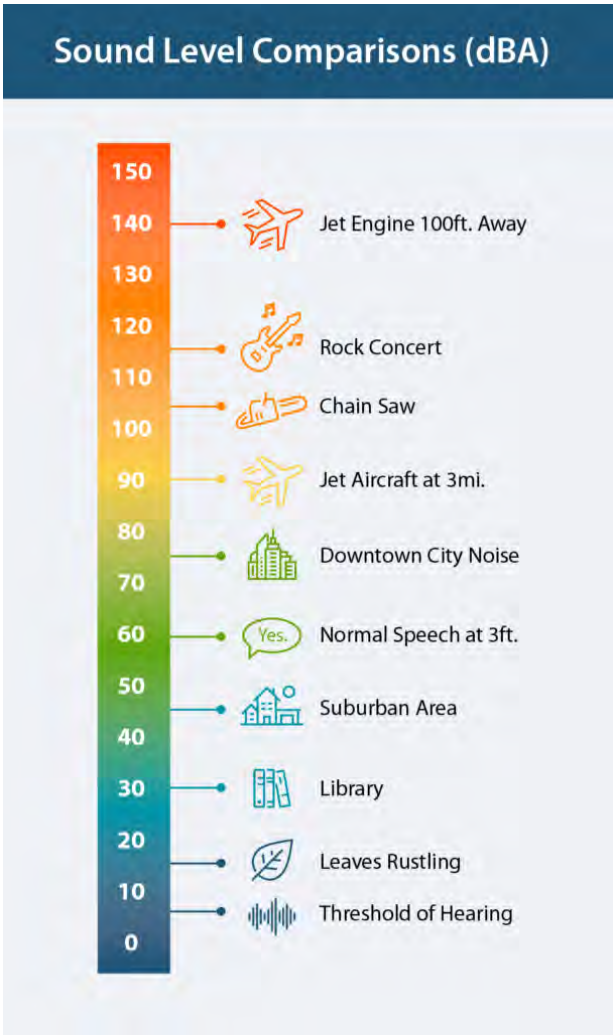
Information About SEL Contours

Revision 1

Changes: N/A

The Innovative Approach Evaluation Criteria, shown on the "Summary" page, use SEL 75 dB and 60 dB contours to compare the population counts impacted by each procedure. In reference to aircraft overflights, SEL is generally 10 dB above Lmax. The SEL 75 dB level was selected as part of the evaluation criteria due to its comparison to Lmax 65 dB, which is approximately the sound level of normal speech at a distance of 3 feet. The SEL 60 dB was selected due to its comparison to Lmax 50 dB, which is approximately the sound level of background noise at a quiet urban area.

Relative to sound level changes, an increase of 5 dBA is readily perceptible to the public and a 3 dBA increase is barely perceivable to the average healthy human ear.



Glossary

Revision 1

Changes: Updated

GBAS

Ground Based Augmentation System – A navigational aid, installed on the airport, that broadcasts a signal to aircraft that enhances ("augments") their existing GPS navigation capabilities enabling precision approaches to all runways at the airport.

GLS

GBAS Landing System (GLS) is the FAA's official term for a GBAS instrument approach procedure. A GLS approach is considered a "precision" approach procedure which means it provides precise navigational guidance similar to the Instrument Landing System (ILS) that have been used at SFO for over 50 years.

SEL

Sound Exposure Level – is a noise metric that represents all the acoustic energy (a.k.a. sound pressure) of an individual noise event as if that event had occurred within a one-second time period. SEL captures both the level (magnitude) and the duration of a sound event in a single numerical quantity, by "squeezing" all the noise energy from an event into one second. This provides a uniform way to make comparisons among noise events of various durations.

Lmax

Maximum Sound Level– is a noise metric that represents the maximum amount of acoustic energy (a.k.a. sound pressure) which occurs during an individual noise event regardless of its duration.

dB or dBA

Decibel (dB) or an "A-weighted" decibel - is the unit used to measure the intensity of a sound. The human ear hears sound pressures over a wide range. Decibels, which are measured on a logarithmic scale, correspond to the way our ears interpret sound pressures. The "A-weighted" scale most closely approximates the relative loudness of sounds in air as perceived by the human ear and provides a more useful way to evaluate the effect of noise exposure on humans by focusing on those parts of the frequency spectrum where we hear most. All noise results in this document use dBA.

MSL

Mean Sea Level (MSL), a tidal datum that is used to express geometric altitude above the earth. MSL references in this packet use imperial feet and can be thought of like a tapeline measurement from the ground to an object.

Glossary

Revision 1

Changes: Updated

ATC

Air Traffic Control, which represents a combination of human beings and technology responsible for aircraft separation from terrain, weather and other aircraft and aeronautical objects. At SFO, ATC is provided by a combination of individuals working locally in the tower and offsite with radar and voice communication capabilities.

Waypoint

Is a geographical location defined by a latitude/longitude geographic coordinate. These 5-letter waypoints, VHF intersections, 5-letter pronounceable DME fixes and 3-letter NAVAID IDs are published on various FAA aeronautical navigation products (IFR Enroute Charts, VFR charts, Terminal Procedures Publications, etc.).

RNAV or RNAV (GPS)

Area Navigation describes a navigation method used by aircraft which commonly utilize the Global Positioning System of satellites to determine information about their lateral position on earth. The GBAS sends an augmentation signal to aircraft using area navigation to increase the precision of the aircraft position, including additional information about the vertical location of the aircraft relative to the airport.

ILS

Instrument Landing System is the technology currently installed on 3 runways at SFO which sends an electronic signal along the final approach path which aircraft can detect and navigate within a fixed lateral and vertical corridor.

RWY

Abbreviation for runway.

Nmi

Nautical Mile – equal to 6,076 feet.

AEDT

Aviation Environmental Design Tool - AEDT is a software system that dynamically models aircraft performance in space and time to produce fuel burn, emissions and noise. Full flight gate-to-gate analyses are possible for study sizes ranging from a single flight at an airport to scenarios at the regional, national, and global levels.

Glossary

Revision 1

Changes: Updated

Waypoint

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VFR

Visual Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is greater than 3,000 feet above ground level and the visibility is greater than five miles.

MVFR

Marginal Visual Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is between 1,000 - 3,000 feet above ground level and the visibility is between three and five miles.

IFR

Instrument Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is less than 1,000 feet above ground level and the visibility is less than three miles.

LIFR

Low Instrument Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is less than 500 feet above ground level and the visibility is less than 1/2 miles.

GLS-R RWY 28R (EDDYY)

Revision 2

Changes: No changes on this page

San Francisco International Airport (SFO) has identified several Innovative Approach (IA) procedures primarily designed for noise reduction. Each procedure is described in a Community Flight Procedure Package (CFPP) that provides information about the IA and compares aircraft noise and flight performance of the IA to a comparable existing procedure if applicable. Please note that 1) IA procedure design is limited to be within approximately 20 nautical miles (nm) from the airport, 2) the maximum expected number of arrivals to use an IA procedure is 30 per day, and 3) the estimated noise reduction – although small or imperceptible in some areas – is part of an incremental noise reduction process that begins with demonstrating procedure design viability with the objective to achieve significant noise reduction in the future.

The CFPP includes the following pages of information:

- Page 1 includes the name and description of the IA, a map of the IA flight path, and the project goals being met by the procedure. The altitudes shown along the flight path indicate the change in altitude on the IA flight path compared to the existing procedure.
- Page 2 compares the navigational charts of the existing approach procedure and the proposed IA, the percentage of aircraft at SFO that are currently capable of using the IA, and the types of weather and visibility conditions in which the IA could be used.
- Pages 3, 5, 7, and 9 include maps that illustrate the waypoints, flight path, and Sound Exposure Level (SEL) contours of the existing and IA procedures for two Narrowbody and two Widebody aircraft. The pages also list the altitude and SEL changes at sample points, and the potential changes in population impacted by the implementation of the IA. Please note that 1) aircraft noise levels below 60 decibels (dB) may be similar to urban ambient noise, and 2) changes in noise levels below 3 dB are generally not perceptible by the human ear. Therefore, the population within an area illustrated as a noise increase may not notice the actual noise increase.
- Pages 4, 6, 8, and 10 show graphs that compare how altitude, flap settings, net thrust, and ground speed change during the flights of the existing approach procedure and the proposed IA. This data was used in the FAA Aviation Environmental Design Tool (AEDT 3d) noise model to calculate the SEL information shown on pages 3, 5, 7 and 9 and reflects the project team's best efforts to model how each of the aircraft would fly the IA without using aerodynamic braking.
- Pages 11 and 12 show comparisons of the existing procedure to the IA relative to evaluation criteria for Narrowbody and Widebody aircraft.

The remaining pages describe information about noise exposure and terms used throughout the CFPP.

GLS-R RWY 28R (EDDYY)

Revision 2

Changes: Increased Altitude at DONNG to Match Current Procedure

GLS Instrument approach to runway 28R originating southeast of the airport, starting at EDDYY.

This approach is an overlay of the existing RNAV (RNP) Y Rwy 28R. The GLS version of the approach would enable a higher altitude for aircraft crossing SIDBY and shorten the final approach segment permitting RF turns overwater to occur prior to the GBAS portion of the approach.

Project Goals

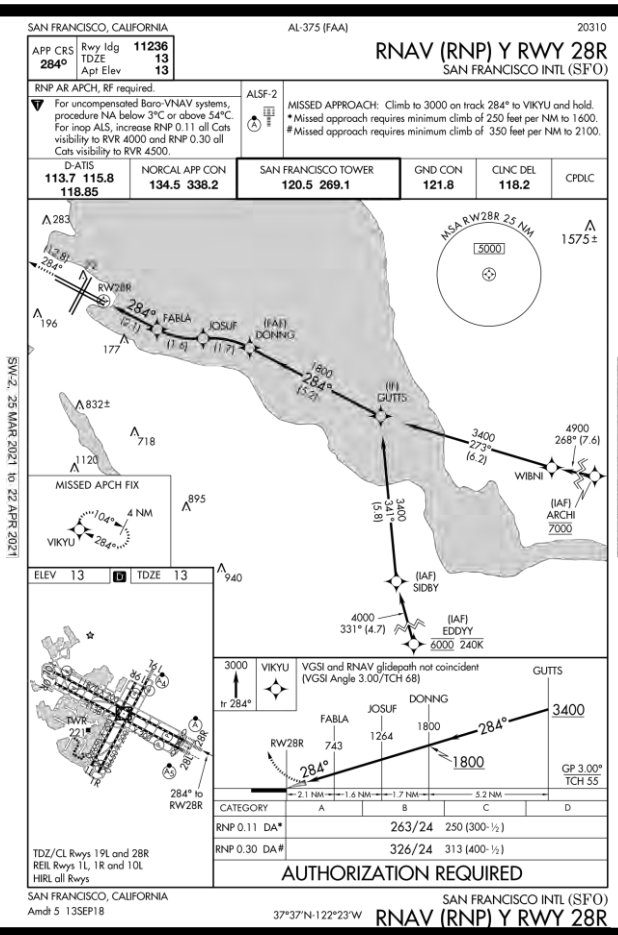
- ✓ Noise reduction
- ✓ ILS Redundancy
- ❑ Efficiency
- ❑ Reduce Delays

GLS-R RWY 28R (EDDYY)

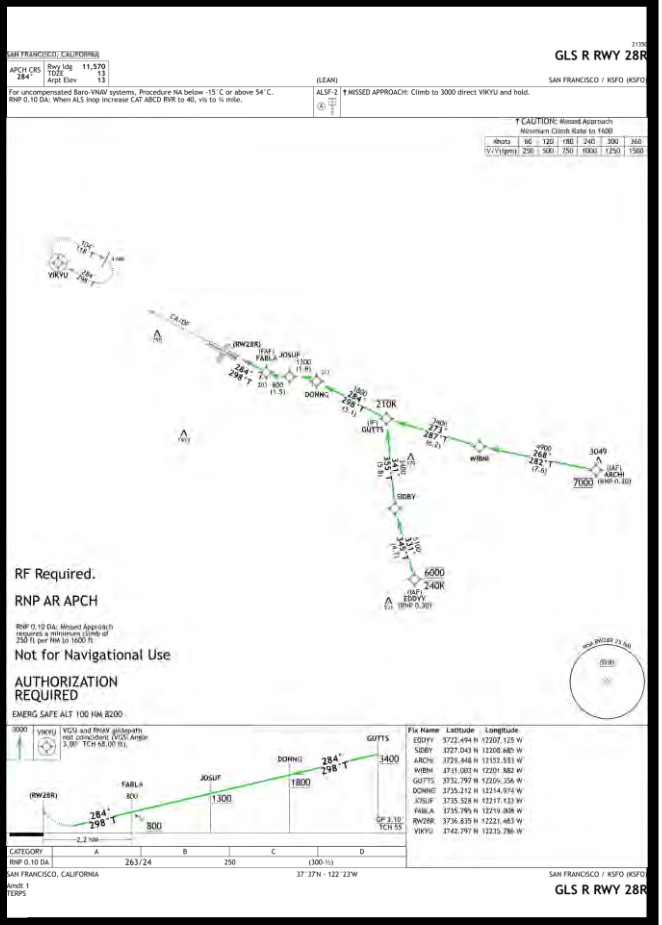
Revision 2

Changes: Increased Altitude at DONNG to Match Current Procedure

Existing Approach
RNAV (RNP) Y RWY 28R



Preliminary Concept
GLS-R RWY 28R



Aircraft @ SFO Capable of Using This Procedure

Regional/BizJet < 1%

Narrowbody ~ 30%

Widebody ~ 30%

Narrowbody and widebody aircraft capable of using this approach into SFO are anticipated to <u>increase</u> over the next 5 years

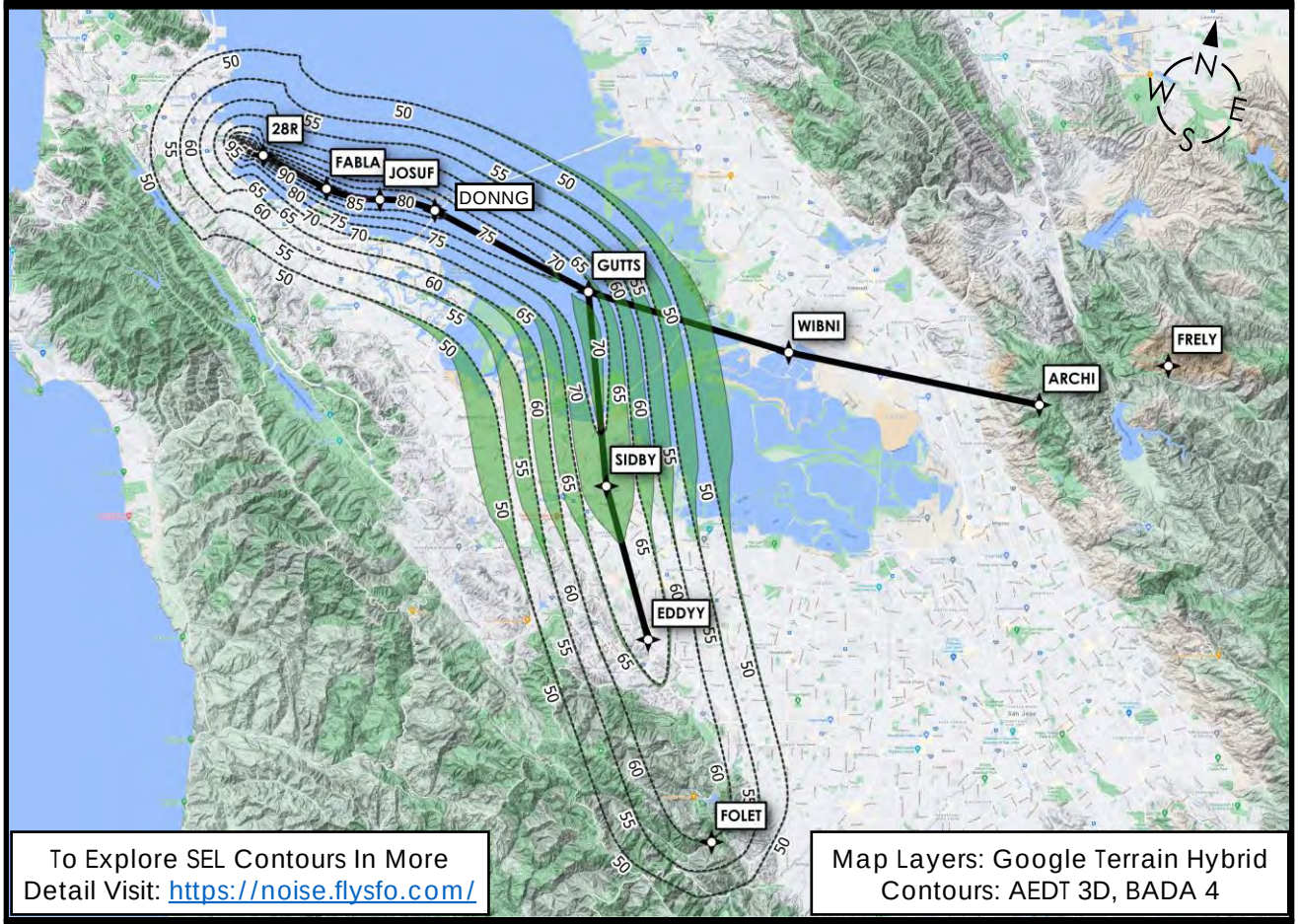
Weather Opportunity

VFR	✓	Day/Night Use
MVFR	✓	Day/Night Use
IFR	⊘	
LIFR	⊘	

Narrowbody 1 SEL GLS-R RWY 28R

Revision 2

Changes: Updated Noise results for altitude change at DONNG



To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	67.01	66.82
SIDBY	4000	5100	74.17	68.8

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

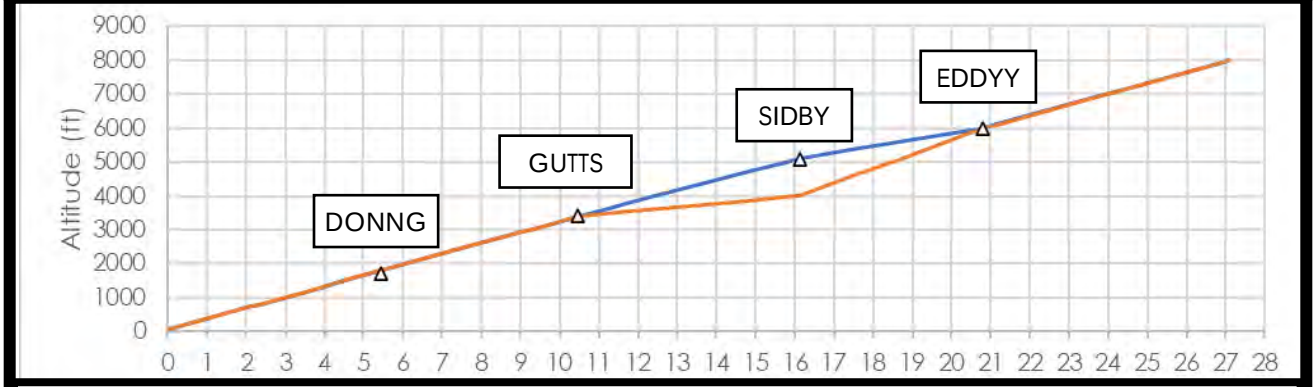
SEL Contour (dBA)	2010 Population
50	-38209
55	-15817
60	-12926
65	-14181
70	-55723
75	0
80	0
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Narrowbody 1 SEL GLS-R RWY 28R

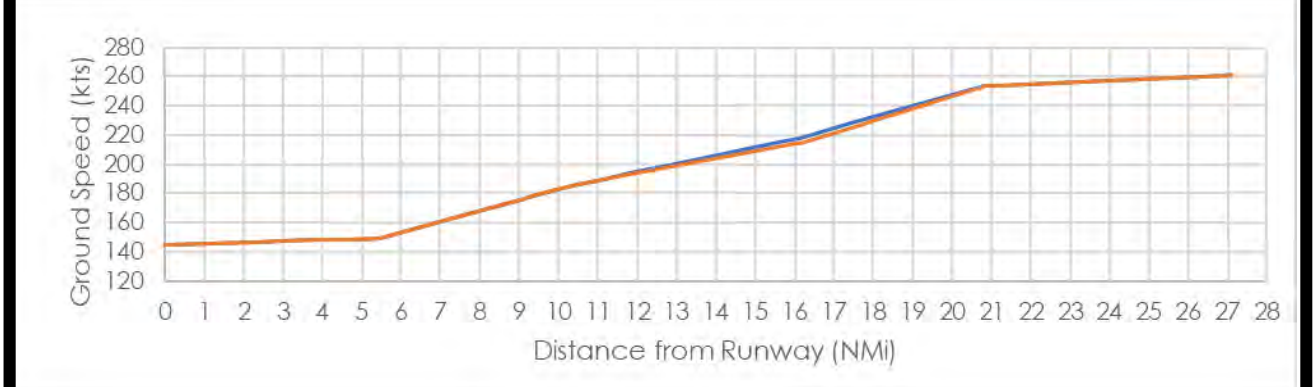
Revision 2

Changes: Increased Altitude at DONNG to Match Current Procedure



Simulated Flight Profile Characteristic for Existing Approach

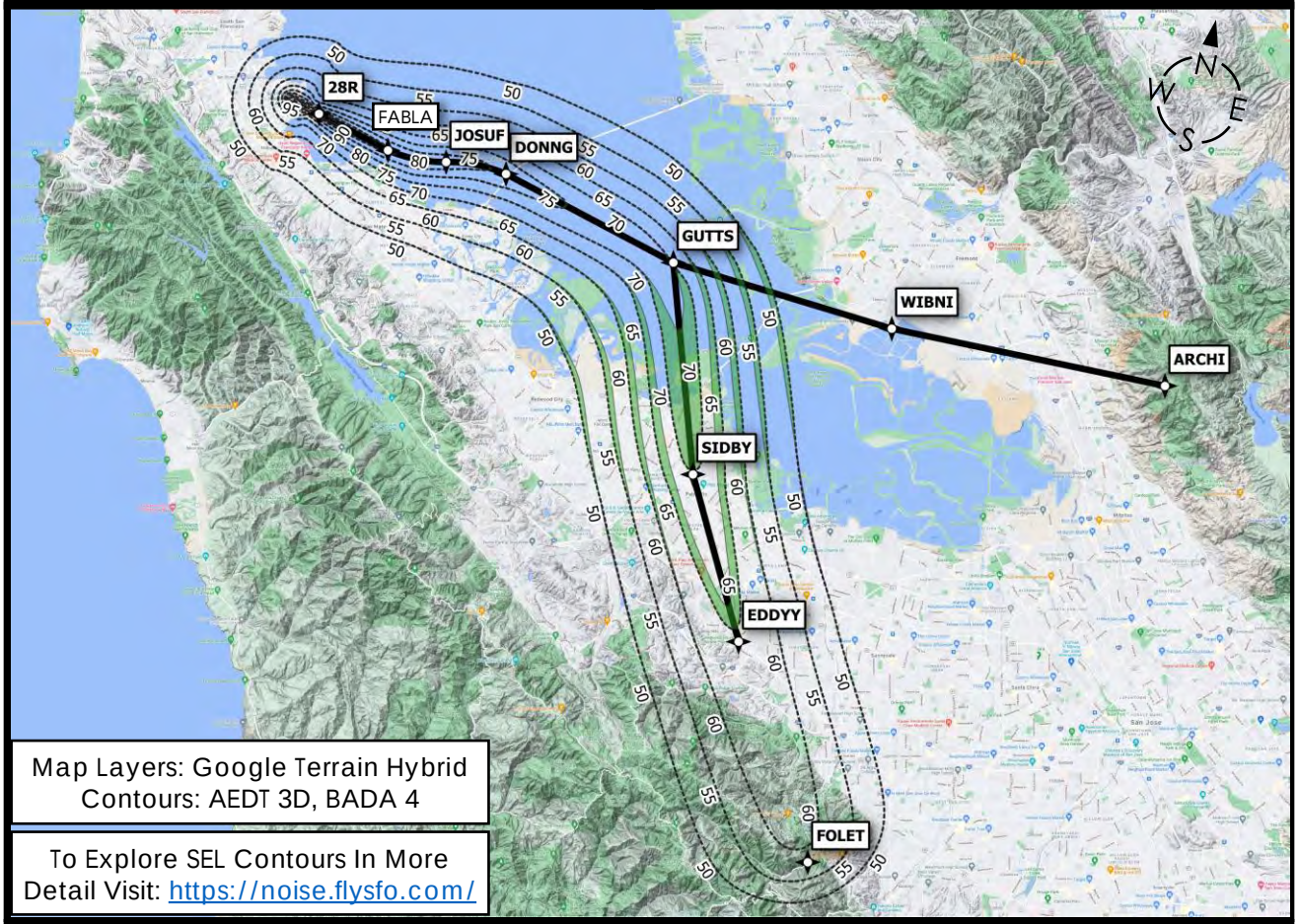
Simulated Flight Characteristic for Innovative Approach Concept



Narrowbody 2 SEL GLS-R RWY 28R

Revision 2

Changes: Updated Noise results for altitude change at DONNG



Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	64.68	64.45
SIDBY	4000	5100	69.75	66.82

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected	
SEL Contour (dBA)	2010 Population
50	-2824
55	-4300
60	-3688
65	-23346
70	-15091
75	0
80	0
85	0
90	0
95	0

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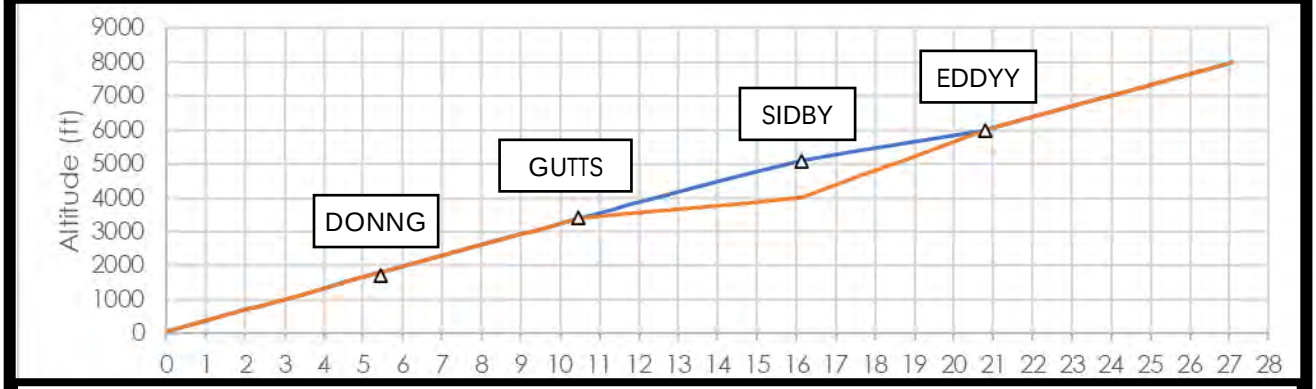
Narrowbody 2 SEL GLS-R RWY 28R

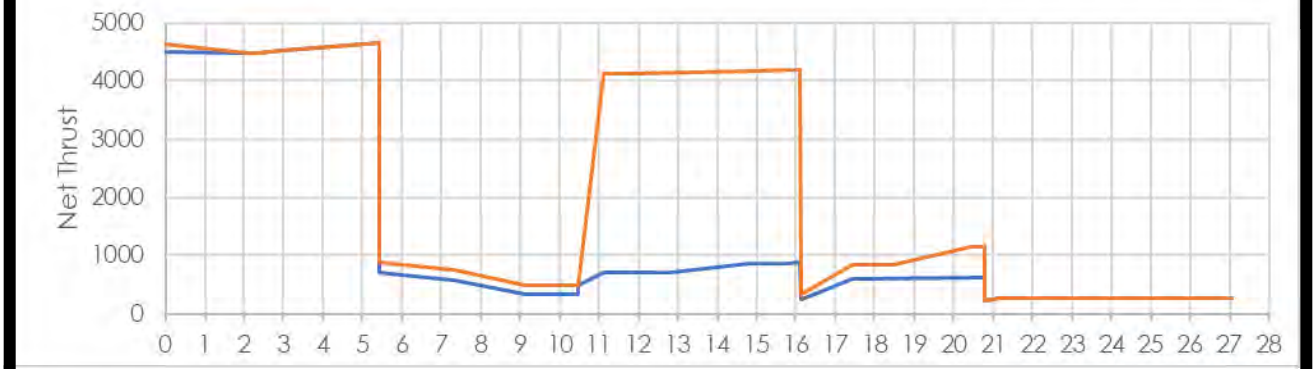
Revision 2

Changes: Increased Altitude at DONNG to Match Current Procedure



Simulated Flight Profile Characteristic for Existing Approach

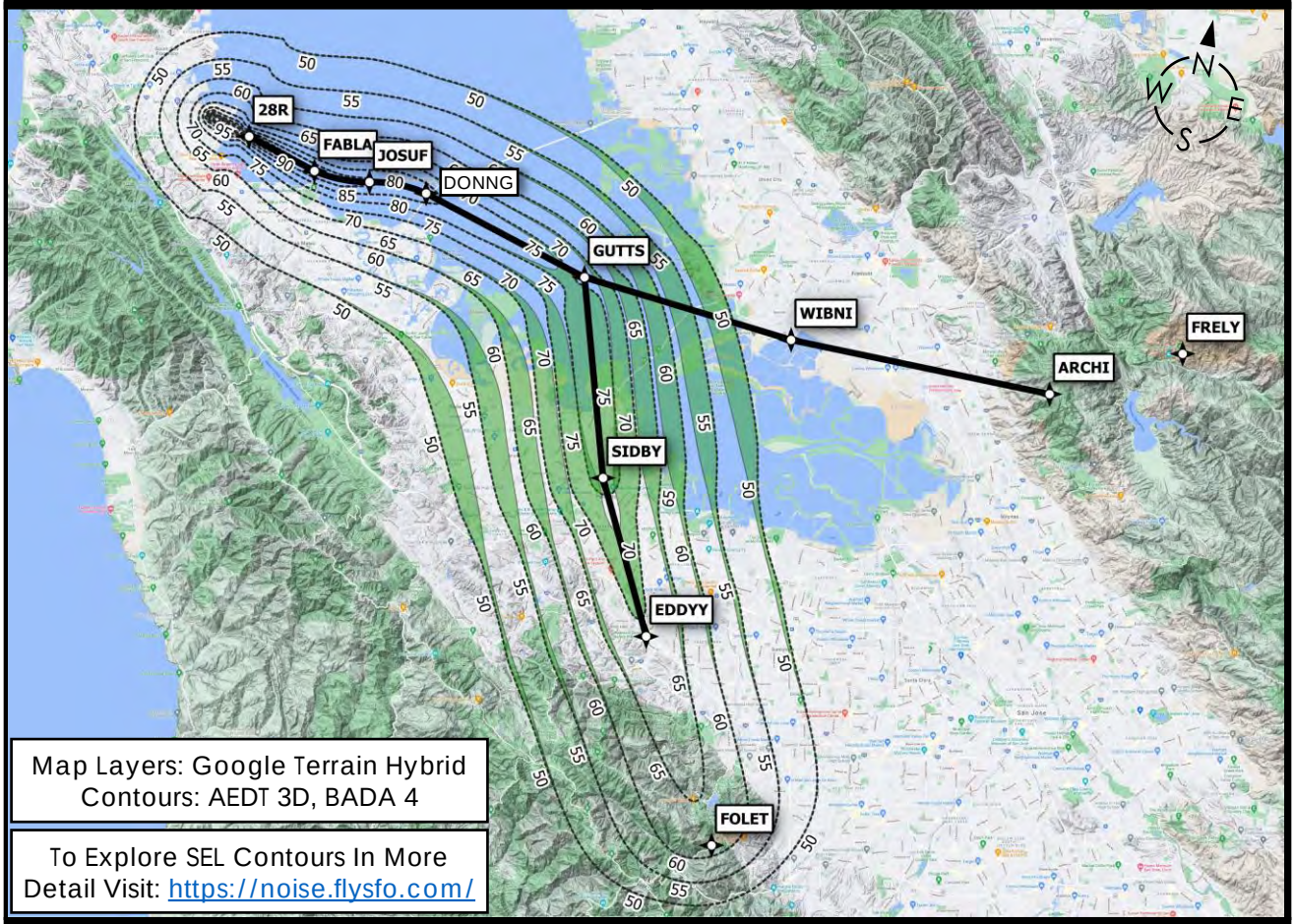
Simulated Flight Characteristic for Innovative Approach Concept



Widebody 1 SEL GLS-R RWY 28R

Revision 2

Changes: Updated Noise results for altitude change at DONNG



Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	69.23	68.37
SIDBY	4000	5100	76.28	70.24

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected	
SEL Contour (dBA)	2010 Population
50	-31197
55	-24936
60	-22868
65	-14246
70	-60076
75	-27142
80	0
85	0
90	0
95	0

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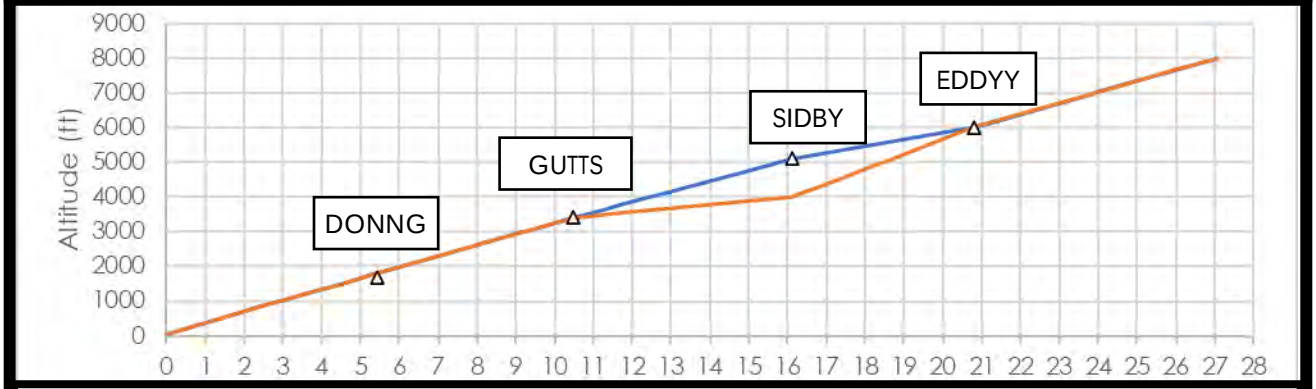
Widebody 1 SEL GLS-R RWY 28R

Revision 2

Changes: Increased Altitude at DONNG to Match Current Procedure



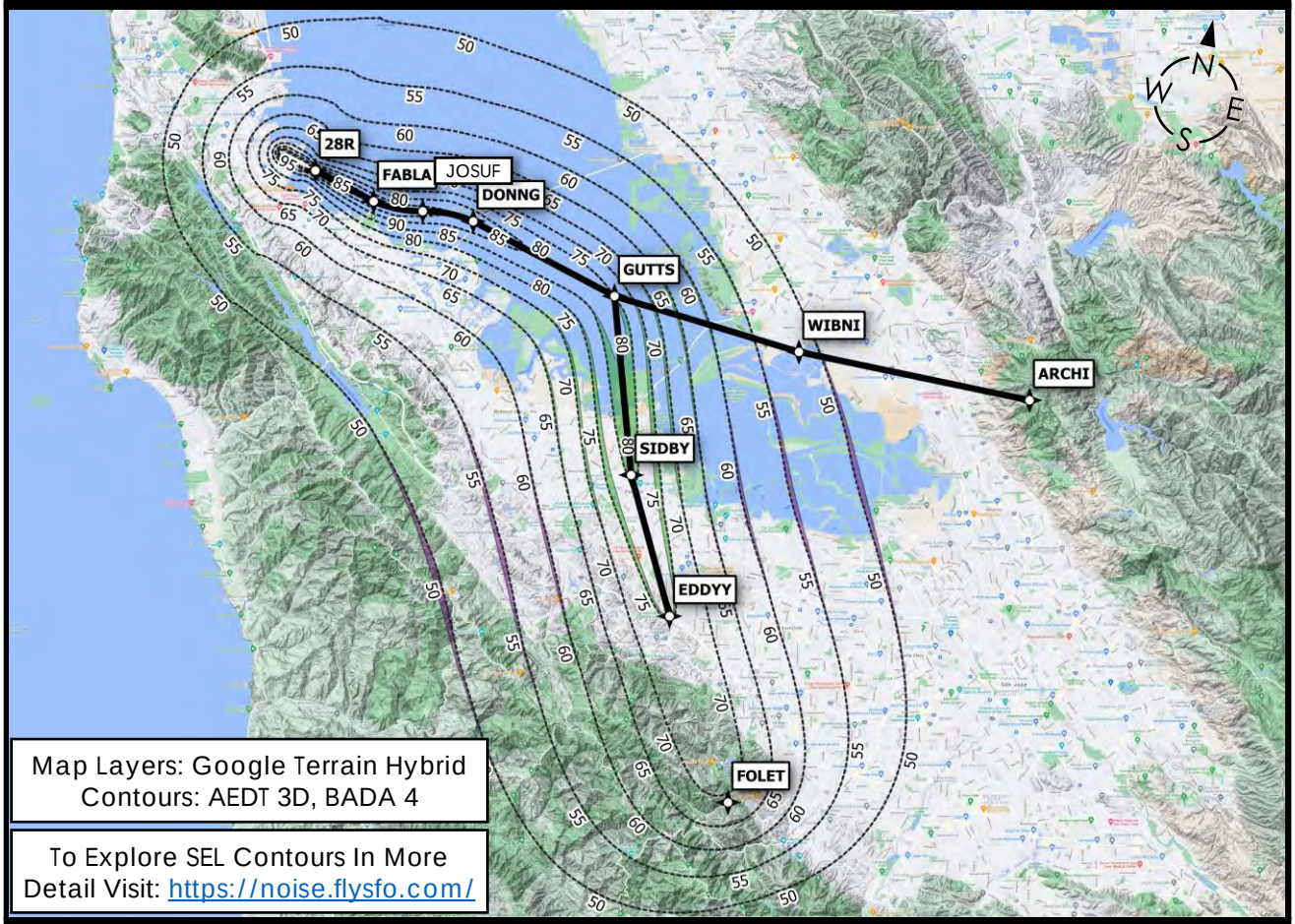
Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept

Widebody 2 SEL GLS-R RWY 28R

Revision 2

Changes: Updated Noise results for altitude change at DONNG



Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	75.13	75.03
SIDBY	4000	5100	80.16	77.24

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

SEL Contour (dBA)	2010 Population
50	6213
55	2760
60	1290
65	-1578
70	-2548
75	-15540
80	-14133
85	0
90	0
95	0

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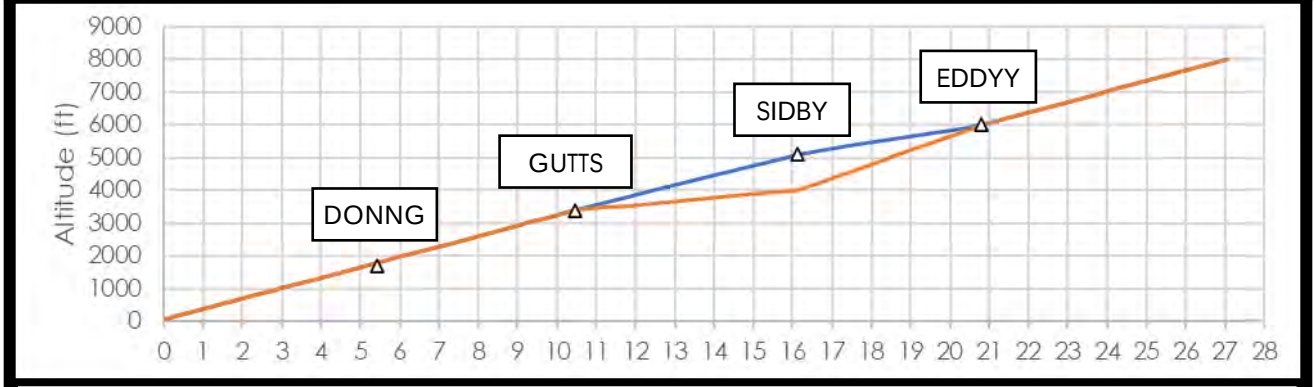
Widebody 2 SEL GLS-R RWY 28R

Revision 2

Changes: Increased Altitude at DONNG to Match Current Procedure



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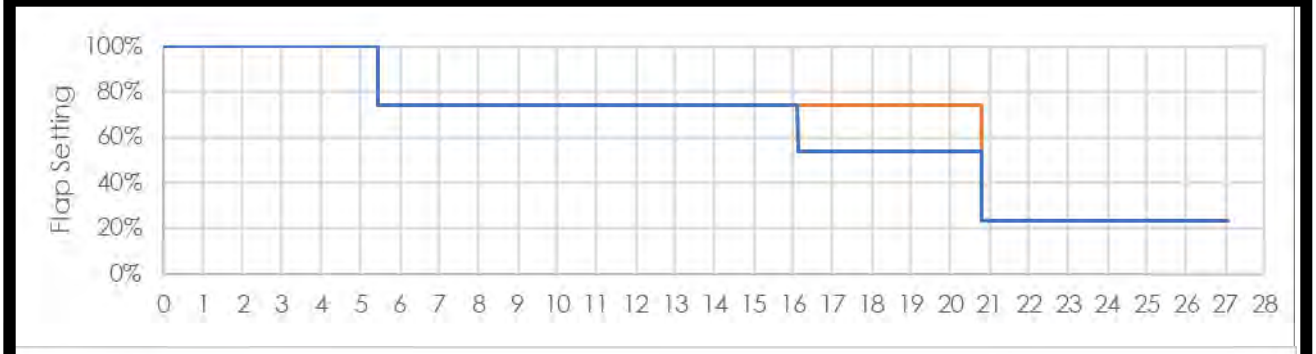
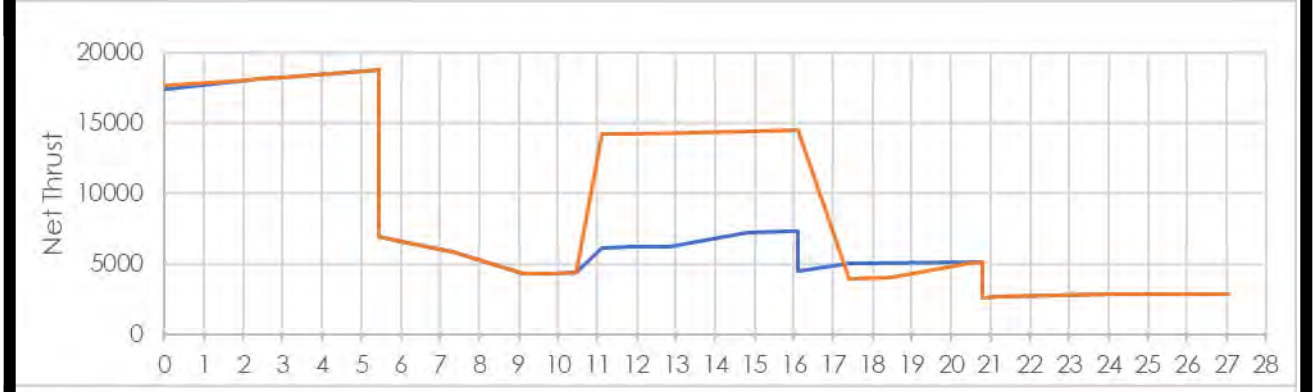
Simulated Flight Characteristic for Innovative Approach Concept





GLS-R RWY 28R (EDDYY)

Revision 2

Changes: Updated Noise results for altitude change at DONNG

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - NARROWBODY 1

PROCEDURE: GLS R RWY 28R (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	RNAV (RNP) Y Rwy 28R	GLS R RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	214040	201114	-12926	
Population within 75 dB SEL contour	60	60	0	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	4000	5100	1100	
SEL at Location EDDYY (dB)	67.01	66.62	-0.39	
SEL at Location SIDBY (dB)	74.17	68.8	-5.37	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	215	218	3	
Number of arrivals between 07:00 - 19:00	TBD	15 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - NARROWBODY 2

PROCEDURE: GLS R RWY 28R (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	RNAV (RNP) Y Rwy 28R	GLS R RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	155645	151957	-3688	
Population within 75 dB SEL contour	22	22	0	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	4000	5100	1100	
SEL at Location EDDYY (dB)	64.68	64.45	-0.23	
SEL at Location SIDBY (dB)	69.75	66.82	-2.93	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	220	216	-4	
Number of arrivals between 07:00 - 19:00	TBD	15 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

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GLS-R RWY 28R (EDDYY)

Revision 2

Changes: Updated Noise results for altitude change at DONNG

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - WIDEBODY 1

PROCEDURE: GLS R RWY 28R (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	RNAV (RNP) Y Rwy 28R	GLS R RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	265403	242535	-22868	
Population within 75 dB SEL contour	27142	0	-27142	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	4000	5100	1100	
SEL at Location EDDYY (dB)	69.23	68.37	-0.86	
SEL at Location SIDBY (dB)	76.28	70.24	-6.04	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	215	218	3	
Number of arrivals between 07:00 - 19:00	TBD	15 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - WIDEBODY 2

PROCEDURE: GLS R RWY 28R (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	RNAV (RNP) Y Rwy 28R	GLS R RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	519862	521152	1290	
Population within 75 dB SEL contour	88734	73192	-15542	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	4000	5100	1100	
SEL at Location EDDYY (dB)	75.13	75.03	-0.1	
SEL at Location SIDBY (dB)	80.16	77.24	-2.92	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	224	224	0	
Number of arrivals between 07:00 - 19:00	TBD	15 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
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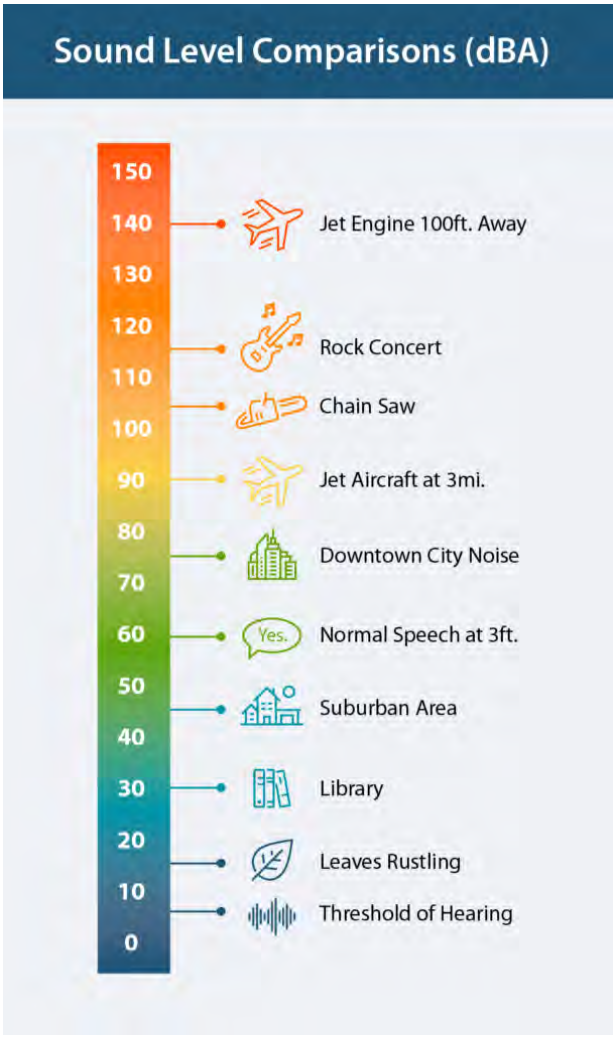
Relative to sound level changes, an increase of 5 dBA is readily perceptible to the public and a 3 dBA increase is barely perceivable to the average healthy human ear.



Glossary

Revision 2

Changes: N/A

GBAS

Ground Based Augmentation System – A navigational aid, installed on the airport, that broadcasts a signal to aircraft that enhances ("augments") their existing GPS navigation capabilities enabling precision approaches to all runways at the airport.

GLS

GBAS Landing System (GLS) is the FAA's official term for a GBAS instrument approach procedure. A GLS approach is considered a "precision" approach procedure which means it provides precise navigational guidance similar to the Instrument Landing System (ILS) that have been used at SFO for over 50 years.

SEL

Sound Exposure Level – is a noise metric that represents all the acoustic energy (a.k.a. sound pressure) of an individual noise event as if that event had occurred within a one-second time period. SEL captures both the level (magnitude) and the duration of a sound event in a single numerical quantity, by "squeezing" all the noise energy from an event into one second. This provides a uniform way to make comparisons among noise events of various durations.

Lmax

Maximum Sound Level– is a noise metric that represents the maximum amount of acoustic energy (a.k.a. sound pressure) which occurs during an individual noise event regardless of its duration.

dB or dBA

Decibel (dB) or an "A-weighted" decibel - is the unit used to measure the intensity of a sound. The human ear hears sound pressures over a wide range. Decibels, which are measured on a logarithmic scale, correspond to the way our ears interpret sound pressures. The "A-weighted" scale most closely approximates the relative loudness of sounds in air as perceived by the human ear and provides a more useful way to evaluate the effect of noise exposure on humans by focusing on those parts of the frequency spectrum where we hear most. All noise results in this document use dBA.

MSL

Mean Sea Level (MSL), a tidal datum that is used to express geometric altitude above the earth. MSL references in this packet use imperial feet and can be thought of like a tapeline measurement from the ground to an object.

Glossary

Revision 2

Changes: N/A

ATC

Air Traffic Control, which represents a combination of human beings and technology responsible for aircraft separation from terrain, weather and other aircraft and aeronautical objects. At SFO, ATC is provided by a combination of individuals working locally in the tower and offsite with radar and voice communication capabilities.

Waypoint

Is a geographical location defined by a latitude/longitude geographic coordinate. These 5-letter waypoints, VHF intersections, 5-letter pronounceable DME fixes and 3-letter NAVAID IDs are published on various FAA aeronautical navigation products (IFR Enroute Charts, VFR charts, Terminal Procedures Publications, etc.).

RNAV or RNAV (GPS)

Area Navigation describes a navigation method used by aircraft which commonly utilize the Global Positioning System of satellites to determine information about their lateral position on earth. The GBAS sends an augmentation signal to aircraft using area navigation to increase the precision of the aircraft position, including additional information about the vertical location of the aircraft relative to the airport.

ILS

Instrument Landing System is the technology currently installed on 3 runways at SFO which sends an electronic signal along the final approach path which aircraft can detect and navigate within a fixed lateral and vertical corridor

RWY

Abbreviation for runway

Nmi

Nautical Mile – equal to 6,076 feet.

AEDT

Aviation Environmental Design Tool - AEDT is a software system that dynamically models aircraft performance in space and time to produce fuel burn, emissions and noise. Full flight gate-to-gate analyses are possible for study sizes ranging from a single flight at an airport to scenarios at the regional, national, and global levels.

Glossary

Revision 2

Changes: N/A

Waypoint

Is a geographical location defined by a latitude/longitude geographic coordinate. These 5-letter waypoints, VHF intersections, 5-letter pronounceable DME fixes and 3-letter NAVAID IDs are published on various FAA aeronautical navigation products (IFR Enroute Charts, VFR charts, Terminal Procedures Publications, etc.).

VFR

Visual Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is greater than 3,000 feet above ground level and the visibility is greater than five miles.

MVFR

Marginal Visual Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is between 1,000 - 3,000 feet above ground level and the visibility is between three and five miles.

IFR

Instrument Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is less than 1,000 feet above ground level and the visibility is less than three miles.

LIFR

Low Instrument Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is less than 500 feet above ground level and the visibility is less than 1/2 miles.

GLS-TT RWY 28L (EDDYY)

Revision 1

Changes: New

San Francisco International Airport (SFO) has identified several Innovative Approach (IA) procedures primarily designed for noise reduction. Each procedure is described in a Community Flight Procedure Package (CFPP) that provides information about the IA and compares aircraft noise and flight performance of the IA to a comparable existing procedure if applicable. Please note that 1) IA procedure design is limited to be within approximately 20 nautical miles (nm) from the airport, 2) the maximum expected number of arrivals to use an IA procedure is 30 per day, and 3) the estimated noise reduction – although small or imperceptible in some areas – is part of an incremental noise reduction process that begins with demonstrating procedure design viability with the objective to achieve significant noise reduction in the future.

The CFPP includes the following pages of information:

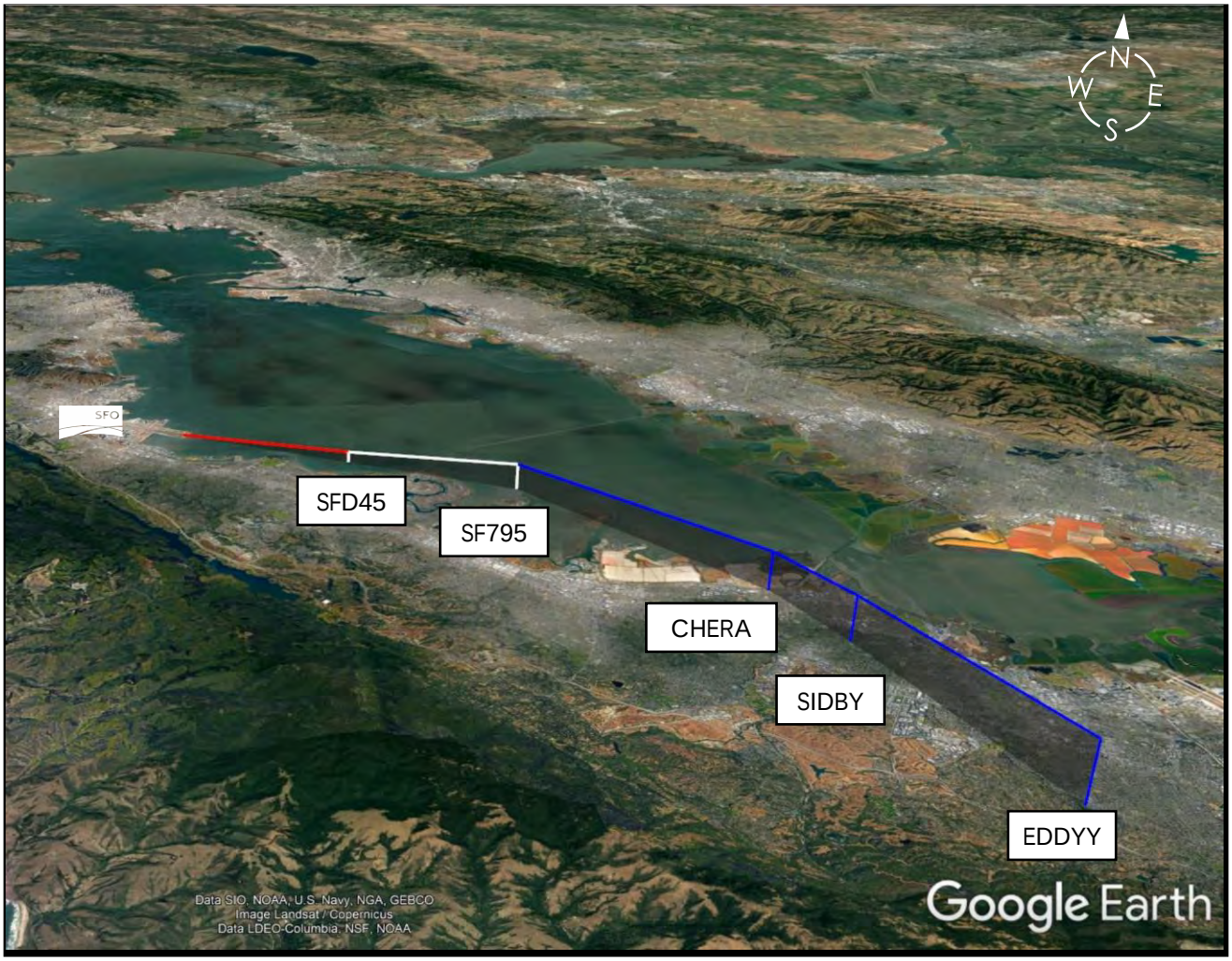
- Page 1 includes the name and description of the IA, a map of the IA flight path, and the project goals being met by the procedure. The altitudes shown along the flight path indicate the change in altitude on the IA flight path compared to the existing procedure.
- Page 2 compares the navigational charts of the existing approach procedure and the proposed IA, the percentage of aircraft at SFO that are currently capable of using the IA, and the types of weather and visibility conditions in which the IA could be used.
- Pages 3, 5, 7, and 9 include maps that illustrate the waypoints, flight path, and Sound Exposure Level (SEL) contours of the existing and IA procedures for two Narrowbody and two Widebody aircraft. The pages also list the altitude and SEL changes at sample points, and the potential changes in population impacted by the implementation of the IA. Please note that 1) aircraft noise levels below 60 decibels (dB) may be similar to urban ambient noise, and 2) changes in noise levels below 3 dB are generally not perceptible by the human ear. Therefore, the population within an area illustrated as a noise increase may not notice the actual noise increase.
- Pages 4, 6, 8, and 10 show graphs that compare how altitude, flap settings, net thrust, and ground speed change during the flights of the existing approach procedure and the proposed IA. This data was used in the FAA Aviation Environmental Design Tool (AEDT 3d) noise model to calculate the SEL information shown on pages 3, 5, 7 and 9 and reflects the project team's best efforts to model how each of the aircraft would fly the IA without using aerodynamic braking.
- Pages 11 and 12 show comparisons of the existing procedure to the IA relative to evaluation criteria for Narrowbody and Widebody aircraft.

The remaining pages describe information about noise exposure and terms used throughout the CFPP.

GLS-TT RWY 28L (EDDYY)

Revision 1

Changes: New



GLS Instrument approach to runway 28L originating southeast of the airport, starting at EDDYY.

This approach is an identical overlay of the existing Tipp Toe Charted Visual Flight Procedure (CVFP) approach, in use today, under VFR conditions. The GLS version of the approach converts optional CVFP published altitudes, into required minimum IFR altitudes.

Project Goals

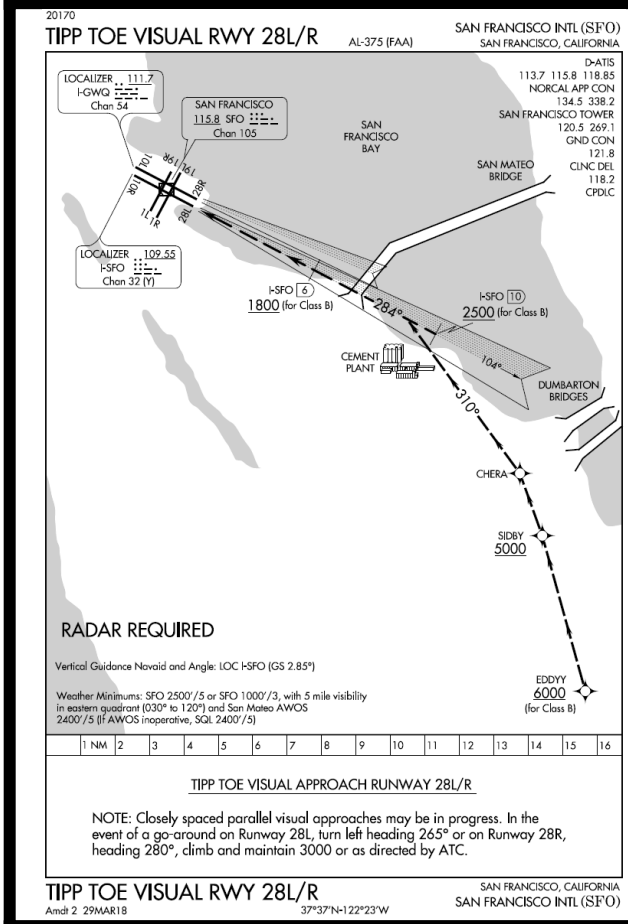
- ✓ Noise reduction
- ✓ ILS Redundancy
- ✓ Efficiency
- ✓ Reduce Delays

GLS-TT RWY 28L (EDDYY)

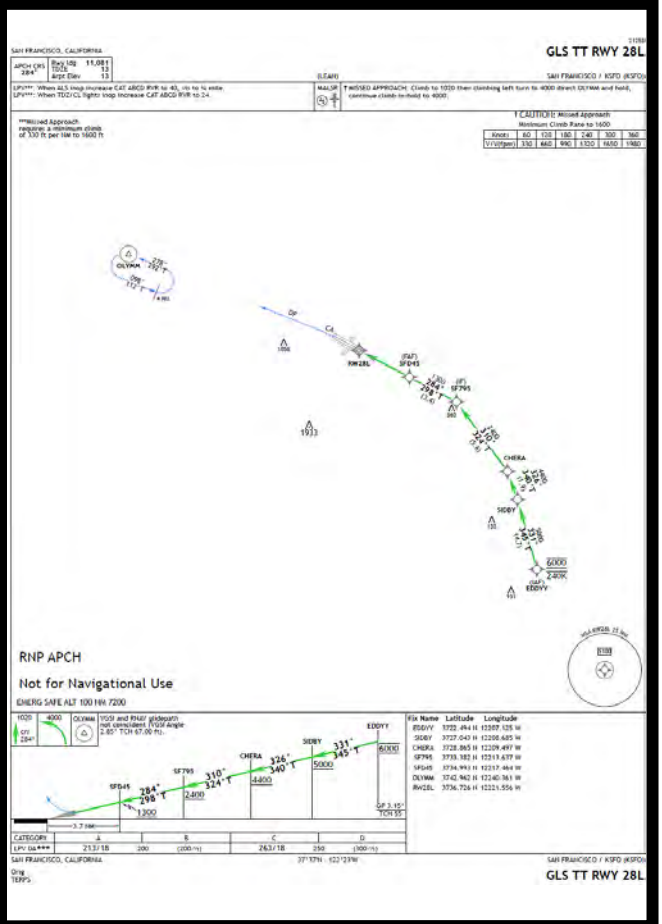
Revision 1

Changes: New

Existing Approach
Tipp Toe Visual RWY 28L



Preliminary Concept
GLS-TT RWY 28L



Aircraft @ SFO Capable of Using This Procedure

Regional/BizJet < 1%

Narrowbody ~ 30%

Widebody ~ 30%

Narrowbody and widebody aircraft capable of using this approach into SFO are anticipated to <u>increase</u> over the next 5 years

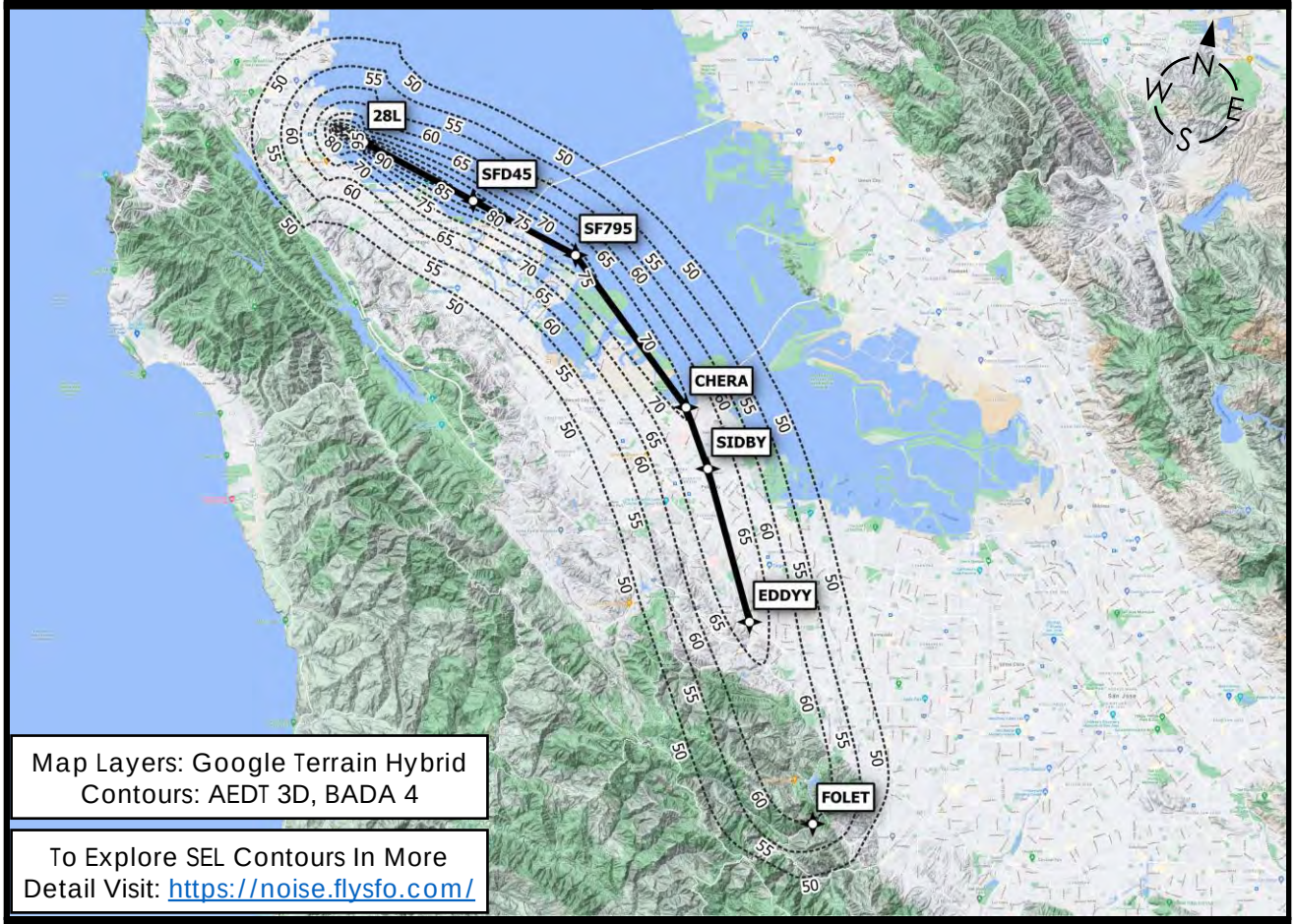
Weather Opportunity

VFR	✓	Day/Night Use
MVFR	✓	Day/Night Use
IFR	⊘	
LIFR	⊘	

Narrowbody 1 SEL GLS-TT RWY 28L

Revision 1

Changes: New



Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	66.41	66.41
SIDBY	5000	5000	68.93	68.93

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

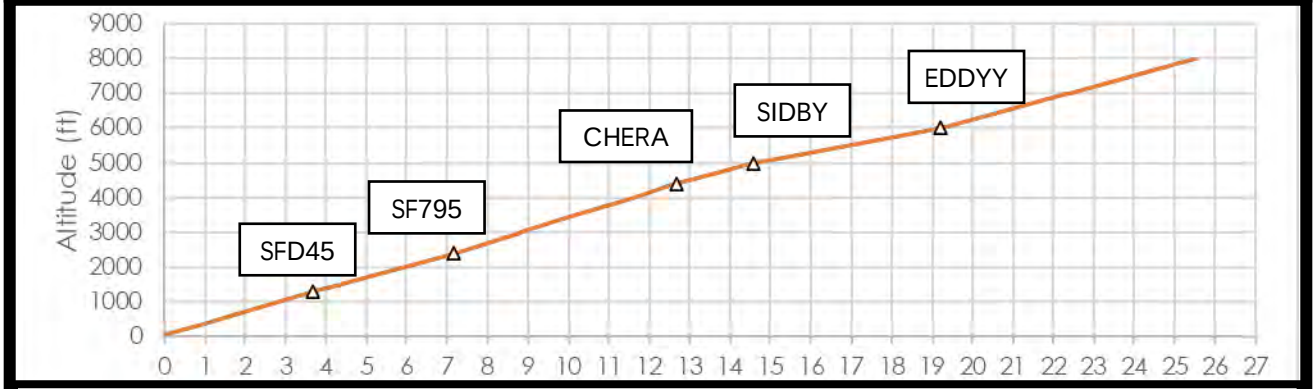
SEL Contour (dBA)	2010 Population
50	0
55	0
60	0
65	0
70	0
75	0
80	0
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Narrowbody 1 SEL GLS-TT RWY 28L

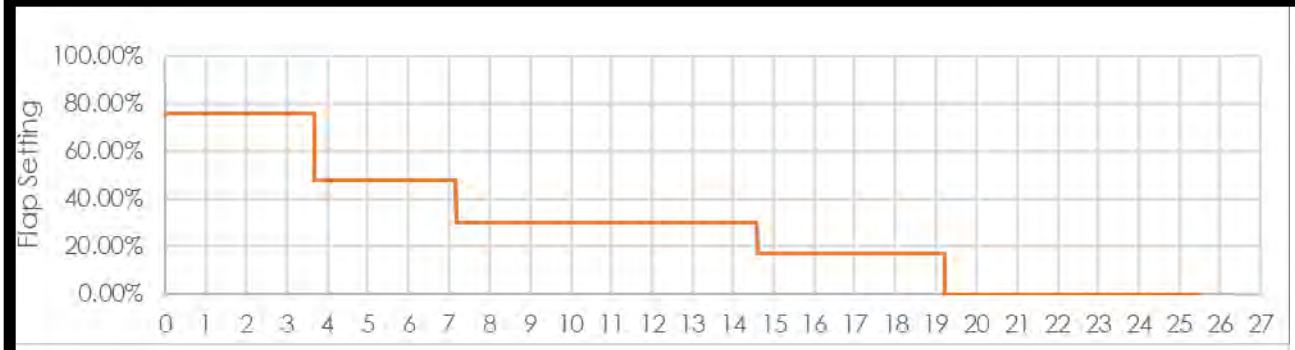
Revision 1

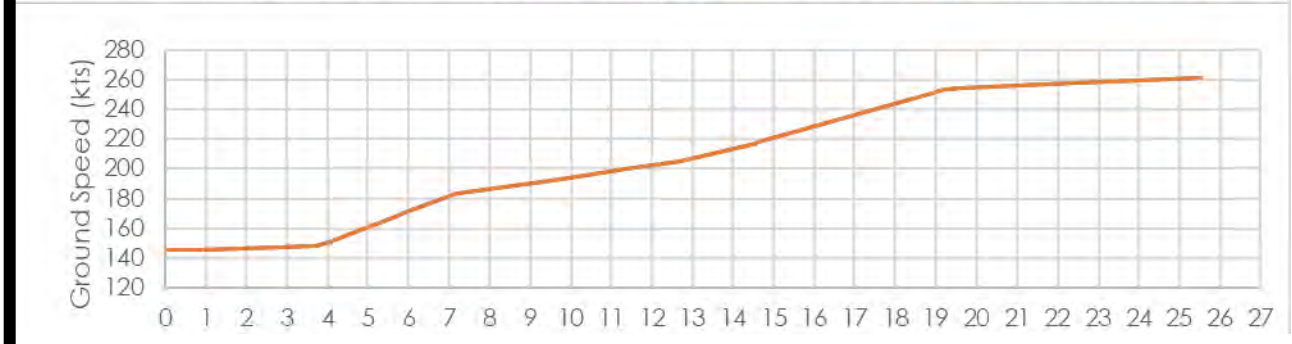
Changes: New



Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept

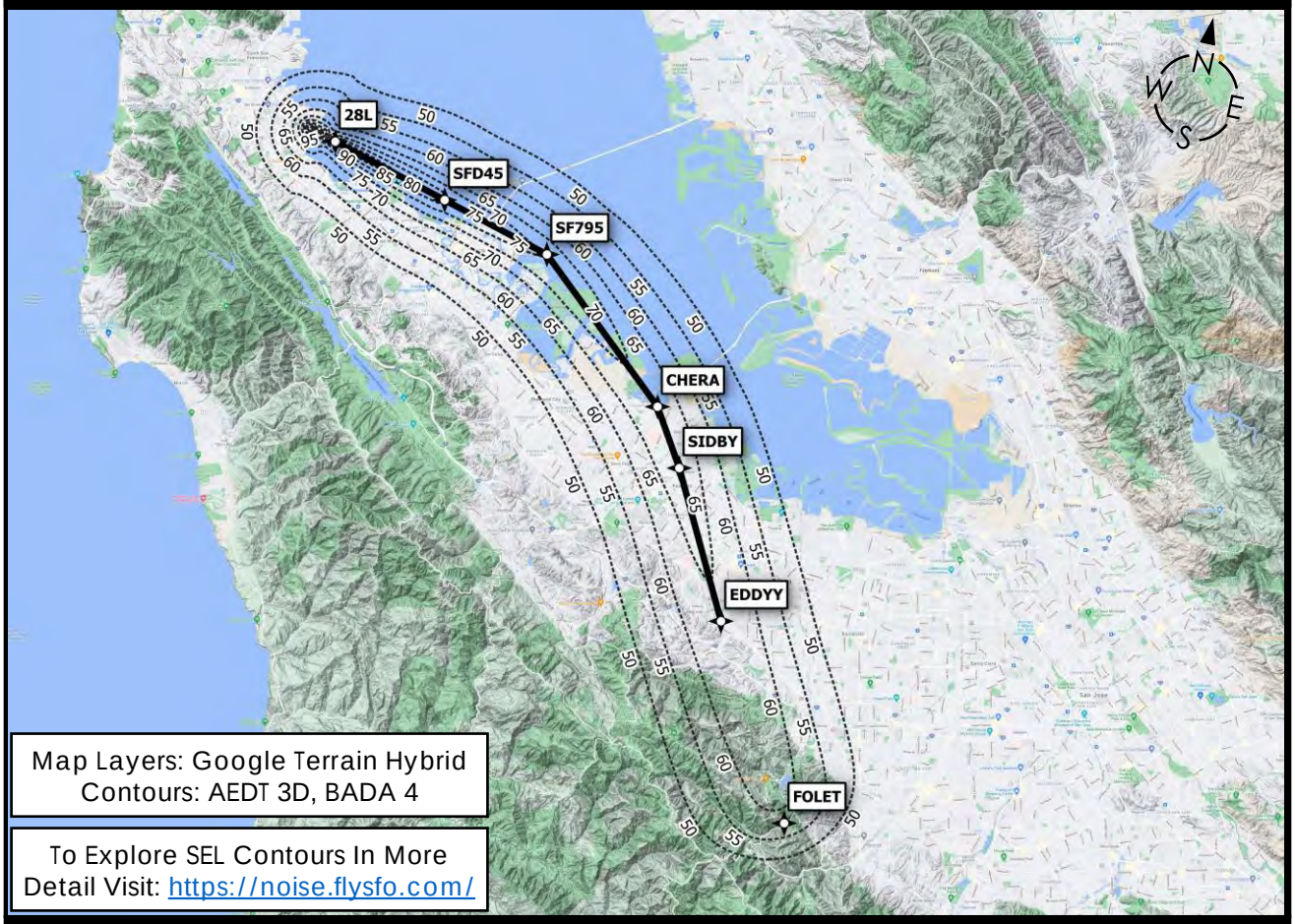




Narrowbody 2 SEL GLS-TT RWY 28L

Revision 1

Changes: New



Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	64.36	64.36
SIDBY	5000	5000	66.94	66.94

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

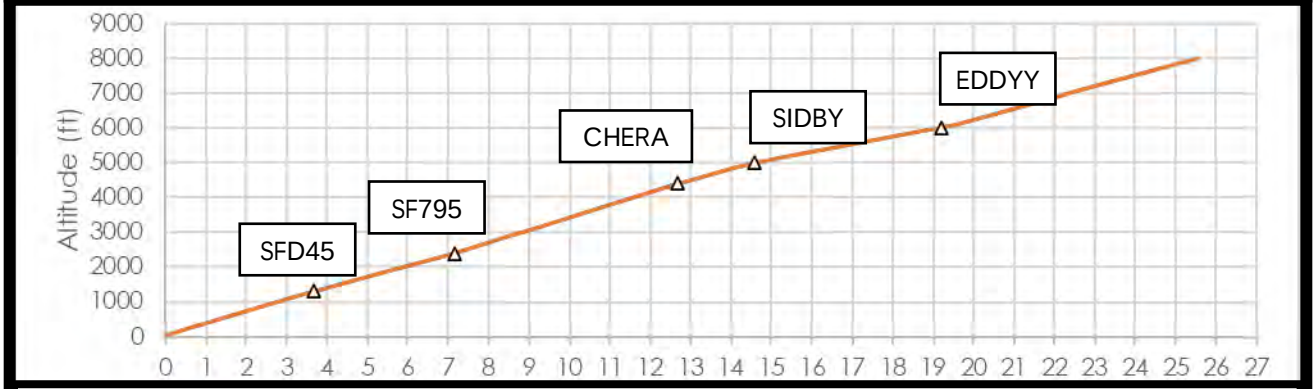
SEL Contour (dBA)	2010 Population
50	0
55	0
60	0
65	0
70	0
75	0
80	0
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Narrowbody 2 SEL GLS-TT RWY 28L

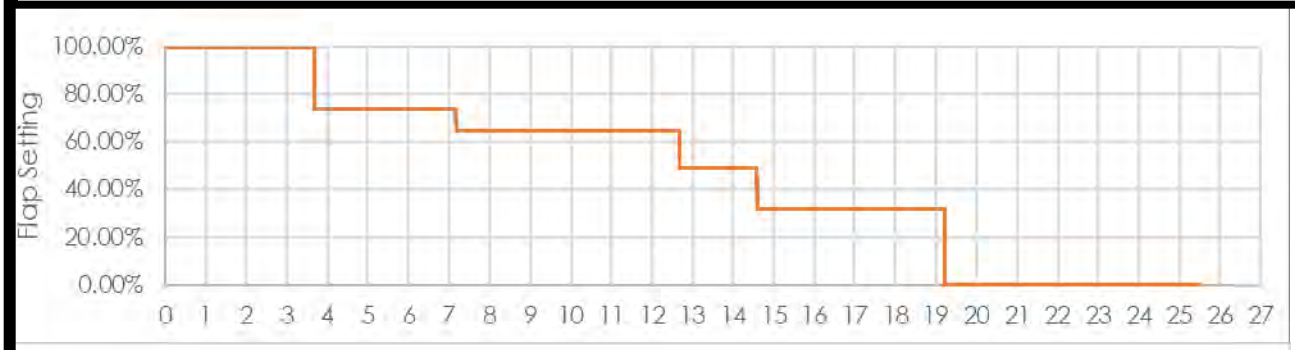
Revision 1

Changes: New



Simulated Flight Profile Characteristic for Existing Approach

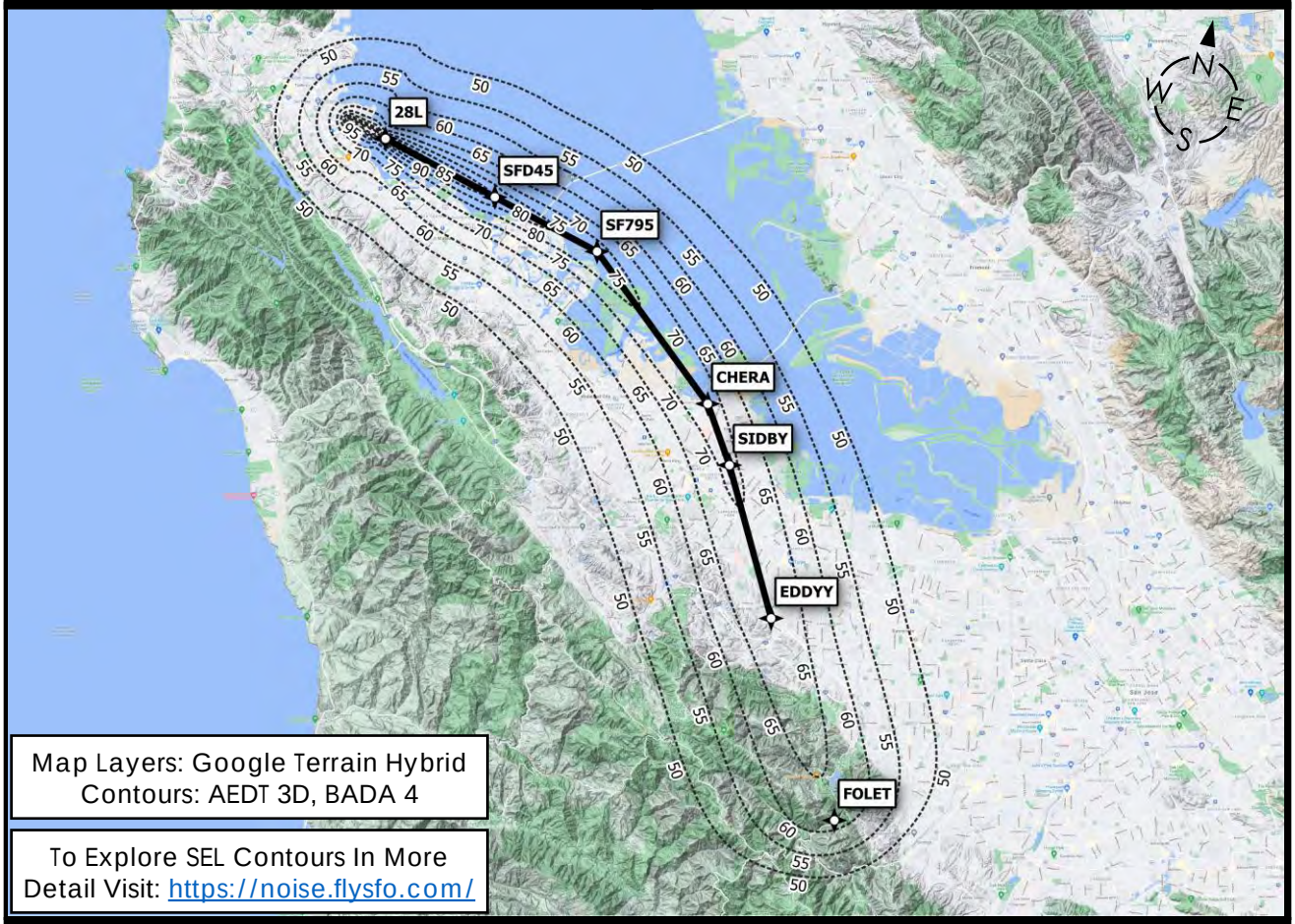
Simulated Flight Characteristic for Innovative Approach Concept



Widebody 1 SEL GLS-TT RWY 28L

Revision 1

Changes: New



Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	68.23	68.23
SIDBY	5000	5000	70.38	70.38

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

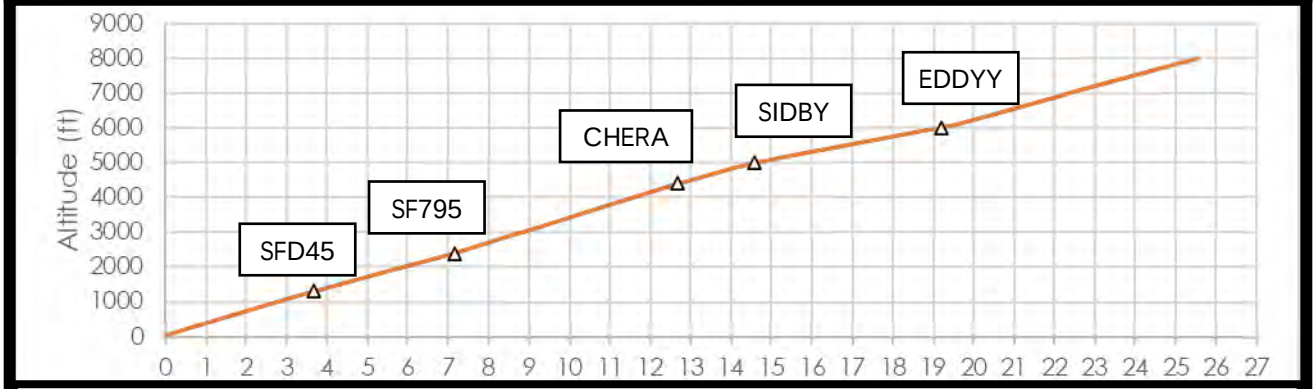
SEL Contour (dBA)	2010 Population
50	0
55	0
60	0
65	0
70	0
75	0
80	0
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Widebody 1 SEL GLS-TT RWY 28L

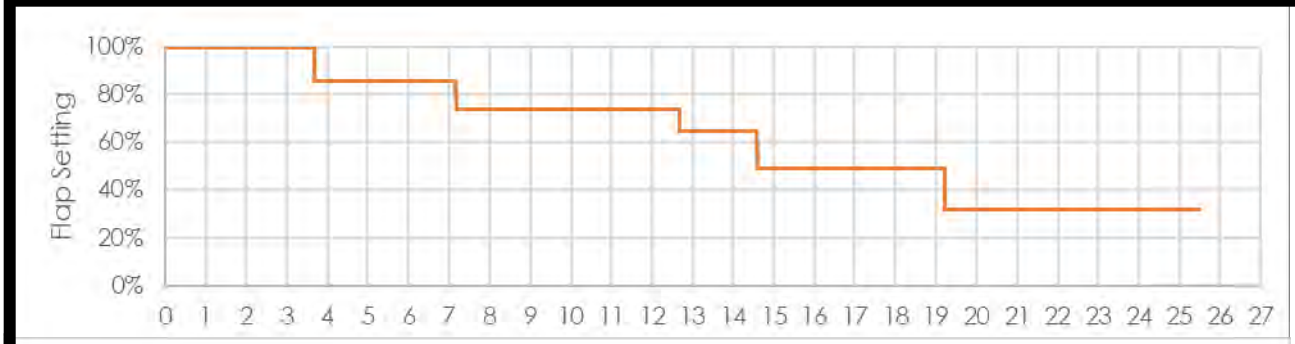
Revision 1

Changes: New



Simulated Flight Profile Characteristic for Existing Approach

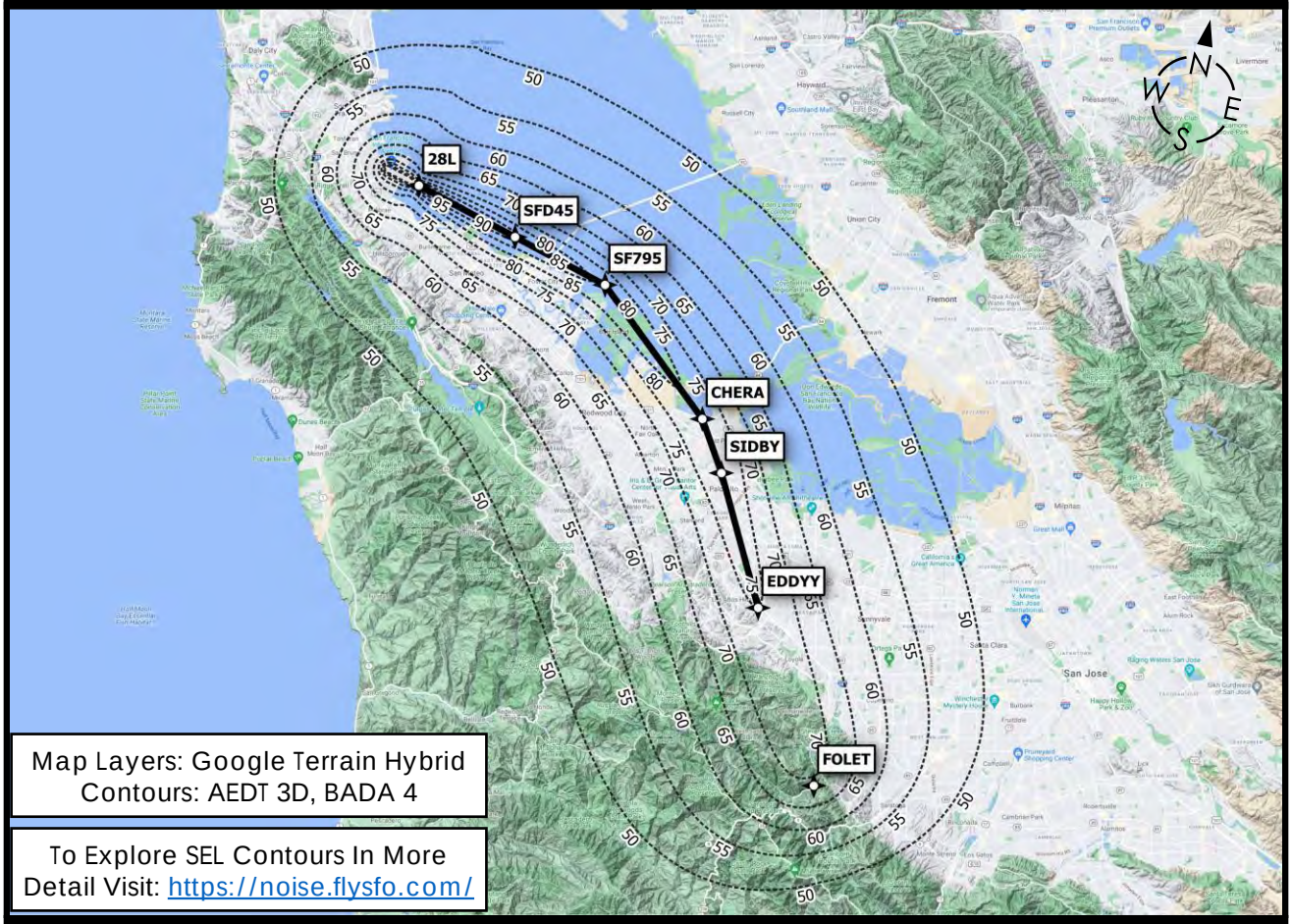
Simulated Flight Characteristic for Innovative Approach Concept



Widebody 2 SEL GLS-TT RWY 28L

Revision 1

Changes: New



Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	74.99	74.99
SIDBY	5000	5000	77.73	77.73

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

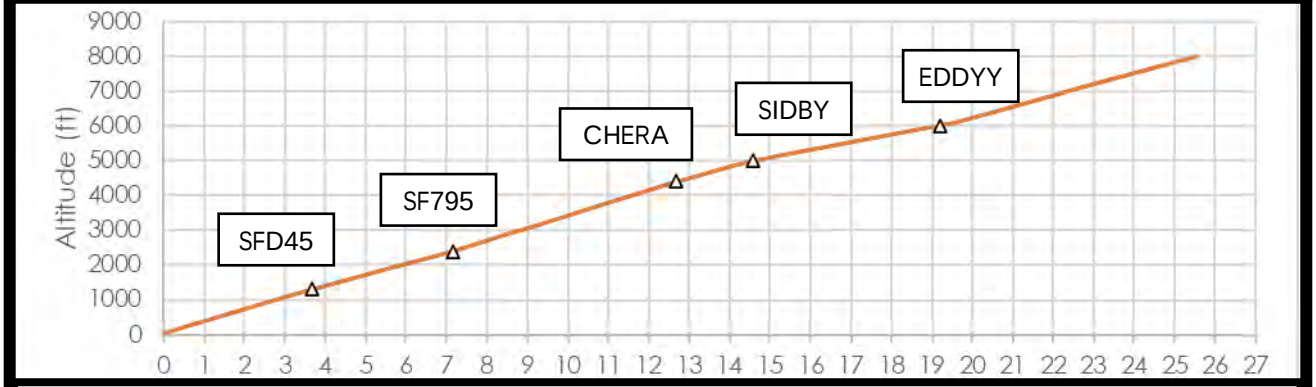
SEL Contour (dBA)	2010 Population
50	0
55	0
60	0
65	0
70	0
75	0
80	0
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Widebody 2 SEL GLS-TT RWY 28L

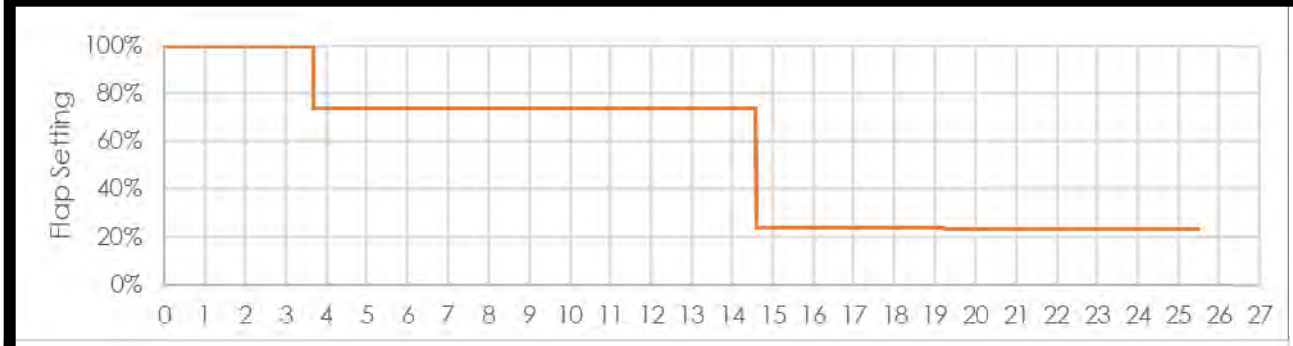
Revision 1

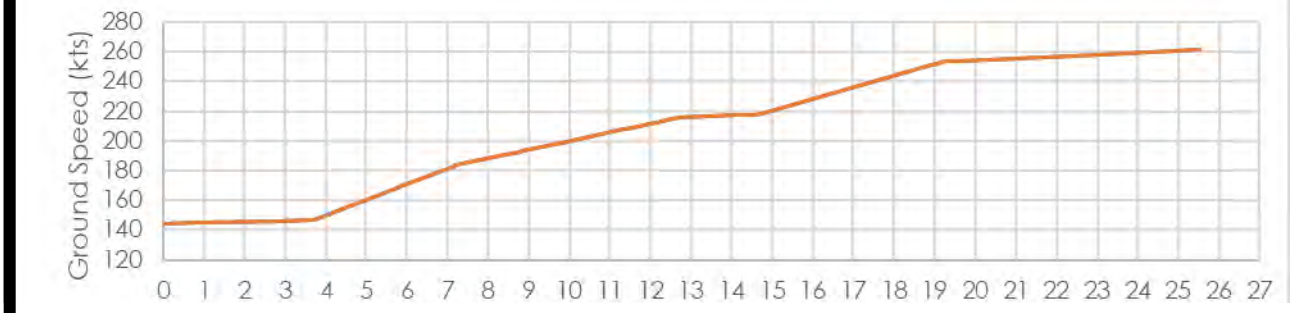
Changes: New



Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept





GLS TT RWY 28L (EDDYY)

Revision 1

Changes: New

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - NARROWBODY 1

PROCEDURE: GLS TT RWY 28L (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	Tipp Toe Visual Rwy 28L	GLS TT RWY 28L	DIFFERENCE	RANKING
Population within 60 dB SEL contour	251814	251814	0	
Population within 75 dB SEL contour	4889	4889	0	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	5000	5000	0	
SEL at Location EDDYY (dB)	66.41	66.41	0	
SEL at Location SIDBY (dB)	68.93	68.93	0	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	207	207	0	
Number of arrivals between 07:00 - 19:00	TBD	30 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - NARROWBODY 2

PROCEDURE: GLS TT RWY 28L (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	Tipp Toe Visual Rwy 28L	GLS TT RWY 28L	DIFFERENCE	RANKING
Population within 60 dB SEL contour	197034	197034	0	
Population within 75 dB SEL contour	3537	3537	0	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	5000	5000	0	
SEL at Location EDDYY (dB)	64.36	64.36	0	
SEL at Location SIDBY (dB)	66.94	66.94	0	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	207	207	0	
Number of arrivals between 07:00 - 19:00	TBD	30 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

Disclaimer

The information provided in this CFPP is intended to assist members of the public to review the potential changes that might be experienced following the implementation of a proposed innovative approach procedure concept when compared to an existing instrument approach procedure.

All information contained in this presentation was prepared by the SFIA GBAS Project Team using industry best practices, insight provided by SFIA Flight Procedures Subcommittee participants and historical experience regarding flight operations into SFIA.

Information presented in this handout is a prediction of current and future aircraft operations and is subject to change. This includes potential changes in the number of aircraft and flight crews that can utilize GLS approaches, changes in air traffic control methods, changes in FAA instrument procedure design criteria, changes in the airspace surrounding SFO and other variables which may not have been modeled that can affect the potential altitude, flap, thrust, aerodynamic configuration and operating weight of the aircraft.

Any further regulatory review of these procedures, including assessment under the National Environmental Policy Act will require an independent noise analysis. The noise results presented in this document are for exploratory purposes only and rely on BADA4 aircraft performance inputs; which are restricted to research purposes only per the Eurocontrol and the FAA terms of use in AEDT.

GLS TT RWY 28L (EDDYY)

Revision 1

Changes: New

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - WIDEBODY 1

PROCEDURE: GLS TT RWY 28L (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	Tipp Toe Visual Rwy 28L	GLS TT RWY 28L	DIFFERENCE	RANKING
Population within 60 dB SEL contour	298994	298994	0	
Population within 75 dB SEL contour	5365	5365	0	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	5000	5000	0	
SEL at Location EDDYY (dB)	68.23	68.23	0	
SEL at Location SIDBY (dB)	70.38	70.38	0	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	207	207	0	
Number of arrivals between 07:00 - 19:00	TBD	30 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - WIDEBODY 2

PROCEDURE: GLS TT RWY 28L (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	Tipp Toe Visual Rwy 28L	GLS TT RWY 28L	DIFFERENCE	RANKING
Population within 60 dB SEL contour	586968	586968	0	
Population within 75 dB SEL contour	97373	97373	0	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	5000	5000	0	
SEL at Location EDDYY (dB)	74.99	74.99	0	
SEL at Location SIDBY (dB)	77.73	77.73	0	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	207	207	0	
Number of arrivals between 07:00 - 19:00	TBD	30 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

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The information provided in this CFPP is intended to assist members of the public to review the potential changes that might be experienced following the implementation of a proposed innovative approach procedure concept when compared to an existing instrument approach procedure.

All information contained in this presentation was prepared by the SFIA GBAS Project Team using industry best practices, insight provided by SFIA Flight Procedures Subcommittee participants and historical experience regarding flight operations into SFIA.

Information presented in this handout is a prediction of current and future aircraft operations and is subject to change. This includes potential changes in the number of aircraft and flight crews that can utilize GLS approaches, changes in air traffic control methods, changes in FAA instrument procedure design criteria, changes in the airspace surrounding SFO and other variables which may not have been modeled that can affect the potential altitude, flap, thrust, aerodynamic configuration and operating weight of the aircraft.

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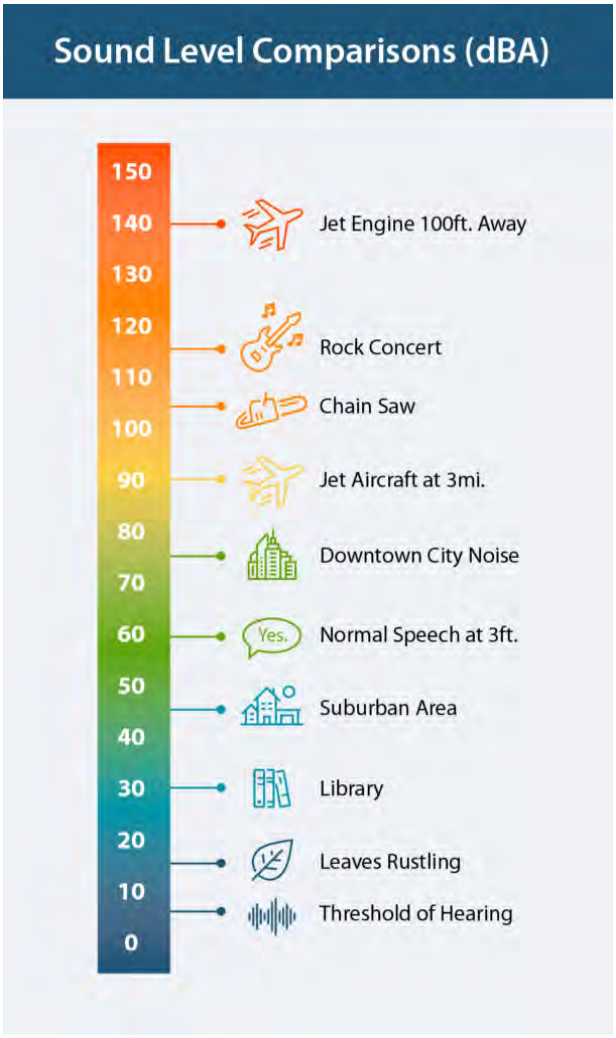
Information About SEL Contours

Revision 1

Changes: N/A

The Innovative Approach Evaluation Criteria, shown on the "Summary" page, use SEL 75 dB and 60 dB contours to compare the population counts impacted by each procedure. In reference to aircraft overflights, SEL is generally 10 dB above Lmax. The SEL 75 dB level was selected as part of the evaluation criteria due to its comparison to Lmax 65 dB, which is approximately the sound level of normal speech at a distance of 3 feet. The SEL 60 dB was selected due to its comparison to Lmax 50 dB, which is approximately the sound level of background noise at a quiet urban area.

Relative to sound level changes, an increase of 5 dBA is readily perceptible to the public and a 3 dBA increase is barely perceivable to the average healthy human ear.



Glossary

Revision 1

Changes: Updated

GBAS

Ground Based Augmentation System – A navigational aid, installed on the airport, that broadcasts a signal to aircraft that enhances ("augments") their existing GPS navigation capabilities enabling precision approaches to all runways at the airport.

GLS

GBAS Landing System (GLS) is the FAA's official term for a GBAS instrument approach procedure. A GLS approach is considered a "precision" approach procedure which means it provides precise navigational guidance similar to the Instrument Landing System (ILS) that have been used at SFO for over 50 years.

SEL

Sound Exposure Level – is a noise metric that represents all the acoustic energy (a.k.a. sound pressure) of an individual noise event as if that event had occurred within a one-second time period. SEL captures both the level (magnitude) and the duration of a sound event in a single numerical quantity, by "squeezing" all the noise energy from an event into one second. This provides a uniform way to make comparisons among noise events of various durations.

Lmax

Maximum Sound Level– is a noise metric that represents the maximum amount of acoustic energy (a.k.a. sound pressure) which occurs during an individual noise event regardless of its duration.

dB or dBA

Decibel (dB) or an "A-weighted" decibel - is the unit used to measure the intensity of a sound. The human ear hears sound pressures over a wide range. Decibels, which are measured on a logarithmic scale, correspond to the way our ears interpret sound pressures. The "A-weighted" scale most closely approximates the relative loudness of sounds in air as perceived by the human ear and provides a more useful way to evaluate the effect of noise exposure on humans by focusing on those parts of the frequency spectrum where we hear most. All noise results in this document use dBA.

MSL

Mean Sea Level (MSL), a tidal datum that is used to express geometric altitude above the earth. MSL references in this packet use imperial feet and can be thought of like a tapeline measurement from the ground to an object.

Glossary

Revision 1

Changes: Updated

ATC

Air Traffic Control, which represents a combination of human beings and technology responsible for aircraft separation from terrain, weather and other aircraft and aeronautical objects. At SFO, ATC is provided by a combination of individuals working locally in the tower and offsite with radar and voice communication capabilities.

Waypoint

Is a geographical location defined by a latitude/longitude geographic coordinate. These 5-letter waypoints, VHF intersections, 5-letter pronounceable DME fixes and 3-letter NAVAID IDs are published on various FAA aeronautical navigation products (IFR Enroute Charts, VFR charts, Terminal Procedures Publications, etc.).

RNAV or RNAV (GPS)

Area Navigation describes a navigation method used by aircraft which commonly utilize the Global Positioning System of satellites to determine information about their lateral position on earth. The GBAS sends an augmentation signal to aircraft using area navigation to increase the precision of the aircraft position, including additional information about the vertical location of the aircraft relative to the airport.

ILS

Instrument Landing System is the technology currently installed on 3 runways at SFO which sends an electronic signal along the final approach path which aircraft can detect and navigate within a fixed lateral and vertical corridor

RWY

Abbreviation for runway

Nmi

Nautical Mile – equal to 6,076 feet.

AEDT

Aviation Environmental Design Tool - AEDT is a software system that dynamically models aircraft performance in space and time to produce fuel burn, emissions and noise. Full flight gate-to-gate analyses are possible for study sizes ranging from a single flight at an airport to scenarios at the regional, national, and global levels.

Glossary

Revision 1

Changes: Updated

Waypoint

Is a geographical location defined by a latitude/longitude geographic coordinate. These 5-letter waypoints, VHF intersections, 5-letter pronounceable DME fixes and 3-letter NAVAID IDs are published on various FAA aeronautical navigation products (IFR Enroute Charts, VFR charts, Terminal Procedures Publications, etc.).

VFR

Visual Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is greater than 3,000 feet above ground level and the visibility is greater than five miles.

MVFR

Marginal Visual Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is between 1,000 - 3,000 feet above ground level and the visibility is between three and five miles.

IFR

Instrument Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is less than 1,000 feet above ground level and the visibility is less than three miles.

LIFR

Low Instrument Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is less than 500 feet above ground level and the visibility is less than 1/2 miles..

GLS-TT RWY 28R (EDDYY)

Revision 1

Changes: New

San Francisco International Airport (SFO) has identified several Innovative Approach (IA) procedures primarily designed for noise reduction. Each procedure is described in a Community Flight Procedure Package (CFPP) that provides information about the IA and compares aircraft noise and flight performance of the IA to a comparable existing procedure if applicable. Please note that 1) IA procedure design is limited to be within approximately 20 nautical miles (nm) from the airport, 2) the maximum expected number of arrivals to use an IA procedure is 30 per day, and 3) the estimated noise reduction – although small or imperceptible in some areas – is part of an incremental noise reduction process that begins with demonstrating procedure design viability with the objective to achieve significant noise reduction in the future.

The CFPP includes the following pages of information:

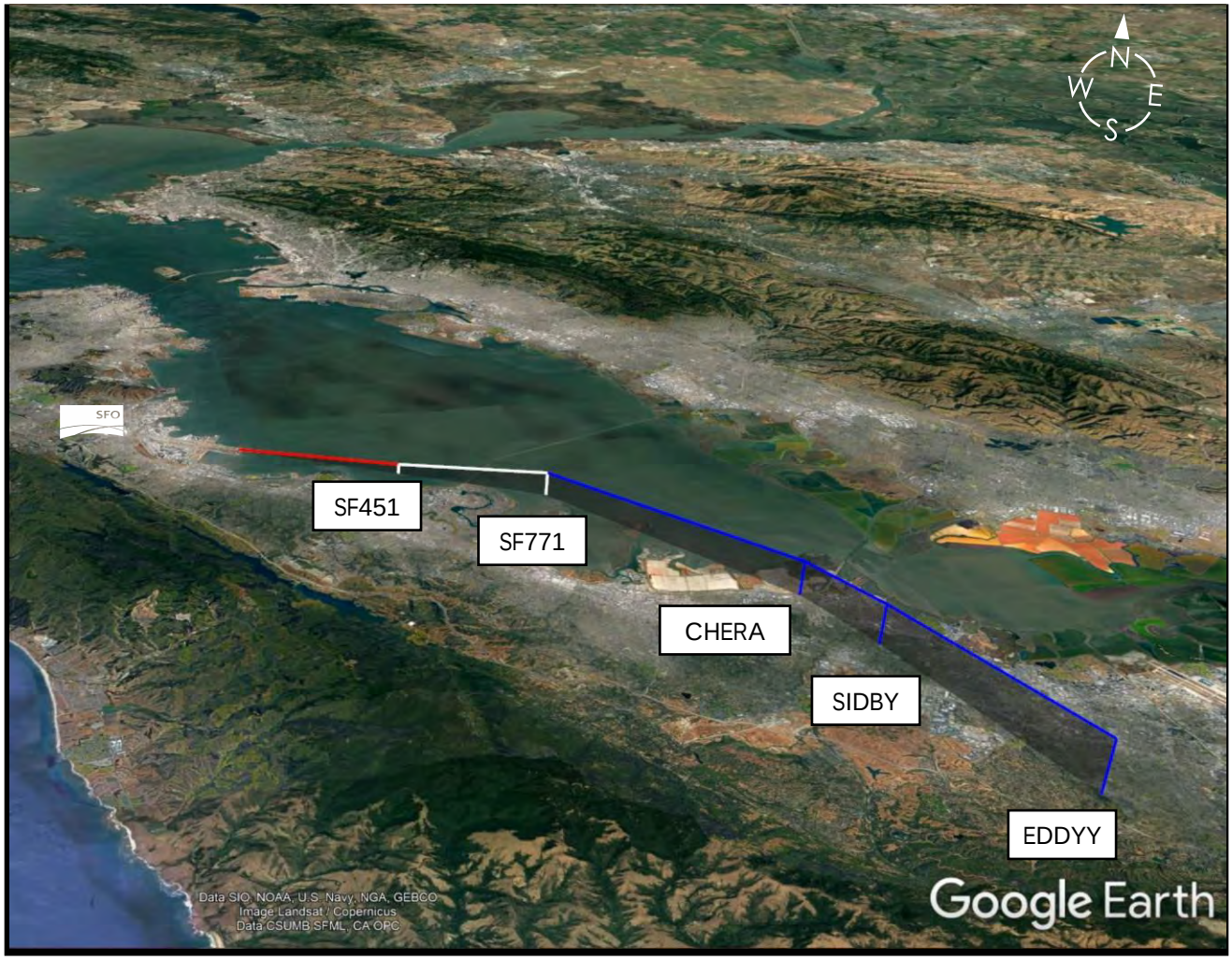
- Page 1 includes the name and description of the IA, a map of the IA flight path, and the project goals being met by the procedure. The altitudes shown along the flight path indicate the change in altitude on the IA flight path compared to the existing procedure.
- Page 2 compares the navigational charts of the existing approach procedure and the proposed IA, the percentage of aircraft at SFO that are currently capable of using the IA, and the types of weather and visibility conditions in which the IA could be used.
- Pages 3, 5, 7, and 9 include maps that illustrate the waypoints, flight path, and Sound Exposure Level (SEL) contours of the existing and IA procedures for two Narrowbody and two Widebody aircraft. The pages also list the altitude and SEL changes at sample points, and the potential changes in population impacted by the implementation of the IA. Please note that 1) aircraft noise levels below 60 decibels (dB) may be similar to urban ambient noise, and 2) changes in noise levels below 3 dB are generally not perceptible by the human ear. Therefore, the population within an area illustrated as a noise increase may not notice the actual noise increase.
- Pages 4, 6, 8, and 10 show graphs that compare how altitude, flap settings, net thrust, and ground speed change during the flights of the existing approach procedure and the proposed IA. This data was used in the FAA Aviation Environmental Design Tool (AEDT 3d) noise model to calculate the SEL information shown on pages 3, 5, 7 and 9 and reflects the project team's best efforts to model how each of the aircraft would fly the IA without using aerodynamic braking.
- Pages 11 and 12 show comparisons of the existing procedure to the IA relative to evaluation criteria for Narrowbody and Widebody aircraft.

The remaining pages describe information about noise exposure and terms used throughout the CFPP.

GLS-TT RWY 28R (EDDYY)

Revision 1

Changes: New



GLS Instrument approach to runway 28R originating southeast of the airport, starting at EDDYY.

This approach is an identical overlay of the existing Tipp Toe Charted Visual Flight Procedure (CVFP) approach, in use today, under VFR conditions. The GLS version of the approach converts optional CVFP published altitudes, into required minimum IFR altitudes.

Project Goals

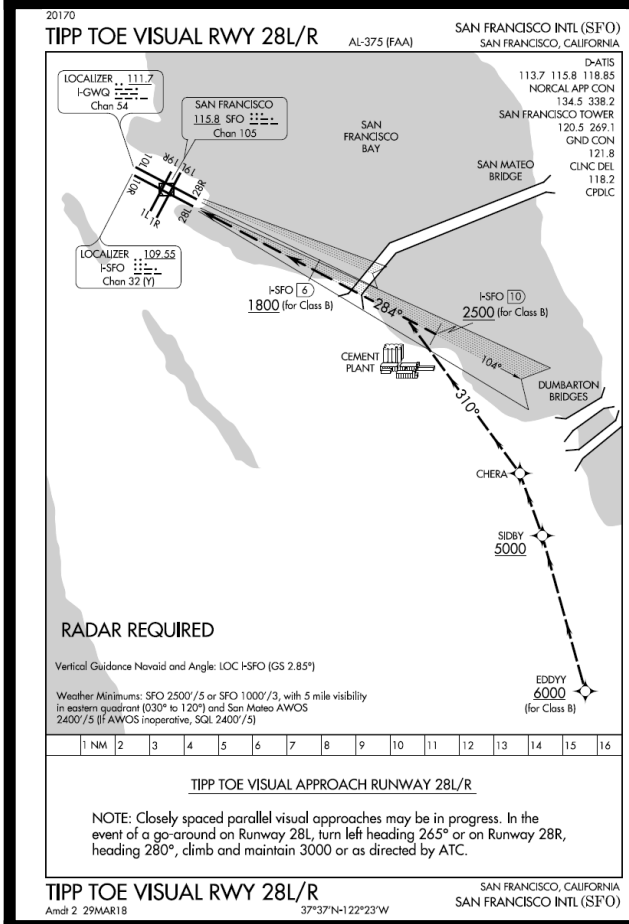
- ✓ Noise reduction
- ✓ ILS Redundancy
- ✓ Efficiency
- ✓ Reduce Delays

GLS-TT RWY 28R (EDDYY)

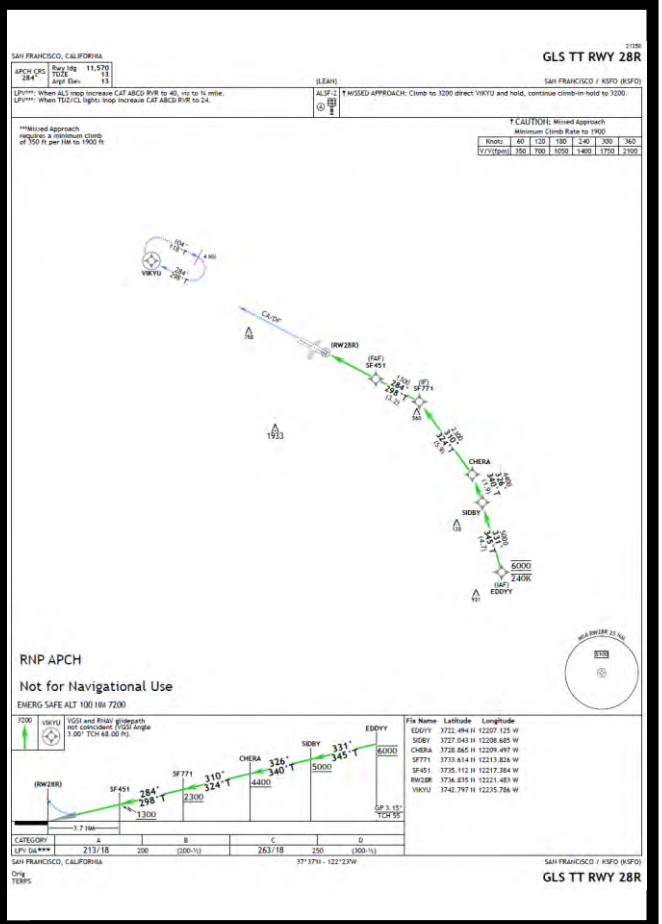
Revision 1

Changes: New

Existing Approach
Tipp Toe Visual RWY 28R



Preliminary Concept
GLS-TT RWY 28R



Aircraft @ SFO Capable of Using This Procedure

Regional/BizJet < 1%

Narrowbody ~ 30%

Widebody ~ 30%

Narrowbody and widebody aircraft capable of using this approach into SFO are anticipated to <u>increase</u> over the next 5 years

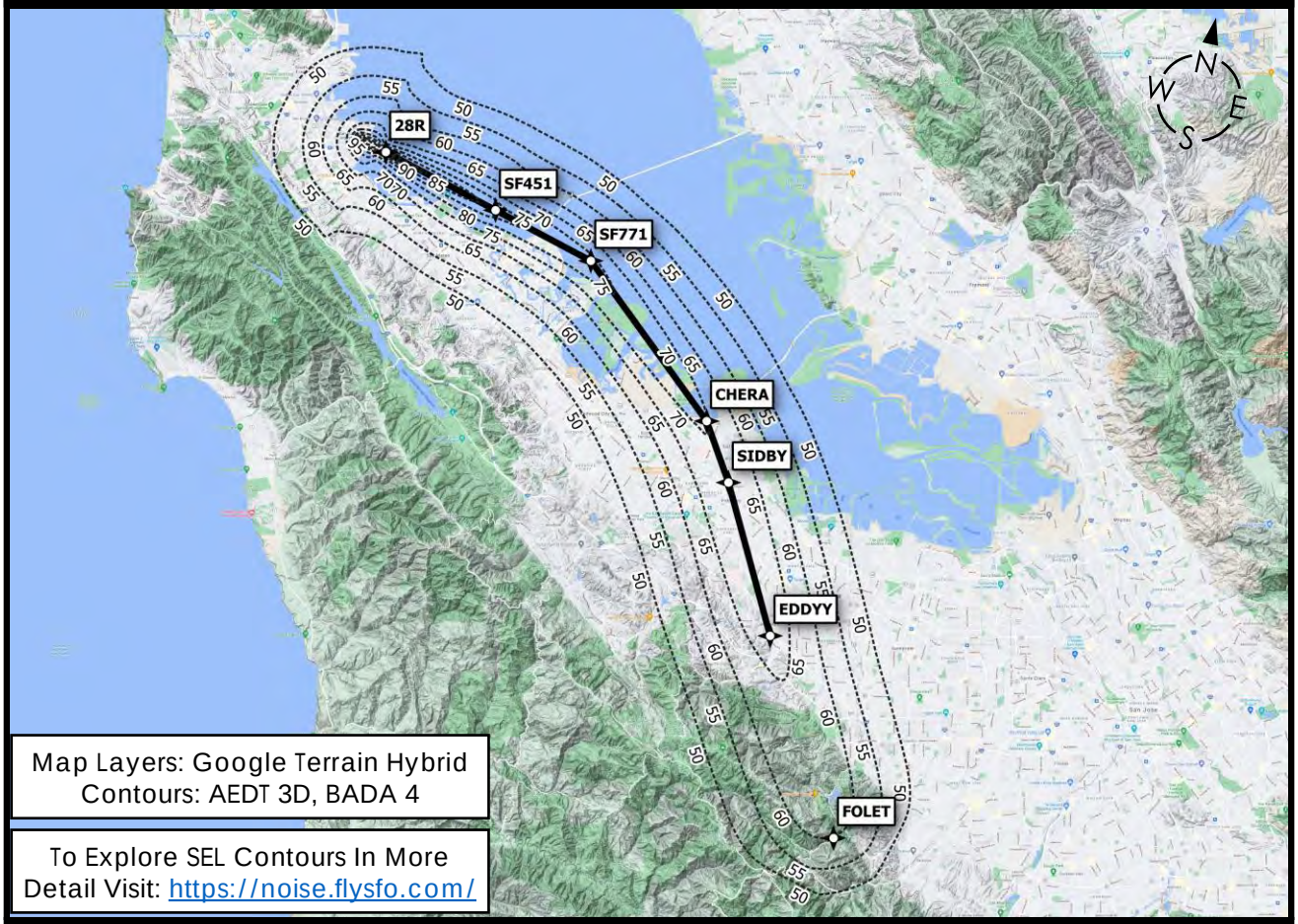
Weather Opportunity

VFR	✓	Day/Night Use
MVFR	✓	Day/Night Use
IFR	⊘	
LIFR	⊘	

Narrowbody 1 SEL GLS-TT RWY 28R

Revision 1

Changes: New



Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	66.46	66.46
SIDBY	5000	5000	69.04	69.04

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

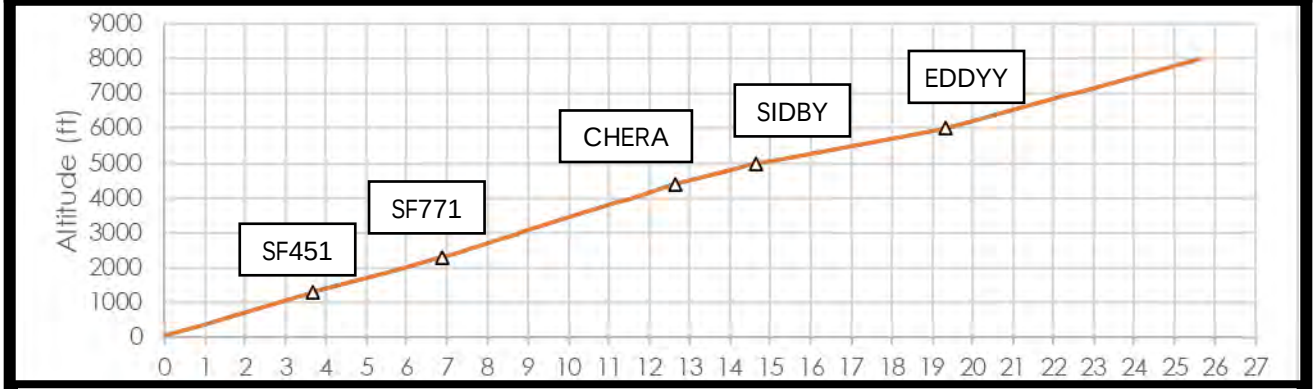
SEL Contour (dBA)	2010 Population
50	0
55	0
60	0
65	0
70	0
75	0
80	0
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Narrowbody 1 SEL GLS-TT RWY 28R

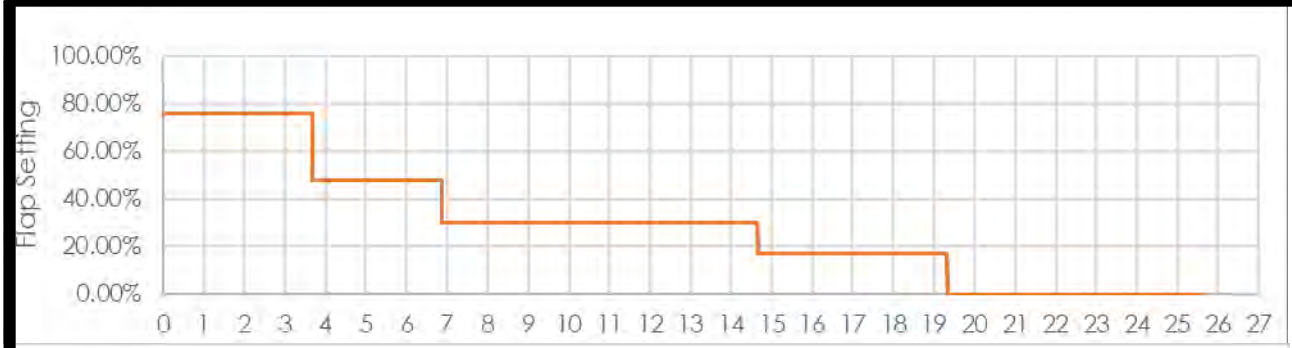
Revision 1

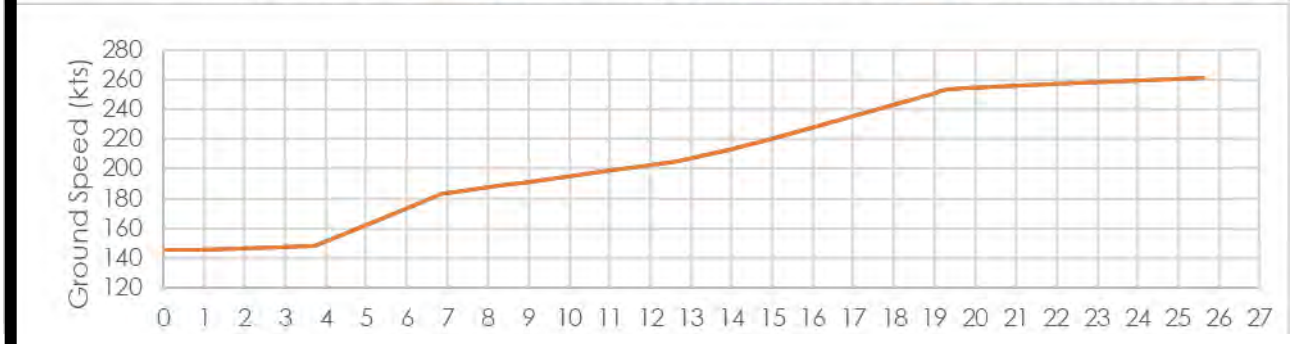
Changes: New



Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept

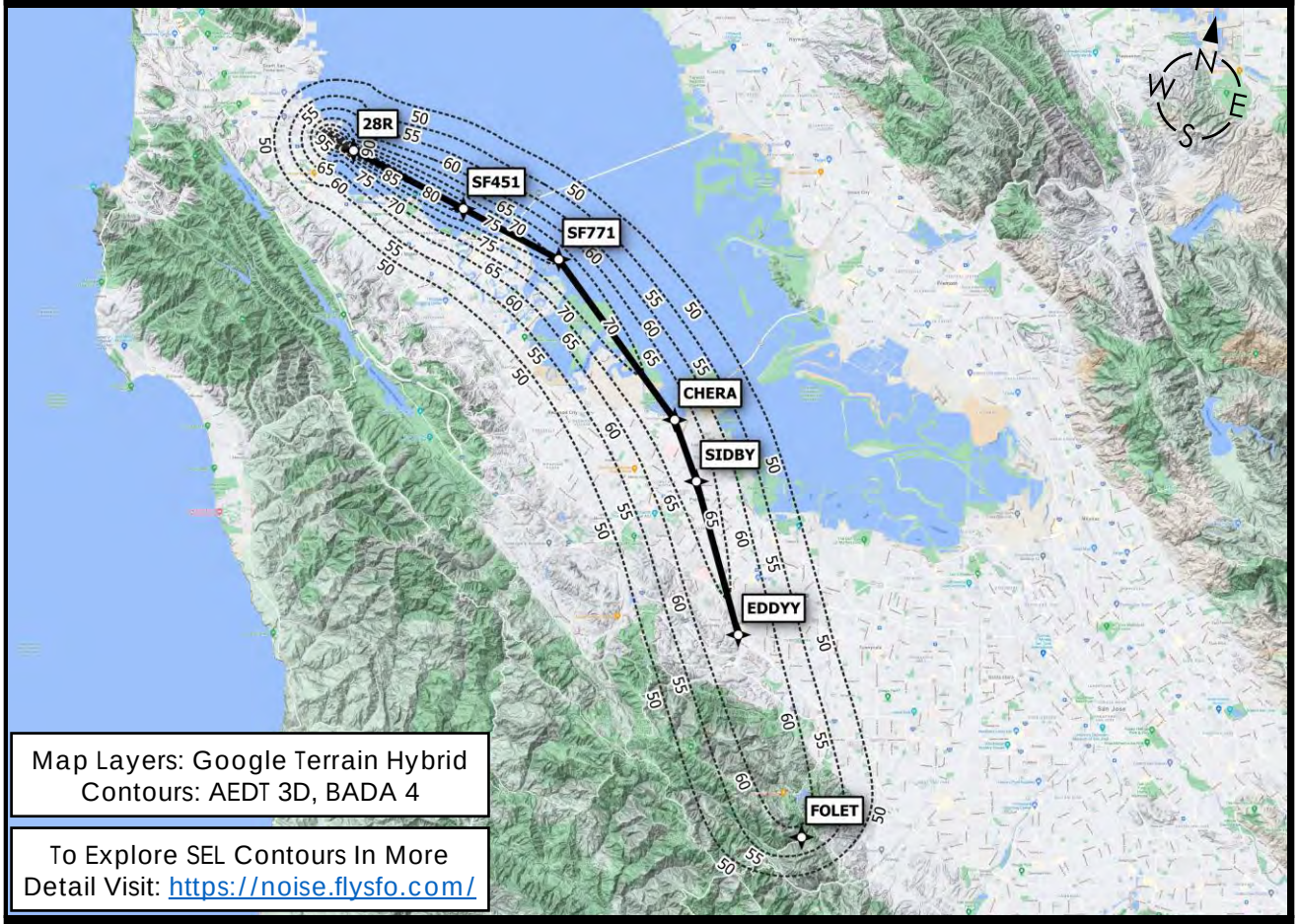




Narrowbody 2 SEL GLS-TT RWY 28R

Revision 1

Changes: New



Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	64.42	64.42
SIDBY	5000	5000	67.01	67.01

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

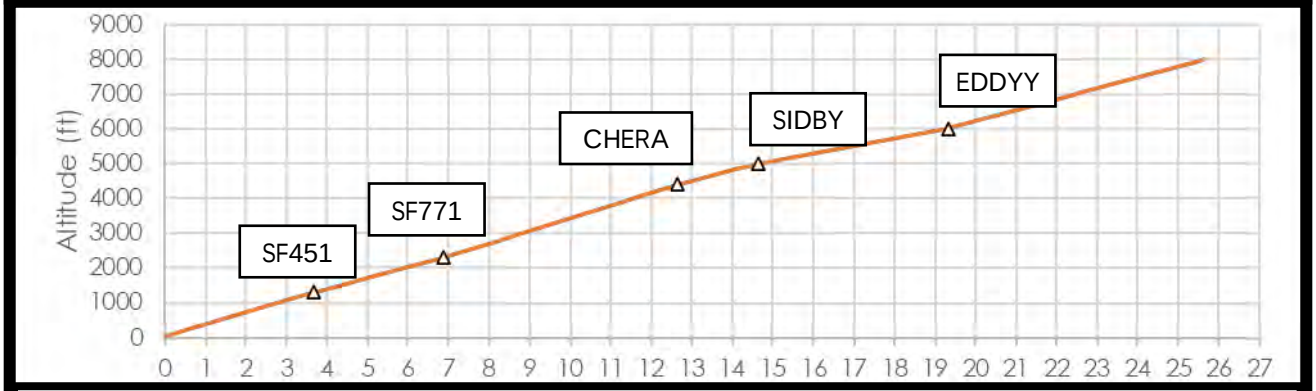
SEL Contour (dBA)	2010 Population
50	0
55	0
60	0
65	0
70	0
75	0
80	0
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Narrowbody 2 SEL GLS-TT RWY 28R

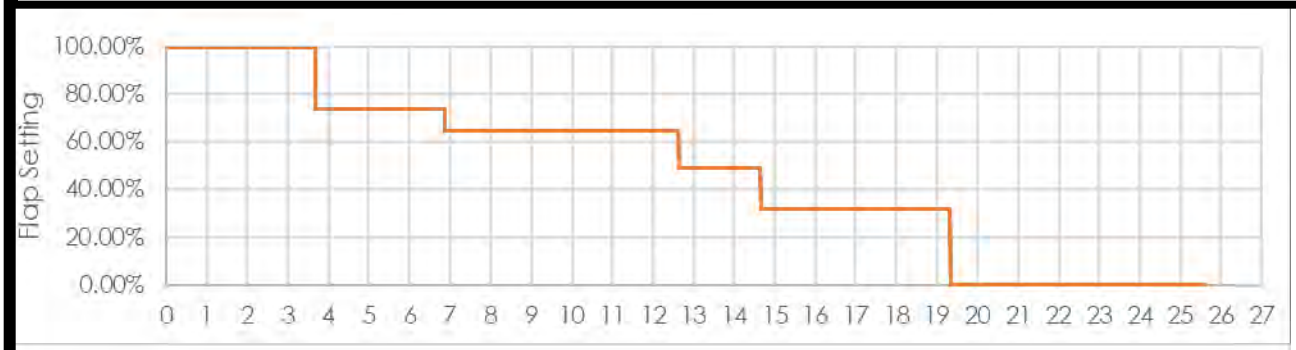
Revision 1

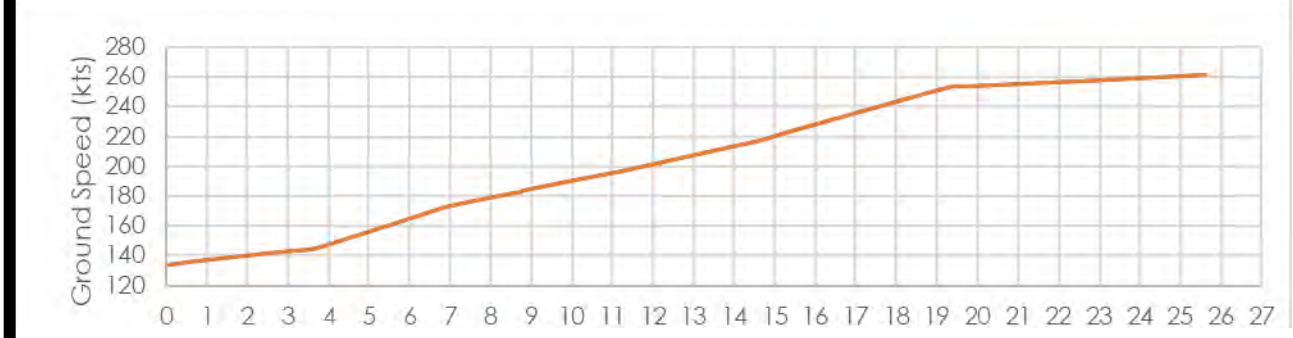
Changes: New



Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept

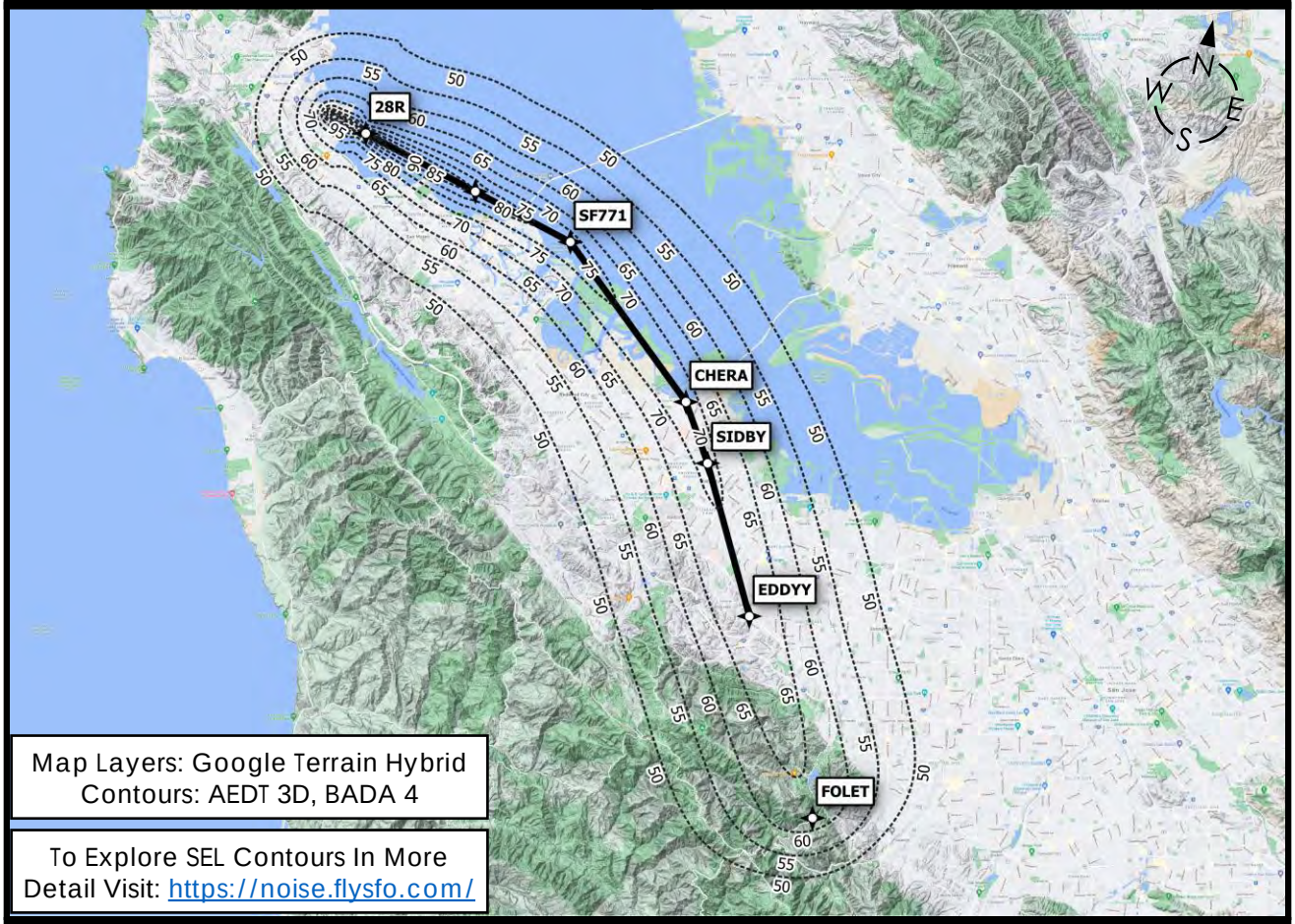




Widebody 1 SEL GLS-TT RWY 28R

Revision 1

Changes: New



Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	68.27	68.27
SIDBY	5000	5000	70.47	70.47

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

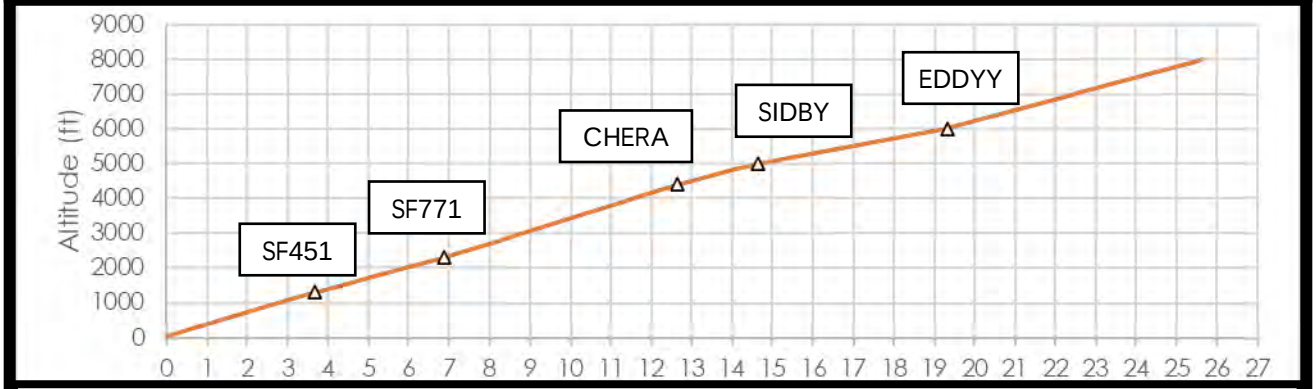
SEL Contour (dBA)	2010 Population
50	0
55	0
60	0
65	0
70	0
75	0
80	0
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Widebody 1 SEL GLS-TT RWY 28R

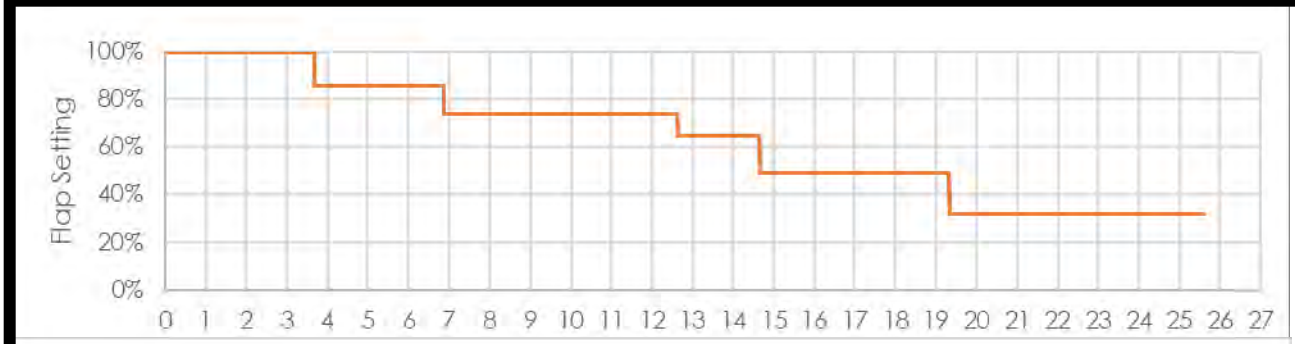
Revision 1

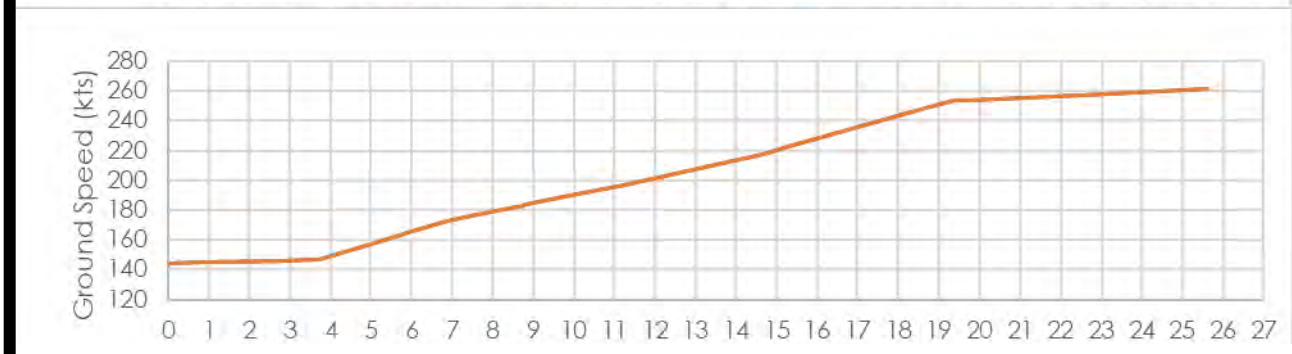
Changes: New



Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept

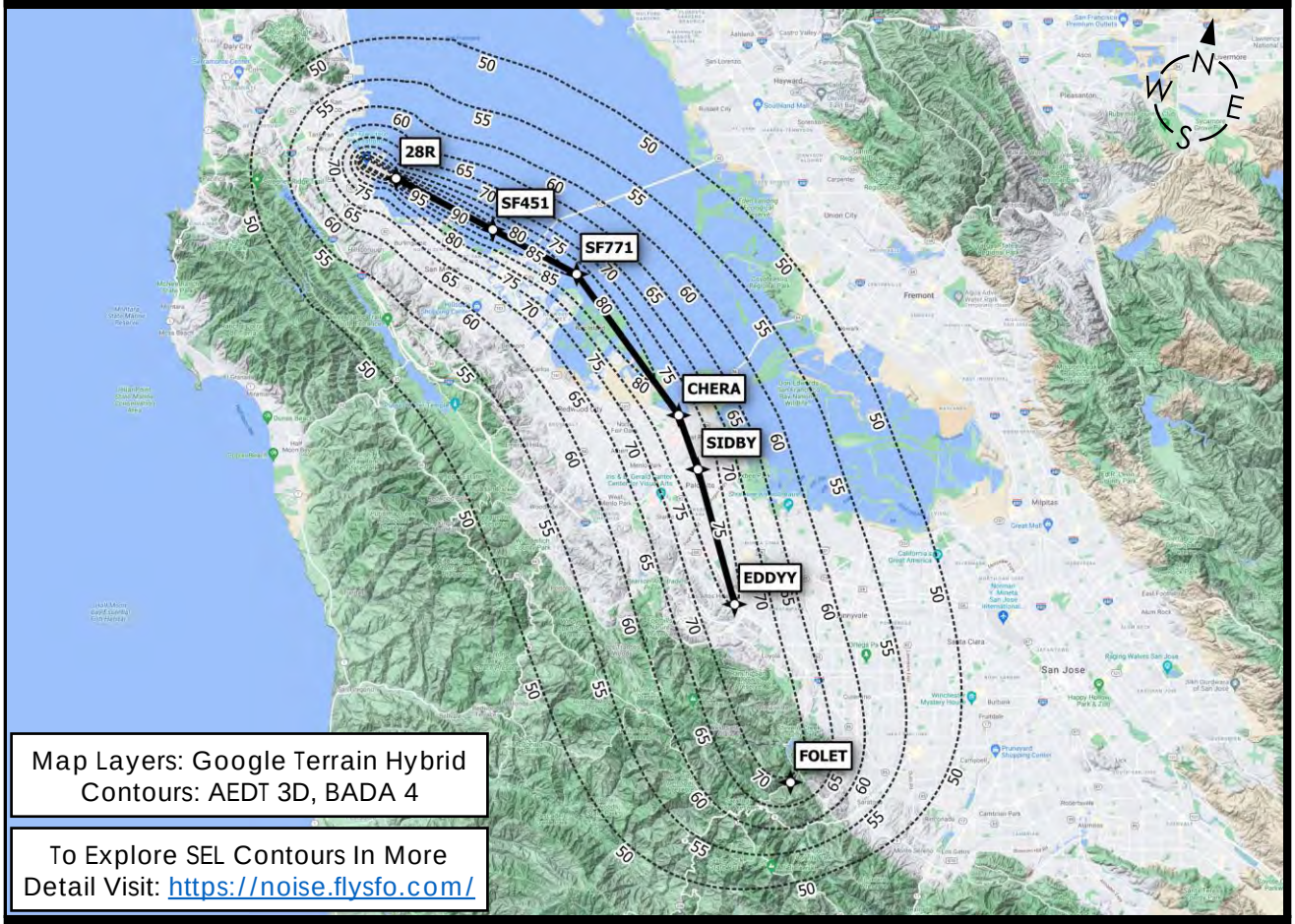




Widebody 2 SEL GLS-TT RWY 28R

Revision 1

Changes: New



Map Layers: Google Terrain Hybrid
Contours: AEDT 3D, BADA 4

To Explore SEL Contours In More Detail Visit: https://noise.flysfo.com/

Sample Points	Altitude		SEL (dBA)	
	Existing	Proposed	Existing	Proposed
EDDYY	6000	6000	75.04	75.04
SIDBY	5000	5000	77.75	77.75

Map Legend

- Instrument Procedure Path
- Estimated Current SEL Noise Contour
- Instrument Procedure Waypoint
- Potential Area of Increased SEL
- Potential Area of Decreased SEL

Potential Change In Population Effected

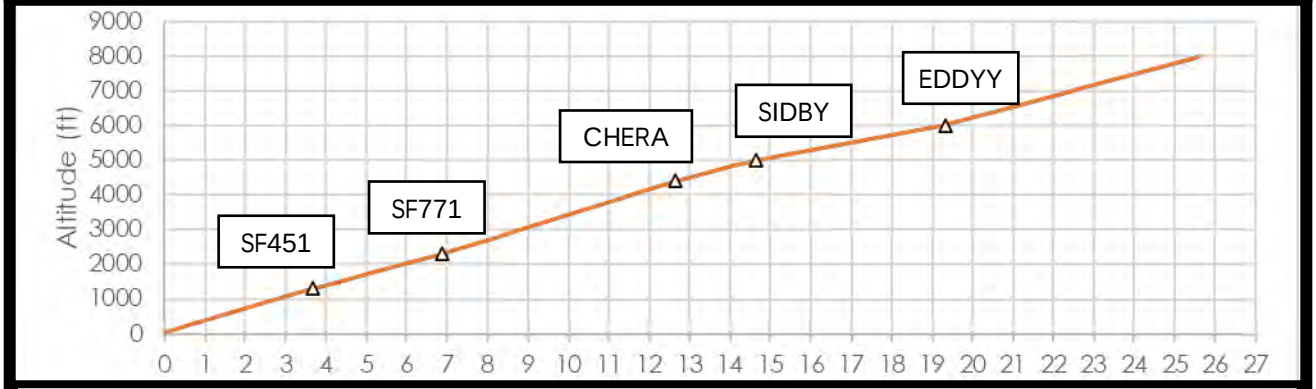
SEL Contour (dBA)	2010 Population
50	0
55	0
60	0
65	0
70	0
75	0
80	0
85	0
90	0
95	0

Results tabulated and depicted are derived from AEDT 3D using Eurocontrol BADA 4 Information. Real world results may differ

Widebody 2 SEL GLS-TT RWY 28R

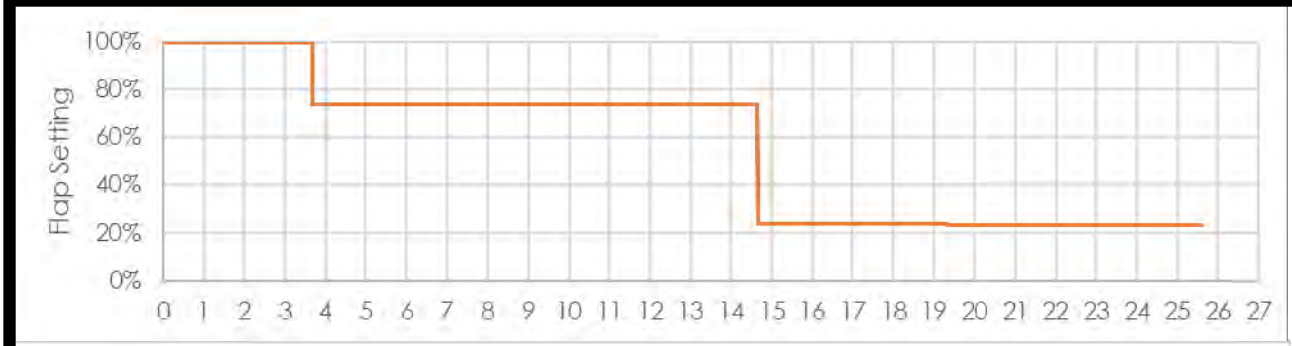
Revision 1

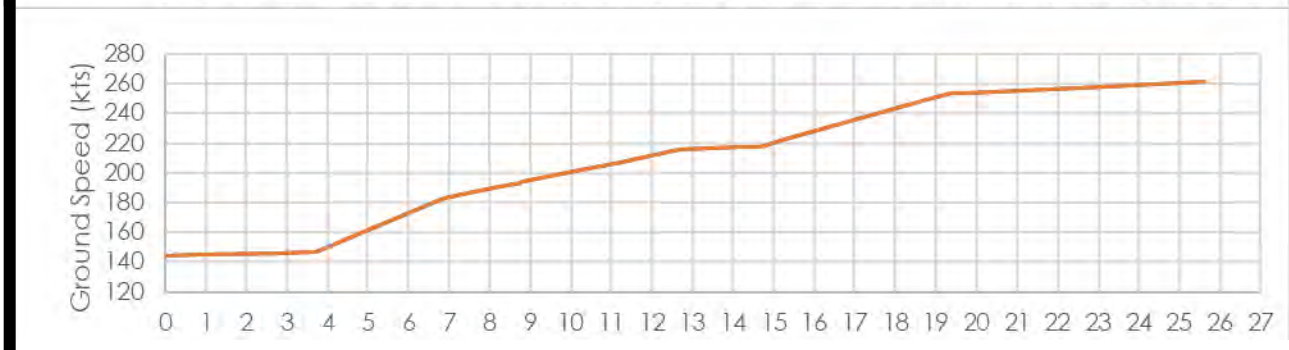
Changes: New



Simulated Flight Profile Characteristic for Existing Approach

Simulated Flight Characteristic for Innovative Approach Concept





GLS TT RWY 28R (EDDYY)

Revision 1

Changes: New

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - NARROWBODY 1

PROCEDURE: GLS TT RWY 28R (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	Tipp Toe Visual Rwy 28R	GLS TT RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	240453	240453	0	
Population within 75 dB SEL contour	3684	3684	0	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	5000	5000	0	
SEL at Location EDDYY (dB)	66.46	66.46	0	
SEL at Location SIDBY (dB)	69.04	69.04	0	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	207	207	0	
Number of arrivals between 07:00 - 19:00	TBD	30 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - NARROWBODY 2

PROCEDURE: GLS TT RWY 28R (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	Tipp Toe Visual Rwy 28R	GLS TT RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	188522	188522	0	
Population within 75 dB SEL contour	1786	1786	0	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	5000	5000	0	
SEL at Location EDDYY (dB)	64.42	64.42	0	
SEL at Location SIDBY (dB)	67.01	67.01	0	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	207	207	0	
Number of arrivals between 07:00 - 19:00	TBD	30 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

Disclaimer

The information provided in this CFPP is intended to assist members of the public to review the potential changes that might be experienced following the implementation of a proposed innovative approach procedure concept when compared to an existing instrument approach procedure.

All information contained in this presentation was prepared by the SFIA GBAS Project Team using industry best practices, insight provided by SFIA Flight Procedures Subcommittee participants and historical experience regarding flight operations into SFIA.

Information presented in this handout is a prediction of current and future aircraft operations and is subject to change. This includes potential changes in the number of aircraft and flight crews that can utilize GLS approaches, changes in air traffic control methods, changes in FAA instrument procedure design criteria, changes in the airspace surrounding SFO and other variables which may not have been modeled that can affect the potential altitude, flap, thrust, aerodynamic configuration and operating weight of the aircraft.

Any further regulatory review of these procedures, including assessment under the National Environmental Policy Act will require an independent noise analysis. The noise results presented in this document are for exploratory purposes only and rely on BADA4 aircraft performance inputs; which are restricted to research purposes only per the Eurocontrol and the FAA terms of use in AEDT.

GLS TT RWY 28R (EDDYY)

Revision 1

Changes: New

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - WIDEBODY 1

PROCEDURE: GLS TT RWY 28R (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	Tipp Toe Visual Rwy 28R	GLS TT RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	289441	289441	0	
Population within 75 dB SEL contour	4119	4119	0	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	5000	5000	0	
SEL at Location EDDYY (dB)	68.27	68.27	0	
SEL at Location SIDBY (dB)	70.47	70.47	0	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	207	207	0	
Number of arrivals between 07:00 - 19:00	TBD	30 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

COMPARISON OF INNOVATIVE APPROACH PROCEDURES - WIDEBODY 2

PROCEDURE: GLS TT RWY 28R (EDDYY)

	EXISTING PROCEDURE	INNOVATIVE APPROACH PROCEDURE REPLACEMENT		
EVALUATION CRITERIA	Tipp Toe Visual Rwy 28R	GLS TT RWY 28R	DIFFERENCE	RANKING
Population within 60 dB SEL contour	576093	576093	0	
Population within 75 dB SEL contour	90717	90717	0	
Altitude at Location EDDYY (MSL, ft)	6000	6000	0	
Altitude at Location SIDBY (MSL, ft)	5000	5000	0	
SEL at Location EDDYY (dB)	75.04	75.04	0	
SEL at Location SIDBY (dB)	77.75	77.75	0	
Speed at Location EDDYY (knts)	253	253	0	
Speed at Location SIDBY (knts)	207	207	0	
Number of arrivals between 07:00 - 19:00	TBD	30 (Estimate reflects highest daily usage based on feedback from SFO GBAS Flight Procedure Subcommittee)		
Number of arrivals between 19:00 - 22:00				
Number of arrivals between 22:00 - 07:00				
Does IA meet current regulations?	Yes	Yes		
Note:		Noise reduction on communities is the design objective		

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Any further regulatory review of these procedures, including assessment under the National Environmental Policy Act will require an independent noise analysis. The noise results presented in this document are for exploratory purposes only and rely on BADA4 aircraft performance inputs; which are restricted to research purposes only per the Eurocontrol and the FAA terms of use in AEDT.

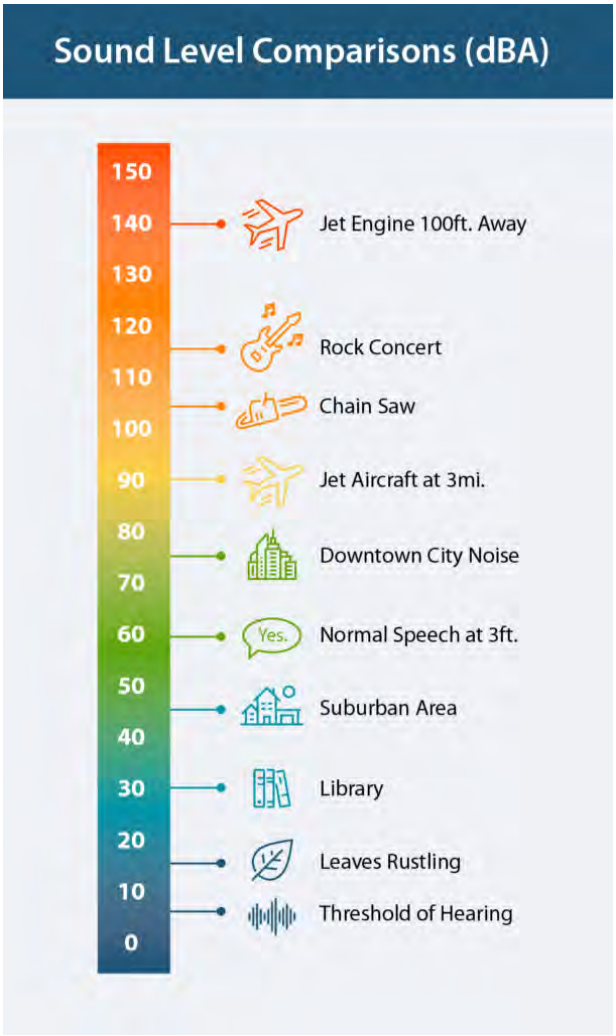
Information About SEL Contours

Revision 1

Changes: N/A

The Innovative Approach Evaluation Criteria, shown on the "Summary" page, use SEL 75 dB and 60 dB contours to compare the population counts impacted by each procedure. In reference to aircraft overflights, SEL is generally 10 dB above Lmax. The SEL 75 dB level was selected as part of the evaluation criteria due to its comparison to Lmax 65 dB, which is approximately the sound level of normal speech at a distance of 3 feet. The SEL 60 dB was selected due to its comparison to Lmax 50 dB, which is approximately the sound level of background noise at a quiet urban area.

Relative to sound level changes, an increase of 5 dBA is readily perceptible to the public and a 3 dBA increase is barely perceivable to the average healthy human ear.



Glossary

Revision 1

Changes: Updated

GBAS

Ground Based Augmentation System – A navigational aid, installed on the airport, that broadcasts a signal to aircraft that enhances ("augments") their existing GPS navigation capabilities enabling precision approaches to all runways at the airport.

GLS

GBAS Landing System (GLS) is the FAA's official term for a GBAS instrument approach procedure. A GLS approach is considered a "precision" approach procedure which means it provides precise navigational guidance similar to the Instrument Landing System (ILS) that have been used at SFO for over 50 years.

SEL

Sound Exposure Level – is a noise metric that represents all the acoustic energy (a.k.a. sound pressure) of an individual noise event as if that event had occurred within a one-second time period. SEL captures both the level (magnitude) and the duration of a sound event in a single numerical quantity, by "squeezing" all the noise energy from an event into one second. This provides a uniform way to make comparisons among noise events of various durations.

Lmax

Maximum Sound Level– is a noise metric that represents the maximum amount of acoustic energy (a.k.a. sound pressure) which occurs during an individual noise event regardless of its duration.

dB or dBA

Decibel (dB) or an "A-weighted" decibel - is the unit used to measure the intensity of a sound. The human ear hears sound pressures over a wide range. Decibels, which are measured on a logarithmic scale, correspond to the way our ears interpret sound pressures. The "A-weighted" scale most closely approximates the relative loudness of sounds in air as perceived by the human ear and provides a more useful way to evaluate the effect of noise exposure on humans by focusing on those parts of the frequency spectrum where we hear most. All noise results in this document use dBA.

MSL

Mean Sea Level (MSL), a tidal datum that is used to express geometric altitude above the earth. MSL references in this packet use imperial feet and can be thought of like a tapeline measurement from the ground to an object.

Glossary

Revision 1

Changes: Updated

ATC

Air Traffic Control, which represents a combination of human beings and technology responsible for aircraft separation from terrain, weather and other aircraft and aeronautical objects. At SFO, ATC is provided by a combination of individuals working locally in the tower and offsite with radar and voice communication capabilities.

Waypoint

Is a geographical location defined by a latitude/longitude geographic coordinate. These 5-letter waypoints, VHF intersections, 5-letter pronounceable DME fixes and 3-letter NAVAID IDs are published on various FAA aeronautical navigation products (IFR Enroute Charts, VFR charts, Terminal Procedures Publications, etc.).

RNAV or RNAV (GPS)

Area Navigation describes a navigation method used by aircraft which commonly utilize the Global Positioning System of satellites to determine information about their lateral position on earth. The GBAS sends an augmentation signal to aircraft using area navigation to increase the precision of the aircraft position, including additional information about the vertical location of the aircraft relative to the airport.

ILS

Instrument Landing System is the technology currently installed on 3 runways at SFO which sends an electronic signal along the final approach path which aircraft can detect and navigate within a fixed lateral and vertical corridor

RWY

Abbreviation for runway

Nmi

Nautical Mile – equal to 6,076 feet.

AEDT

Aviation Environmental Design Tool - AEDT is a software system that dynamically models aircraft performance in space and time to produce fuel burn, emissions and noise. Full flight gate-to-gate analyses are possible for study sizes ranging from a single flight at an airport to scenarios at the regional, national, and global levels.

Glossary

Revision 1

Changes: Updated

Waypoint

Is a geographical location defined by a latitude/longitude geographic coordinate. These 5-letter waypoints, VHF intersections, 5-letter pronounceable DME fixes and 3-letter NAVAID IDs are published on various FAA aeronautical navigation products (IFR Enroute Charts, VFR charts, Terminal Procedures Publications, etc.).

VFR

Visual Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is greater than 3,000 feet above ground level and the visibility is greater than five miles.

MVFR

Marginal Visual Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is between 1,000 - 3,000 feet above ground level and the visibility is between three and five miles.

IFR

Instrument Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is less than 1,000 feet above ground level and the visibility is less than three miles.

LIFR

Low Instrument Flight Rules are meteorological conditions which occur on, or near, the airport during which the ceiling (lowest continuous height of cloud cover) is less than 500 feet above ground level and the visibility is less than 1/2 miles..

San Francisco International Airport GBAS and GLS Procedures

Palo Alto Workshop

June 9, 2021

SFO

Why are We Here?

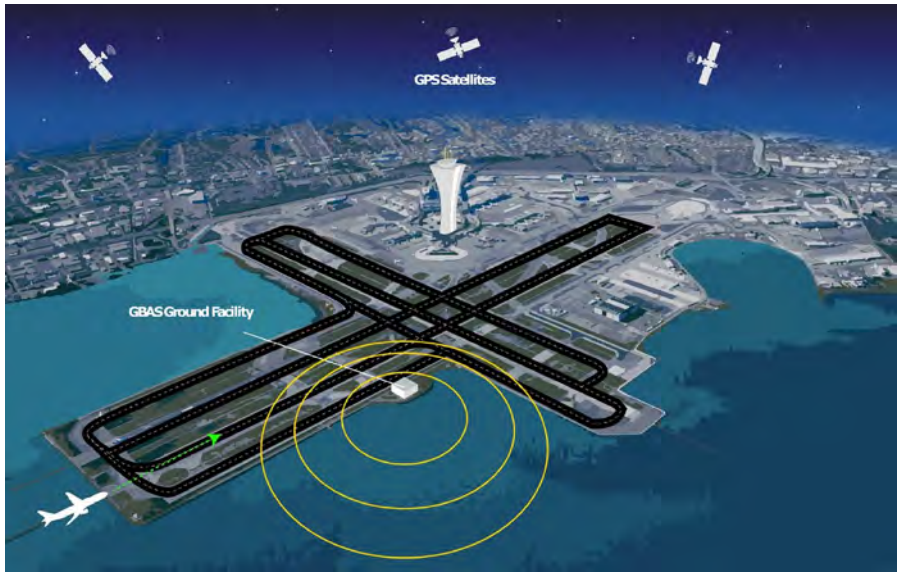
- SFO has been working with South Bay Cities to identify solutions to an increasing number of noise complaints following the implementation of NextGen
- SFO will have invested $11M from 2018 – 2023 on a tool that has proven to provide noise reduction at other airports internationally
- SFO wants to demonstrate a successful collaboration between the airport, airlines and residents to identify procedures that have the potential to deliver a tangible benefit before the traditional FAA engagement
- This is the first step on a long journey of incremental changes for the SFO GBAS to achieve a significant improvements to the noise impacts of a complex airspace like the Bay Area

Agenda for Today's Workshop

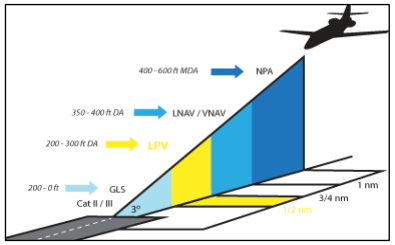
1. Review SFO GBAS Project and Goals
2. What does GBAS mean for South Bay Cities?
3. Discuss Overlay GLS Approaches
4. Discuss Innovative GLS Approach Concepts
5. Describe and solicit feedback on Community Flight Procedure Packages (CFPPs)
6. Propose future South Bay City outreach opportunities

Ground Based Augmentation System (GBAS) at SFO

1. GBAS supports up to 48 unique GBAS Landing System (GLS) approach procedures to SFO runways
2. SFO GBAS receives information from Global Positioning System (GPS), and Wide Area Augmentation System (WAAS), to create precision approach paths for aircraft to follow
3. Equipped aircraft, and trained flight crews, request GLS approach and tune into the GBAS data broadcast specific to the runway and procedures
4. The GLS precision approach path is currently limited to the final approach segment, which is approximately 5 – 10 Nautical Miles from the end of the runway



GBAS Project Goals

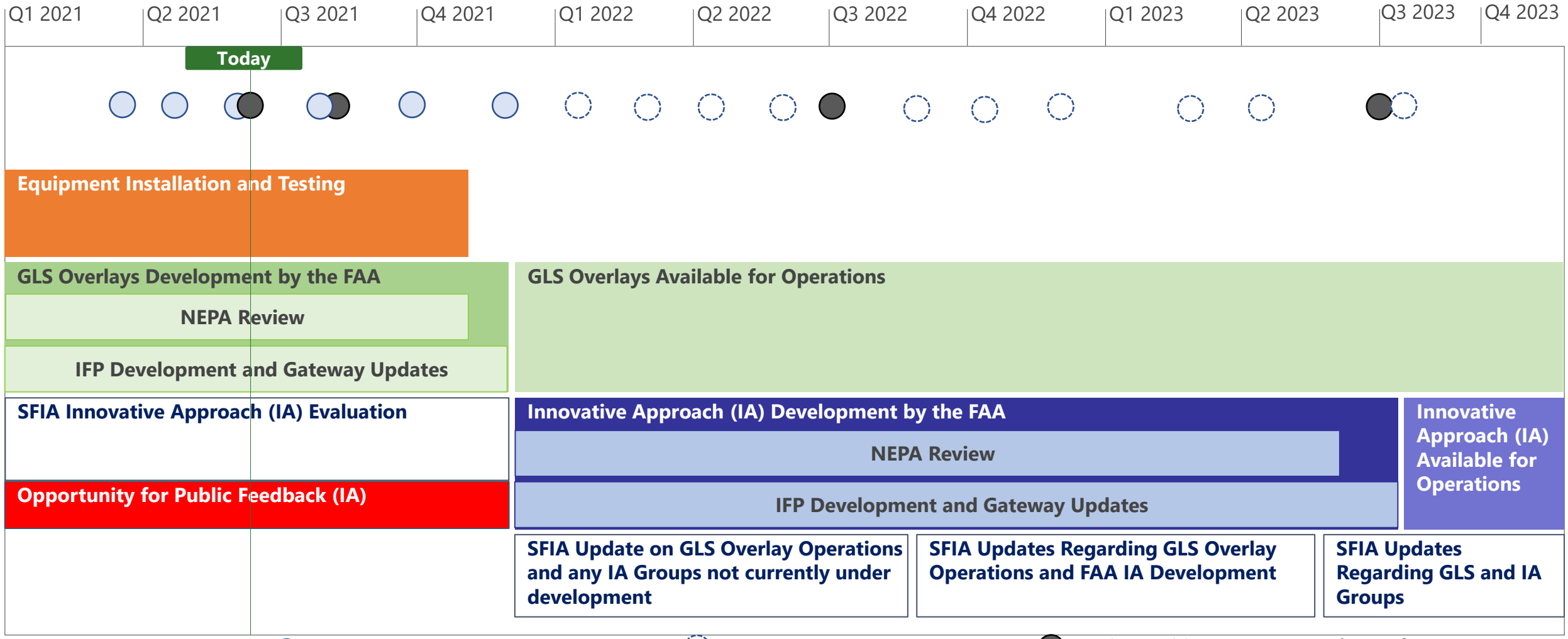


1. Reduce Noise Impact to the Community
   - GLS, and RNP to GLS, allows innovative procedure design resulting in unique flight tracks and increased operational altitudes.
2. Create Redundant ILS Capabilities
   - Allows continued ILS like operations during runway/taxiway rehabilitation and equipment outages.
3. Enhance Efficiency
   - Single GBAS can support multiple runway ends steeper approaches and reduced track miles via RNP to GLS leading to reduced fuel burn and GHG
4. Reduce Delays
   - Closely Spaced Parallel Runway Operations (CSPR) and CAT I/II/III Capabilities to runways that do not currently have ILS.

SFIA GBAS/GLS Project Steps

1. **FAA develops GLS approaches** which overlay existing ILS and RNAV (GPS) approaches into SFO
2. **FAA follows normal NEPA review process** for development of GLS Overlay approaches
3. **SFIA Installs and commissions the GBAS**, which is an airport owned Non-Federal NAVAID
4. **SFIA Project Team identifies Innovative GLS approach concepts that achieve the project goals**
5. **SFIA Project Team reviews Innovative GLS concepts with residents of the Bay Area**
6. **Residents provide feedback to SFO**, including recommended procedures for development from Roundtables
7. **SFIA requests FAA to develop recommended Innovative procedures**
8. **FAA develops Innovative GLS procedures**
9. **FAA follows normal NEPA review**

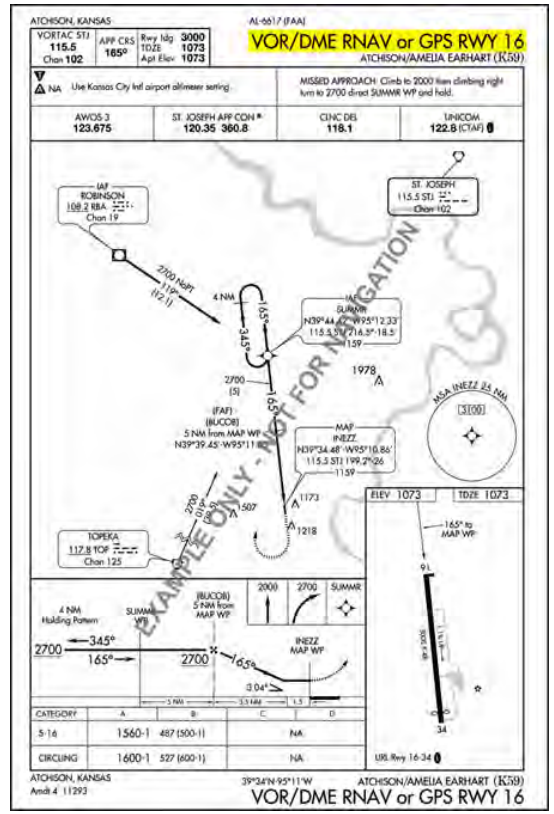
SFO GBAS Estimated Schedule and Planned Outreach



What is an Overlay Approach?

FAA Overlay Procedures

- FAA originally used “overlay” procedures to introduce new navigational technologies into the national airspace system
- In the 1990s GPS approaches were introduced as “overlays” to conventional navigation procedures ensuring that flight crews and air traffic could safely evaluate the two navigation methods using an **identical/established** path
- When Wide Area Augmentation Systems (WAAS) and Ground Based Augmentation Systems (GBAS) were introduced, the FAA decided to follow the same plan by starting with “overlays” of existing approach procedures
- As the navigation method proves to be safe and reliable, then the FAA enables more innovative approach designs supported by updated criteria and installed aircraft capabilities



FAA example of an early GPS approach overlay

What is an Overlay Approach?

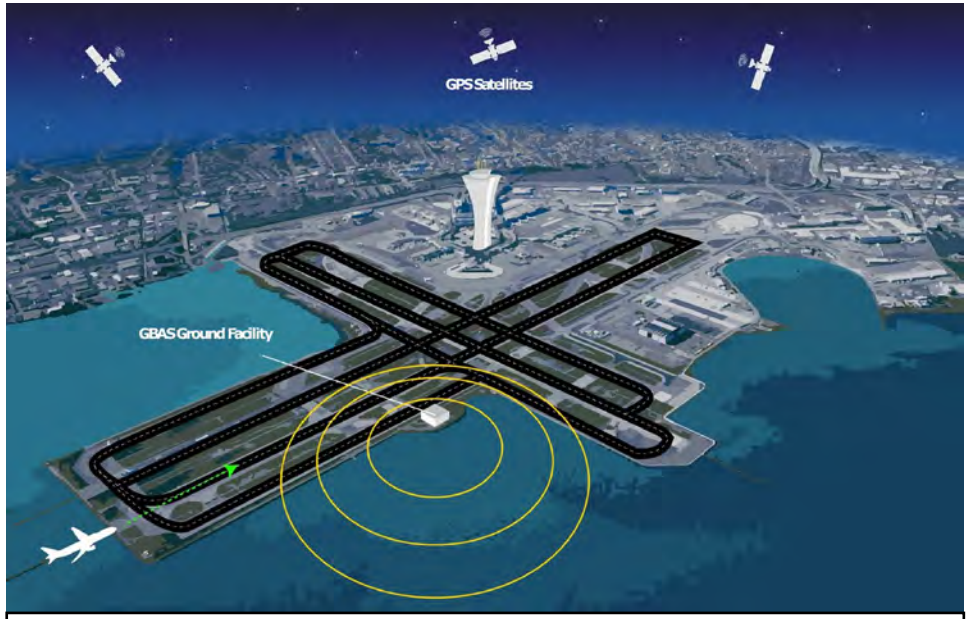
SFO GBAS Overlay Approaches

SFO's GBAS navigation will be:

- The third public GBAS in the US (EWR, IAH)
- The first GBAS in the Western Service Area
- The first GBAS in the Northern California TRACON

Due to the existing complexity of operations in the Bay Area, and the "new" navigational method being introduced, **SFO's GLS overlay approaches must be identical to existing procedures:**

- Identical waypoints
- Identical altitudes
- Identical approach angles and decision heights
- Identical approach segments
- Identical vectoring capability



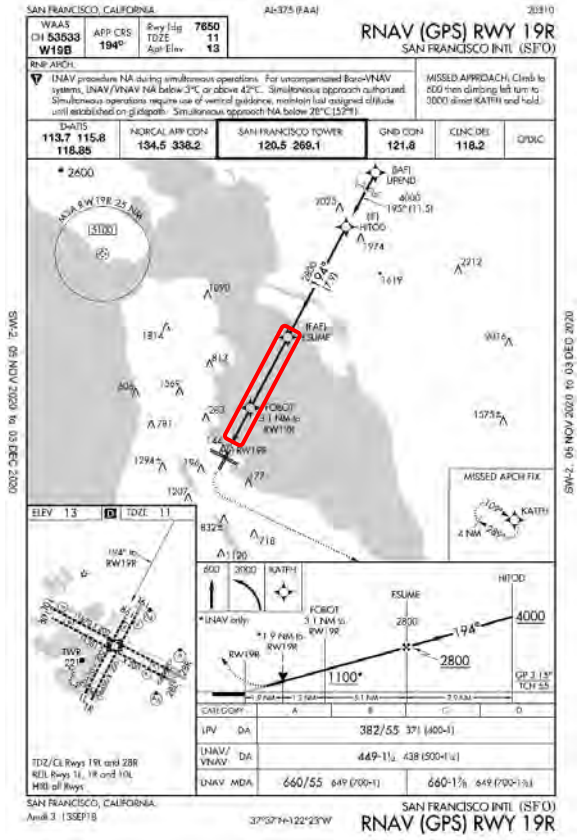
Current Daily Arrivals: Approximately 300
Pre-COVID Daily Arrivals: Approximately 600

GLS Overlays 02DEC21 – 02DEC23:
2 – 15 Flights Per Day*

Innovative Approach 2023 – 2025
15 - 30 Flights Per Day*

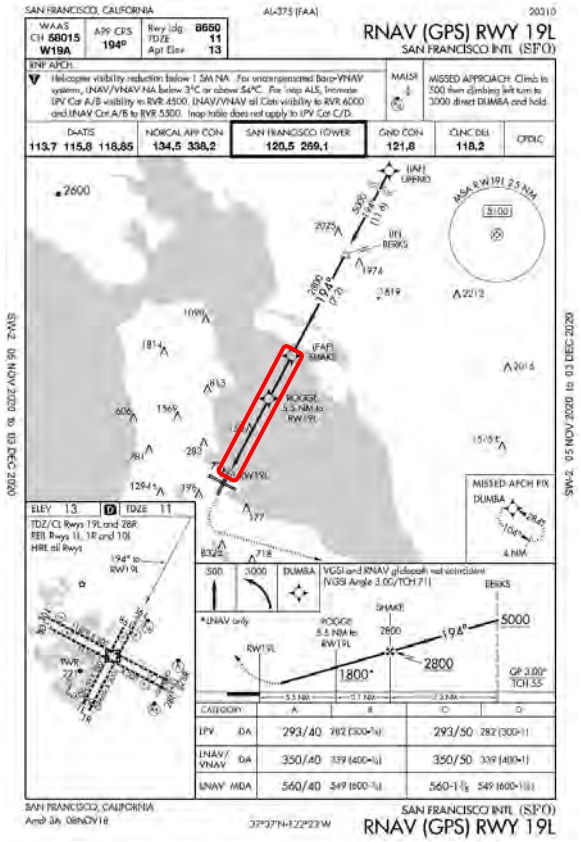
*Estimated on current GLS capable fleet serving SFO, assumes CSPR and at least 2 innovative approaches can be used under VFR

SFO GLS Overlay Approaches



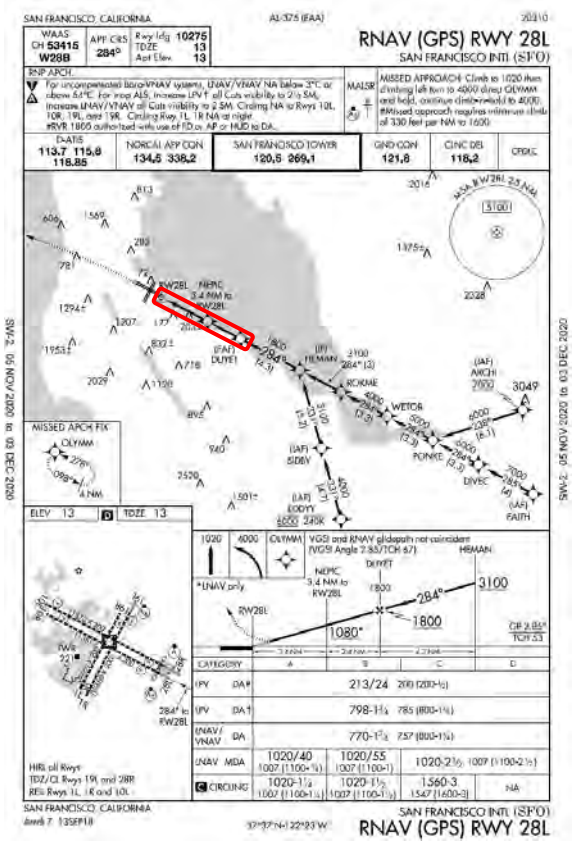
GLS RWY 19R

- RNAV (GPS) RWY 19R
- GPA: 3.15^0
- Opportunity: 5%
- CSPR: TBD



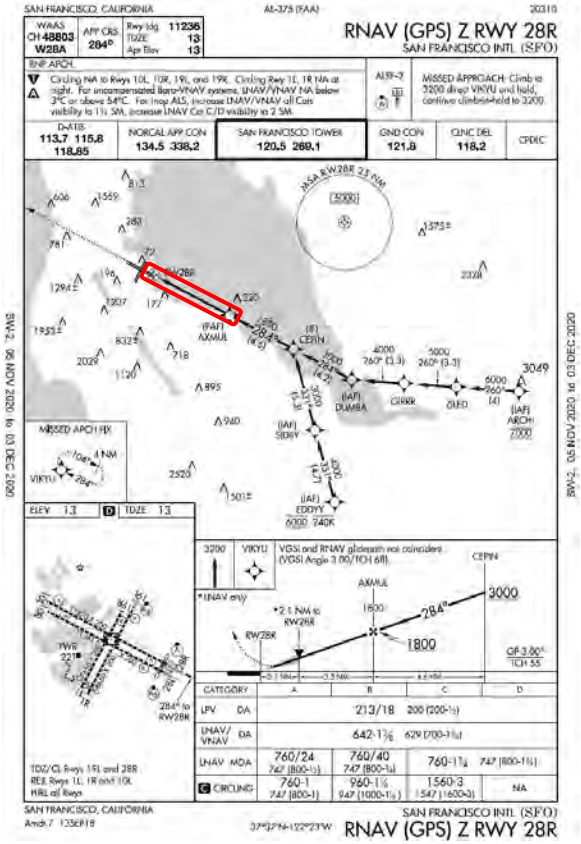
GLS RWY 19L

- RNAV (GPS) RWY 19L
- GPA: 3.00^0
- Opportunity: 5%
- CSPR: TBD



GLS RWY 28L

- RNAV (GPS) RWY 28L
- GPA: 2.85^0
- Opportunity: 95%
- CSPR: Yes



GLS RWY 28R

- RNAV (GPS) Z RWY 28R
- GPA: 3.00^0
- Opportunity: 95%
- CSPR: Yes

GBAS Overlay Approach Status

Tracking Direct and Indirect Changes to SFO GLS Overlay Approaches

- Current GLS Overlay approaches are slated for 02DEC21*,**
- GLS version of LDA approaches to 28R are no longer being pursued
  - No current FAA criteria for "offset" GLS approaches that terminate in a long visual segment
  - LDA approach is being decommissioned
- Potential change to ILS, RNAV and GLS Overlay Rwy 19L and 19R *missed approaches* are being studied to enhance safety during CSPR in southeast flow

**This date is established by the FAA and subject to change*
***Any additional airspace changes identified by the select committee will be tracked by FAA and considered in a separate FAA noise evaluation*

SFO SAN FRANCISCO/SAN FRANCISCO INTL

Notify me of changes to SFO

Charts (58) | IFP Production Plan (16) | IFP Coordination (9) | IFP Documents (NDBR) (53)

IFP Production Plan - Current IFPs under Development or Amendments with Tentative Publication Date and Status.

Filter Options

Showing results 1 - 16 of 16

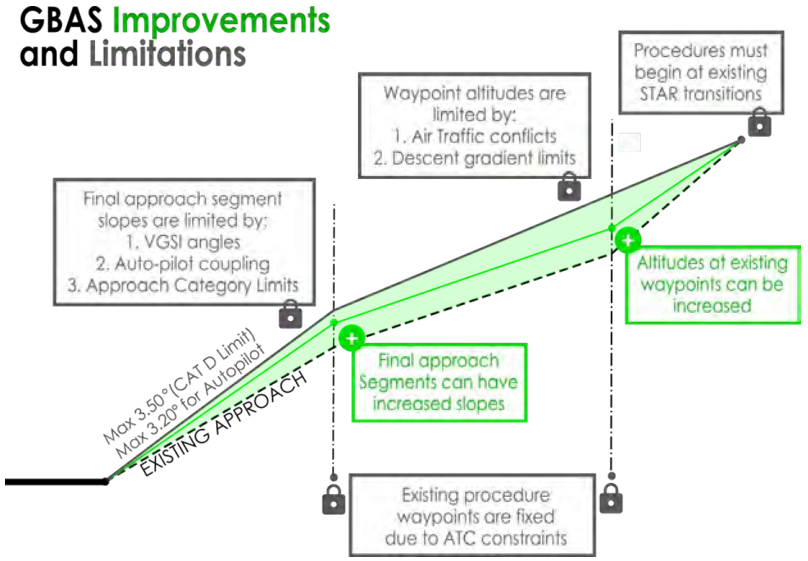
Procedure	Airport Name	Airport ID	City/State	Scheduled Pub Date	Status	Actual Pub Date	
GLS RWY 19R, Orig	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
GLS RWY 28L, Orig	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
GLS RWY 19L, Orig	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
GLS RWY 28R, Orig	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
ILS or LOC RWY 19L, AMDT 23	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
RNAV (GPS) RWY 19L, AMDT 4	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
RNAV (GPS) RWY 19R, AMDT 4	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA

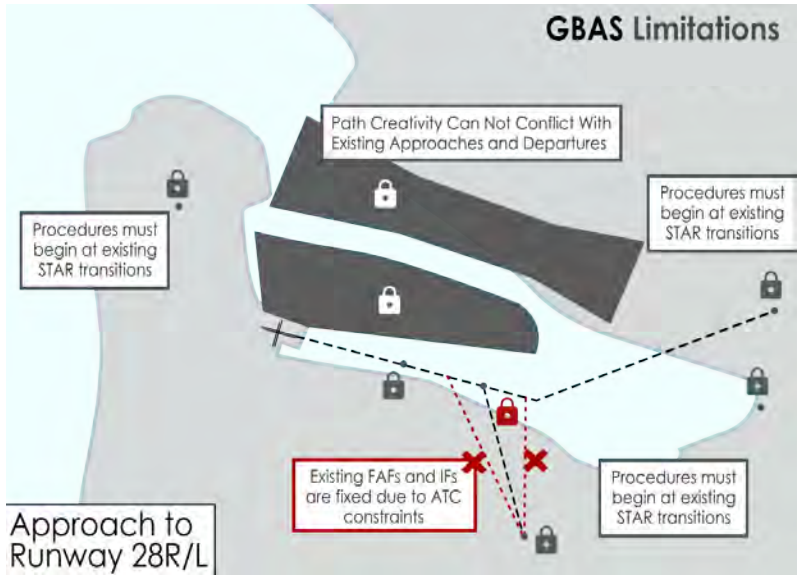
https://www.faa.gov/air_traffic/flight_info/aeronav/procedures/application/?event=procedure.results&tab=productionPlan&nasrId=SFO#searchResultsTop

GBAS Innovative Approach Evaluation Status

SFO GBAS Project Team Has 7 Innovative GLS Concepts For Evaluation

- Developed through a flight procedures subcommittee to identify criteria, ATC and flyability challenges
- 23 initial concepts were reduced to 7
- Resulted in two "groups" of concept approaches to pursue
- Group 1 focusses on what can be published and flown within the next 5 years
  - 28R – 4 Concepts
  - 28L – 1 Concept
  - 10R – 1 Concept
  - 10L – 1 Concept
- Group 2 procedures may have more substantial noise benefits, but will require further coordination for FAA to implement





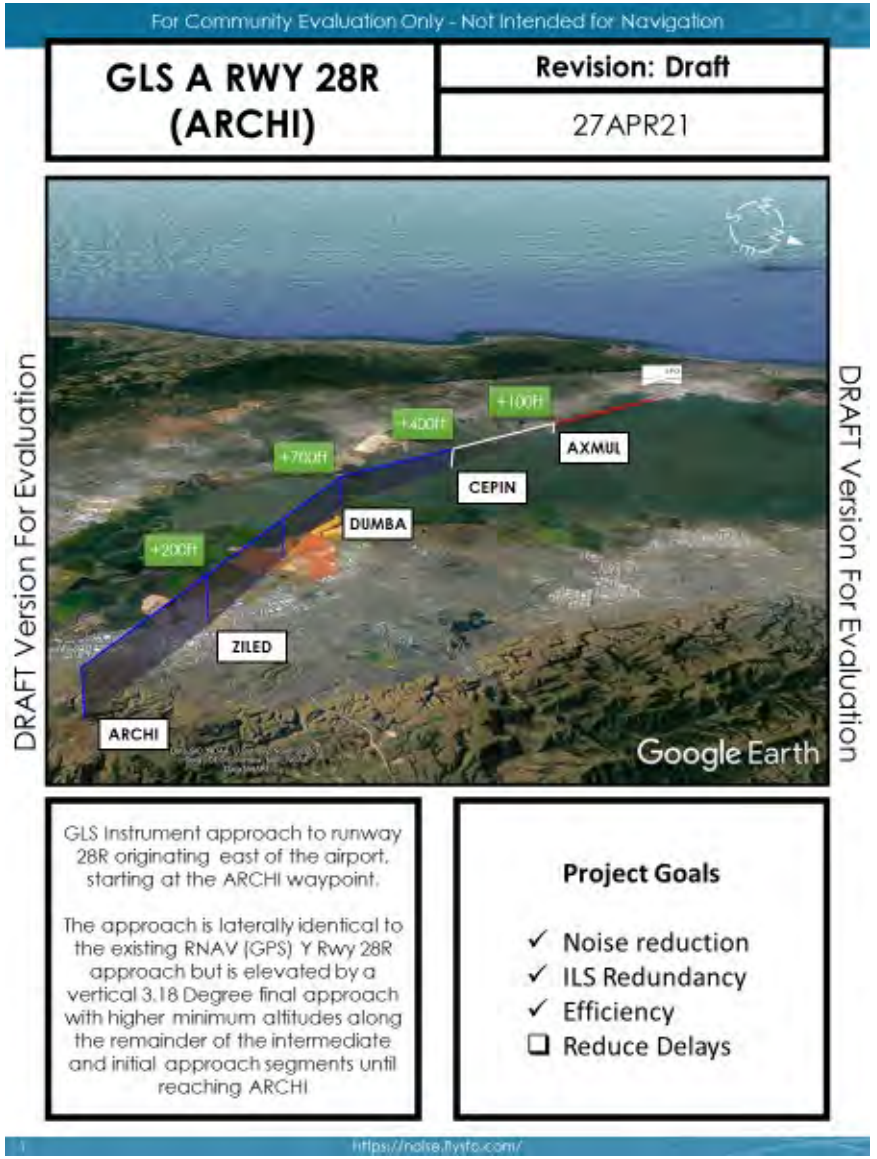
Evaluating Environmental Effects of SFO GLS

FAA is evaluating GLS Overlay approaches for environmental effects

- GLS overlay approaches are being evaluated in their current form, **identical** to existing RNAV (GPS) approaches
  - *Any additional airspace changes identified by the select committee will be tracked by FAA and considered in a separate FAA noise evaluation*

SFO GBAS Project Team is preparing Innovative Approach CFPP

- The SFO GBAS Project team is preparing Community Flight Procedure Packages (CFPPs) to evaluate the difference between Innovative GLS Approach concepts and the nearest existing approaches
- The current AEDT v3D/BADA 4 SEL noise analysis methods can identify potential noise changes resulting from an individual aircraft/flight
- At this time the same SEL noise analysis does not reveal any differences between existing RNAV (GPS) approaches and GLS overlays and there is no plan to produce CFPPs for the overlay GLS



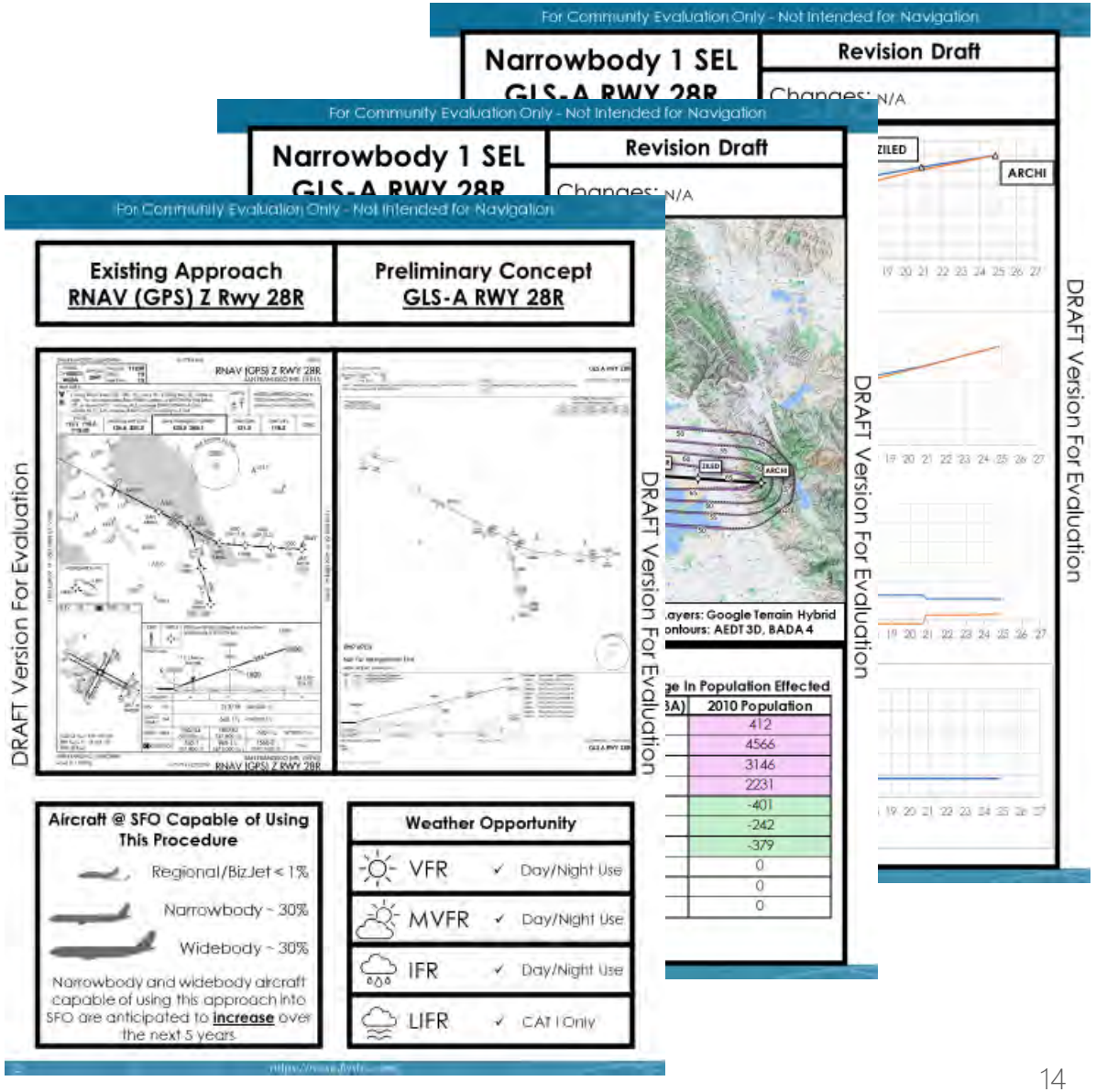
CFPPs and Where to Find Them

https:\\noise.flysfo.com

Draft CFPP Contents

- 3D Flight path depiction
- Textual description of the procedure
- Side by side comparison of instrument procedure graphics
- Anticipated aircraft utilization information
- Single event SEL noise contours (also available directly in the map browser via https:\\noise.flysfo.com)
- Single event SEL and altitude (speed) sample points of interest
- Single event SEL population exposure
- Flight profile information for Narrowbody and Widebody aircraft

The CFPPs currently available on the website are a draft for feedback



Additional Information on SFO Noise Portal

(https://noise.flysfo.com/2021/05/14/gbas-innovative-approach-procedures/)

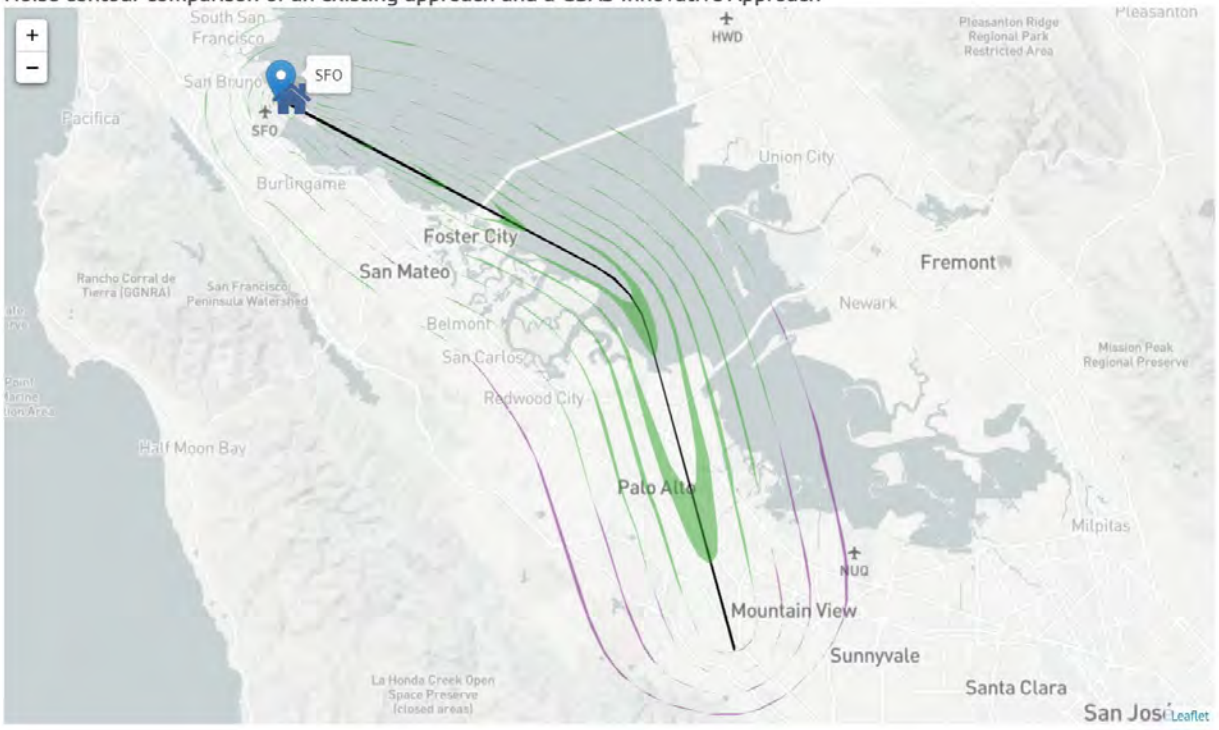
Interactive Map – Runway 28R EDDYY Innovative Approach

The areas shaded in green and purple represent the comparison of one existing approach vs one GBAS Innovative Approach. The areas in purple represent potential noise increase at each noise contour interval. The noise increase is expected to be no greater than 1 dB. Similarly, areas in green represent potential noise reduction at each noise contour interval. The noise reduction for some aircraft is expected to be as great as 4 dB in certain areas. Changes in noise levels less than 3 dB are generally not perceivable by the human ear.

Area of Potential Noise Reduction | Area of Potential Noise Increase | Flight Path

Wide Body Approach RWY 28R EDDYY - Slide 2 of 2

Noise contour comparison of an existing approach and a GBAS Innovative Approach



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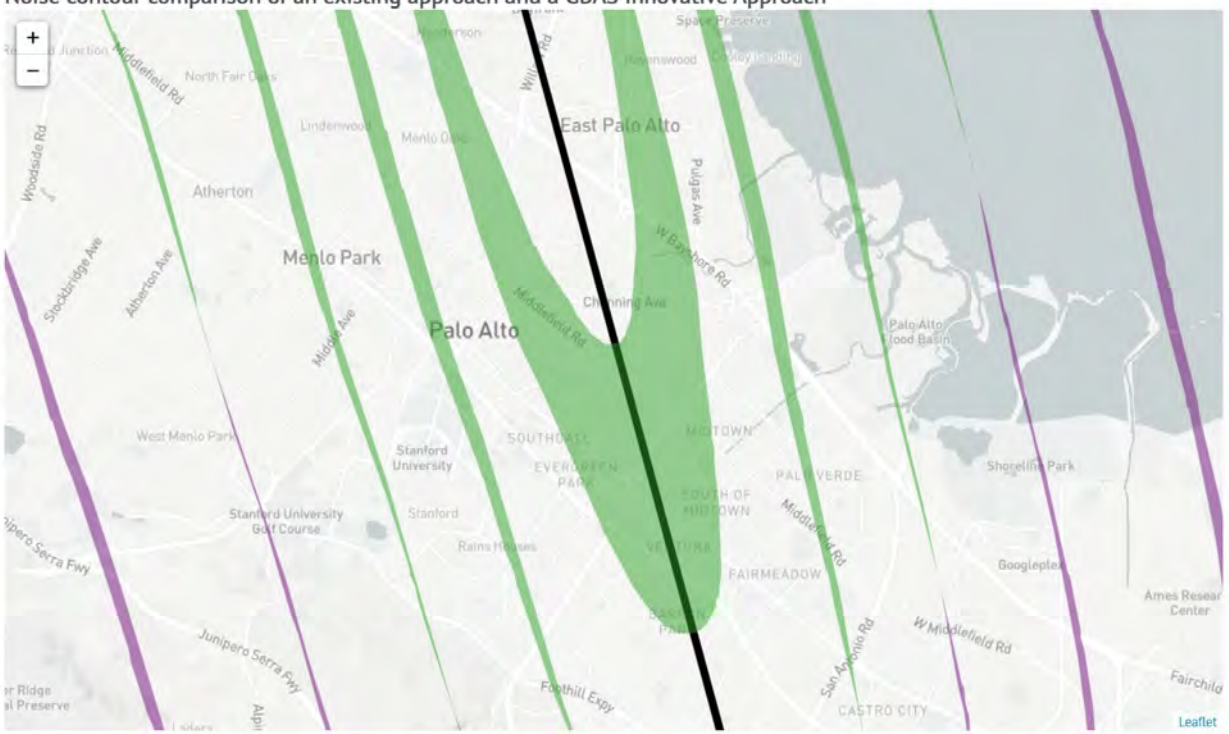


2021 Remaining Meetings for SFO TWG to Review GBAS

SFIA GBAS Project Team plans to continue working with the SFO Roundtable via the Technical Working Group

- 26MAY21 – Review format for CFPPs
- 28JUL21 – Review of all CFPPs
- 22SEP21 – Review of any flight simulation/flight evaluation results
- 24NOV21 – Review any changes to CFPPs and brief on commissioning/activation of GBAS

In addition to SFO Roundtable, SFIA GBAS Project has the budget to support meetings with South Bay Cities

- 09JUN21 – Palo Alto Review format for CFPPs

Additional direct engagement in 2021 could be handled by either

- 2021 – SCSC Roundtable Technical Working Group meetings on GBAS

  or

- 2 additional meetings with Palo Alto (following today's meeting)

Questions

We look forward to your feedback on the CFPP format

https://noise.flysfo.com/2021/05/14/gbas-innovative-approach-procedures/

Backup Material

Flight Test and Validation of CFPP Noise Modeling

Flight Evaluation of SFO GLS Approaches

As a part of SFO's commitment to ensure that the goal of reducing noise impact to the community is achieved, the GBAS Project Team has been working with the Flight Procedures Subcommittee to identify opportunities for enhanced noise modeling and data collection.

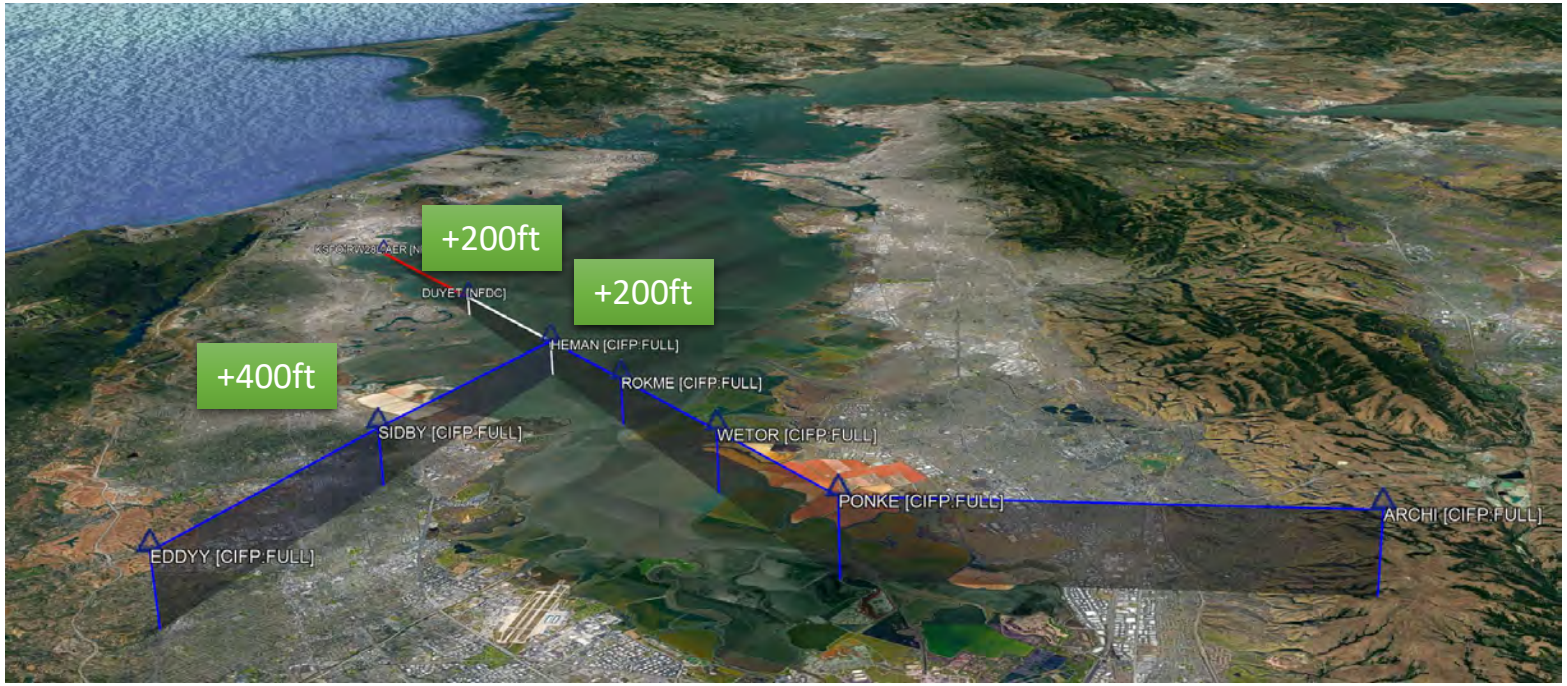
United Airlines has offered to support the community evaluation of both the overlay and innovative GLS approach concepts by performing evaluation flights for the purposes of noise data collection*, **

The flights will occur in 2021, with results made available via https://noise.flysfo.com
The Flight Procedures Subcommittee, aided by the SFO GBAS Project Team, will use the information from the test flights to:

1. Verify that overlay GLS approaches will not introduce "new" noise when compared to current approaches
2. Evaluate initial AEDT v3D / BADA 4 SEL noise predictions (presented in the CFPPs) vs noise monitor results
3. Make adjustments to the AEDT v3D / BADA 4 noise predictions where applicable

**UAL flight test information may not precisely reflect the current AEDT/BADA modeling assumptions*
***SFO GBAS Project team may not be able to modify the BADA 4 models to take advantage of detected noise results due to differences in aircraft weight, pilot technique, ambient conditions and data samples per procedure*

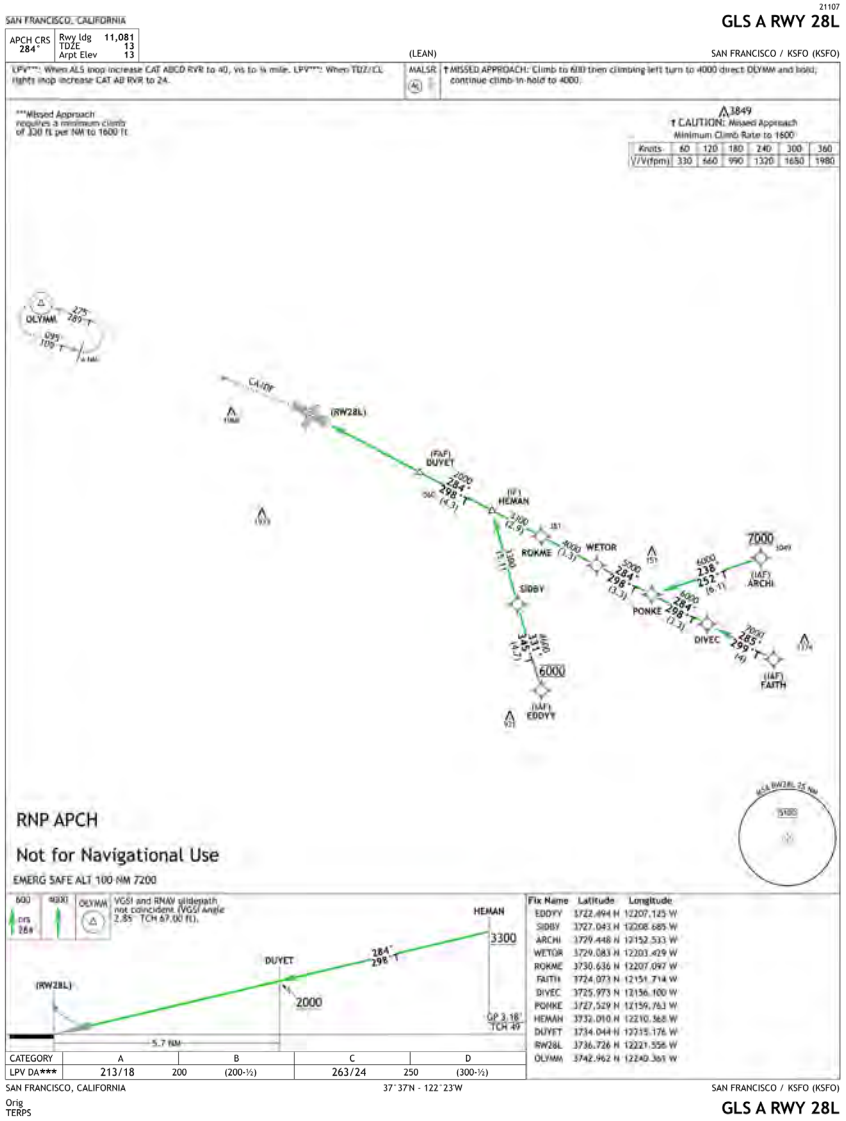
SFO GLS Concept: 28L



28L GLS Procedure Image TARGETS, Background Image Google Earth

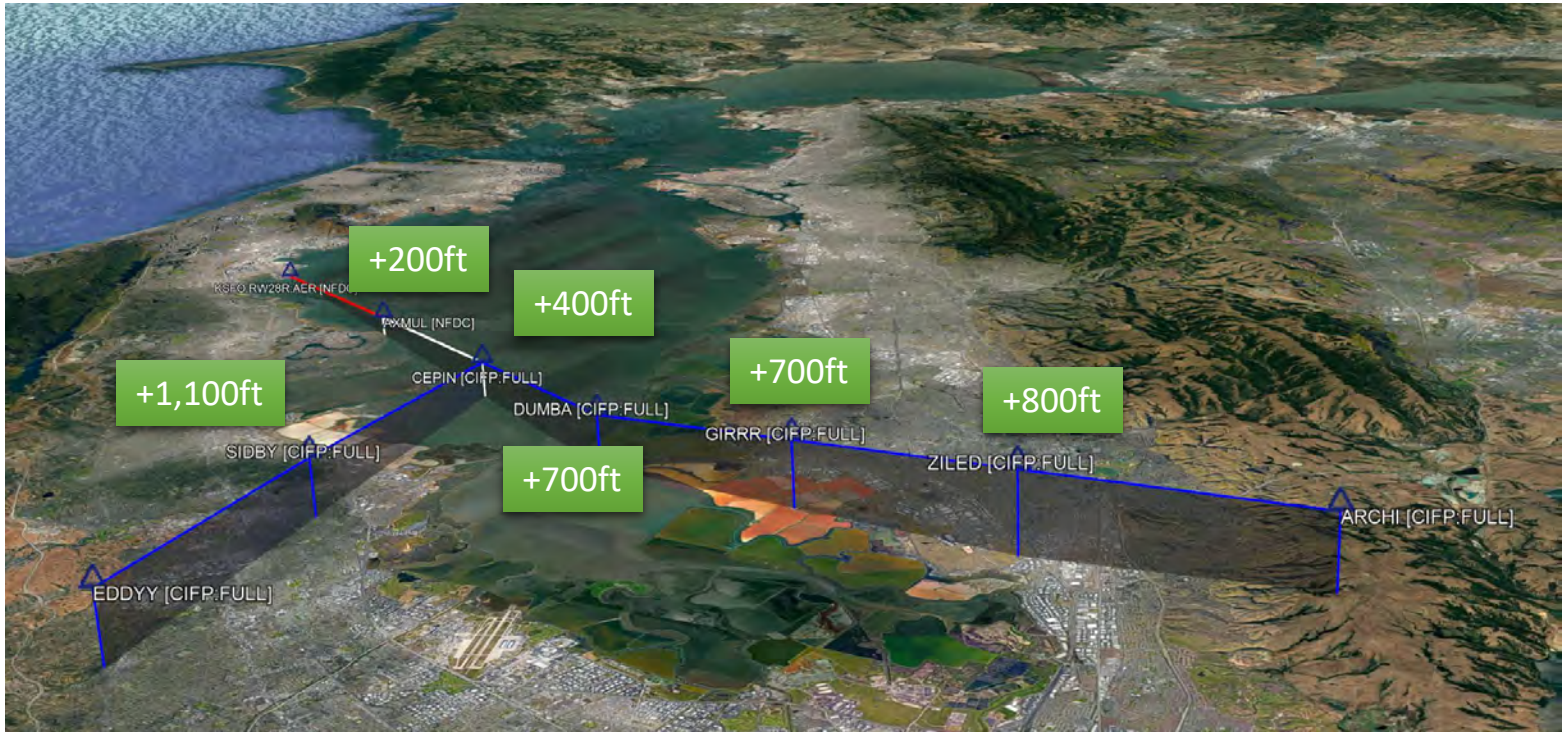
GLS A RWY 28L

- GPA: 3.18°
- Expected Arrivals Per Day: 15 (2023)
- CSPR: TBD
- Final approach, and preceding altitudes are increased
- Can not change location or altitude at EDDYY or ARCHI
- Can not change location of any other waypoints



28L GLS Flight Inspection Graphic from GPD

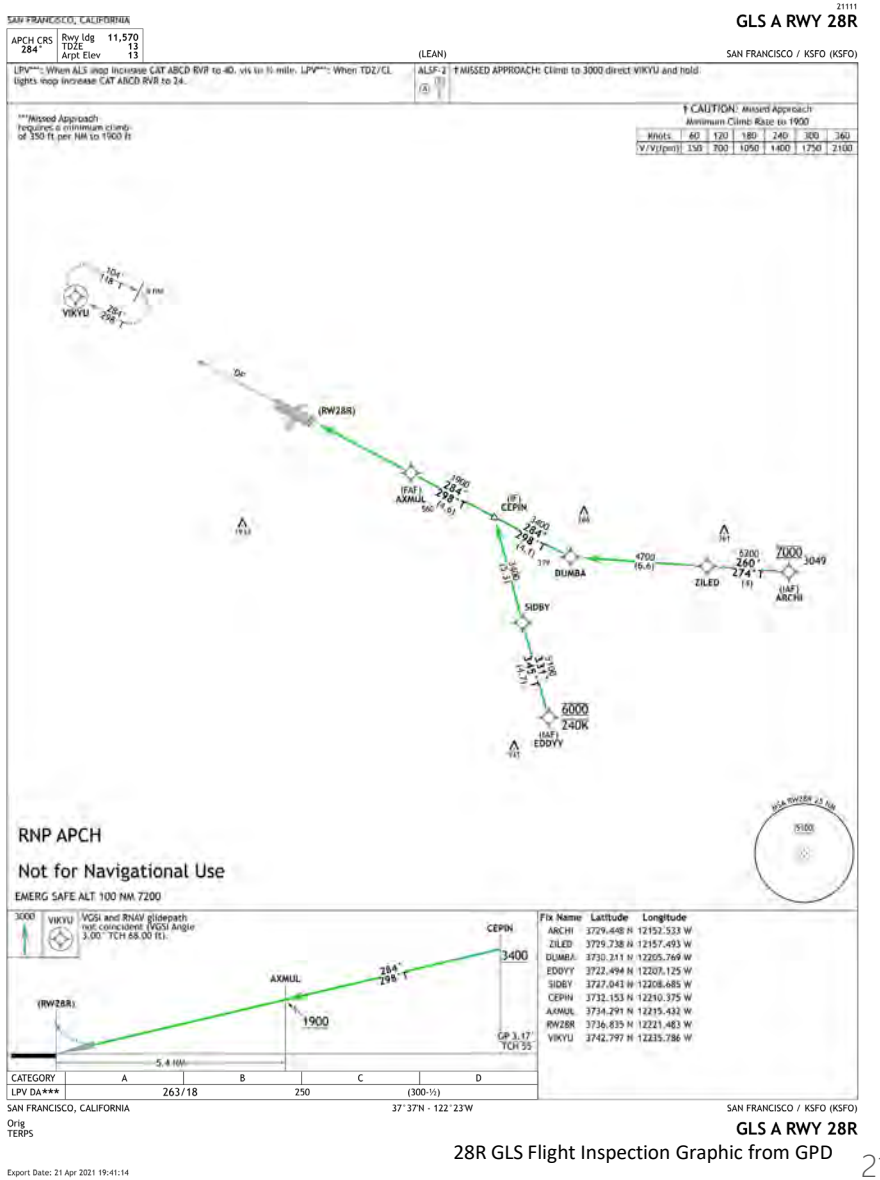
SFO GLS Concept: 28R



28R GLS Procedure Image TARGETS, Background Image Google Earth

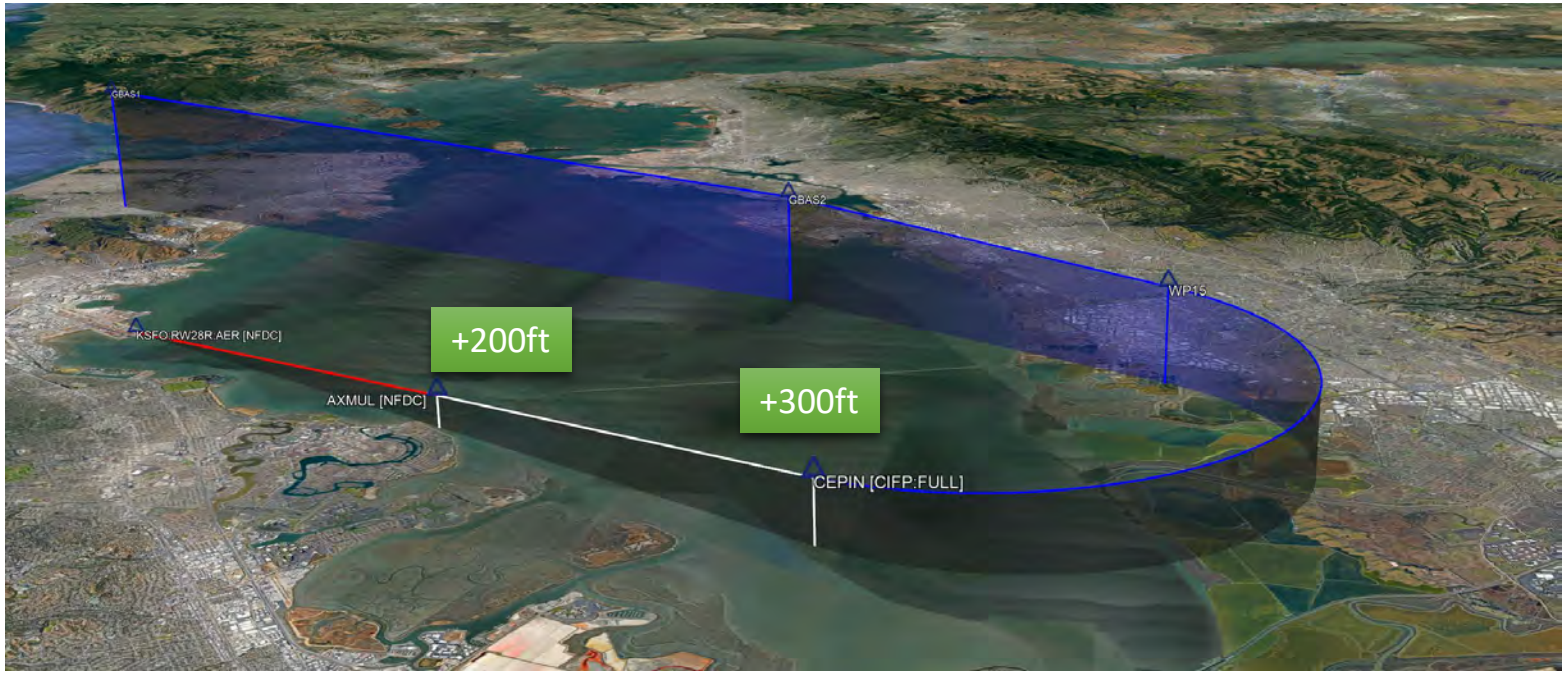
GLS A RWY 28R

- GPA: 3.17°
- Expected Arrivals Per Day: 15 (2023)
- CSPR: TBD
- Final approach, and preceding altitudes are increased
- Can not change location or altitude at EDDYY or ARCHI
- Can not change location of any other waypoints



28R GLS Flight Inspection Graphic from GPD

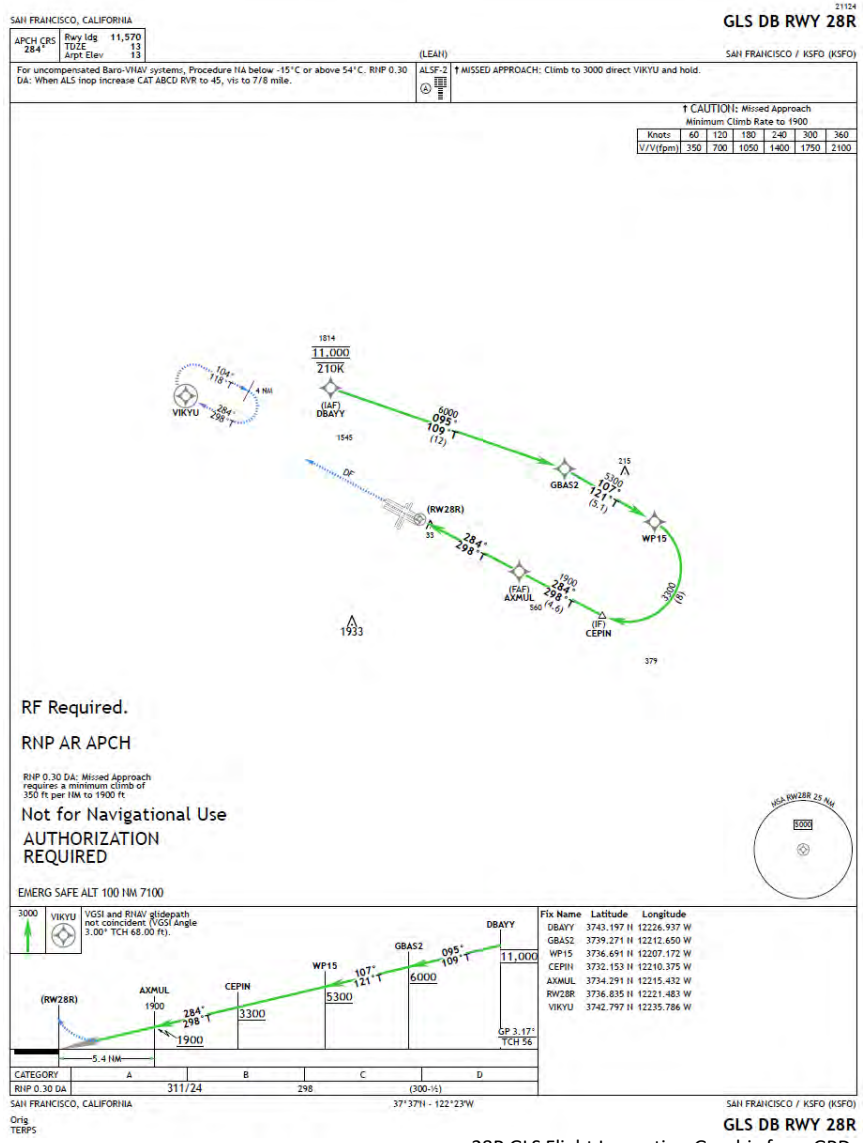
SFO GLS Concept: 28R “Down the Bay”



28R GLS Procedure Image TARGETS, Background Image Google Earth

GLS DB RWY 28R “Down the Bay”

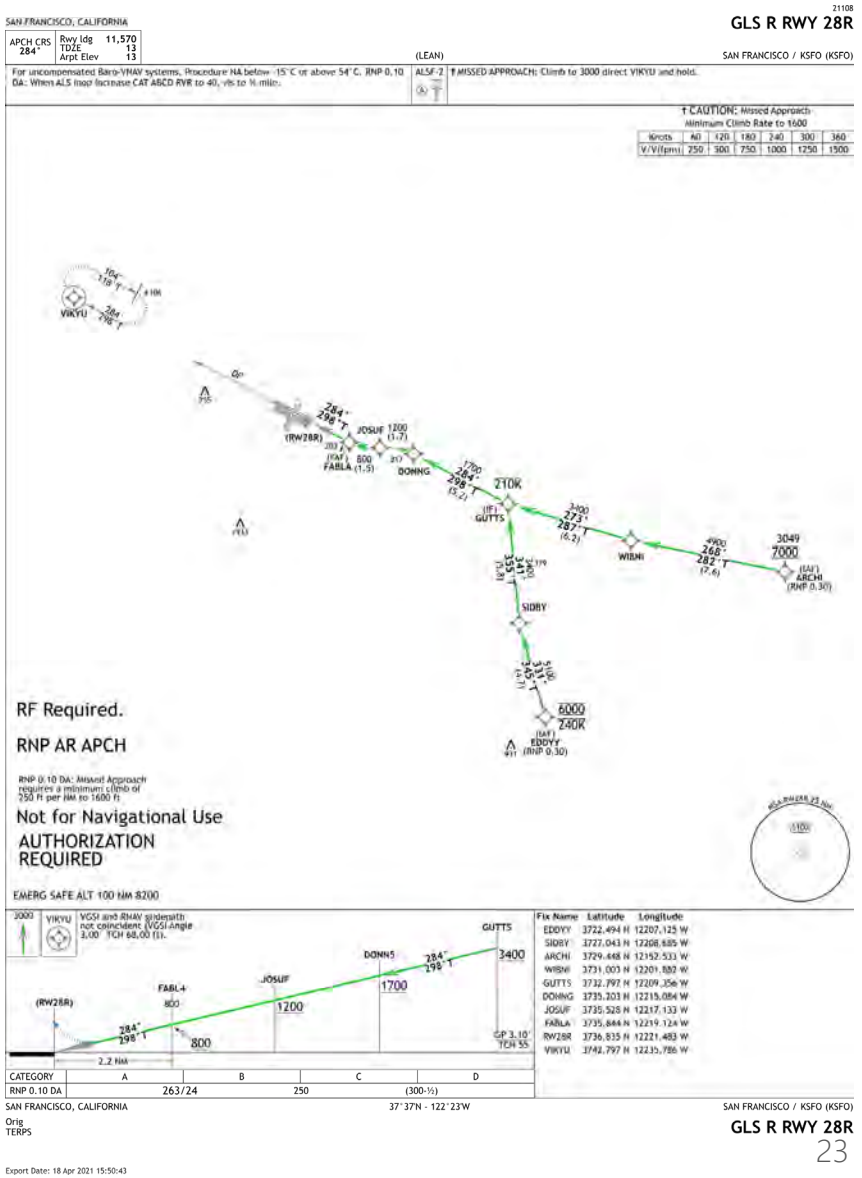
- GPA: 3.17°
- Expected Arrivals Per Day: 30 (2023)
- CSPR: No
- Intended to mirror existing vectors from BDEGA Arrival to 28R at CEPIN
- Can not start the approach at CORKK (New Waypoint – GBAS 1)
- Can not change location of CEPIN or AXMUL



28R GLS Flight Inspection Graphic from GPD

SFO GLS Concept: 28R “RNP-Y to GLS”

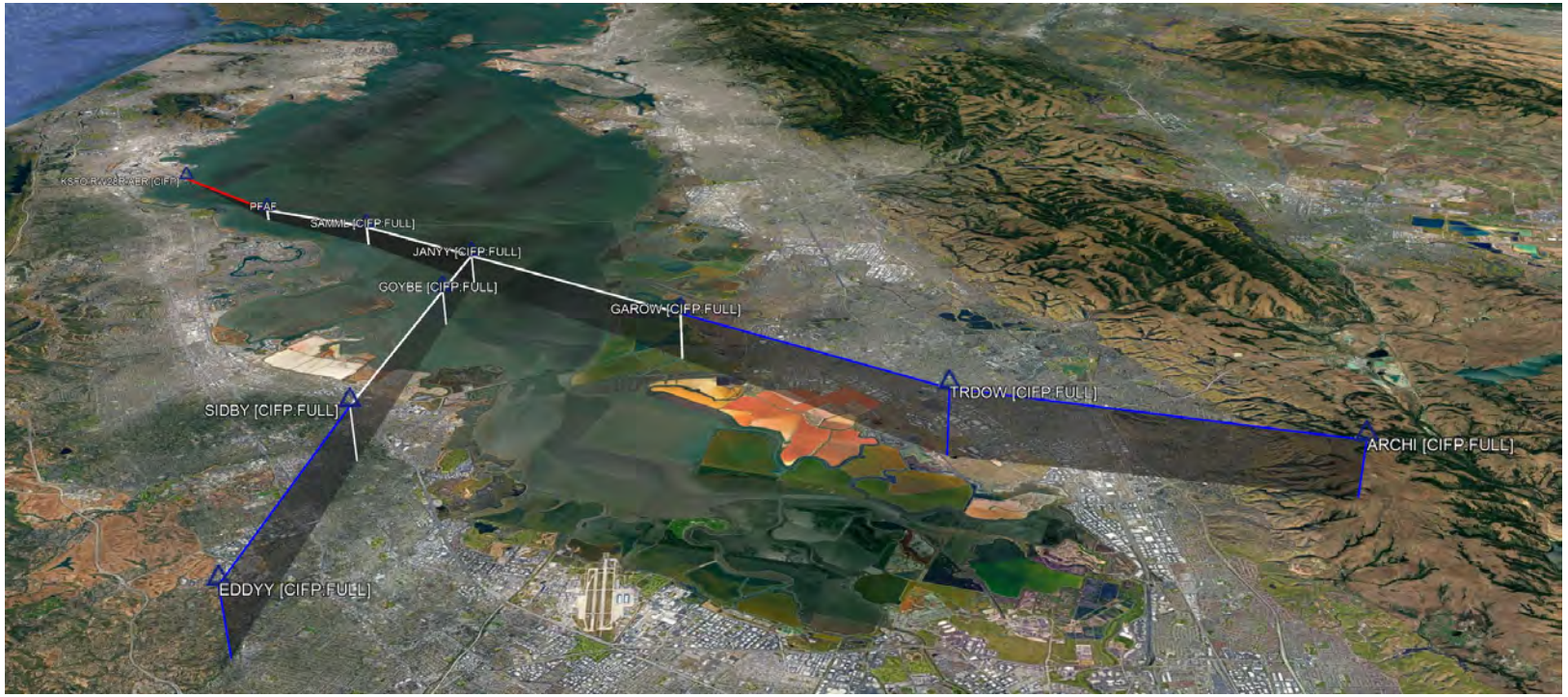
28R GLS Procedure Image TARGETS, Background Image Google Earth



GLS R RWY 28R “RNP-Y to GLS”

- GPA: 3.00°
- Expected Arrivals Per Day: 10 (2023)
- CSPR: No
- GLS Conversion of RNAV (RNP) Y RWY 28R
- Short FROP will prevent increase in GPA
- FAA Criteria for this is in development

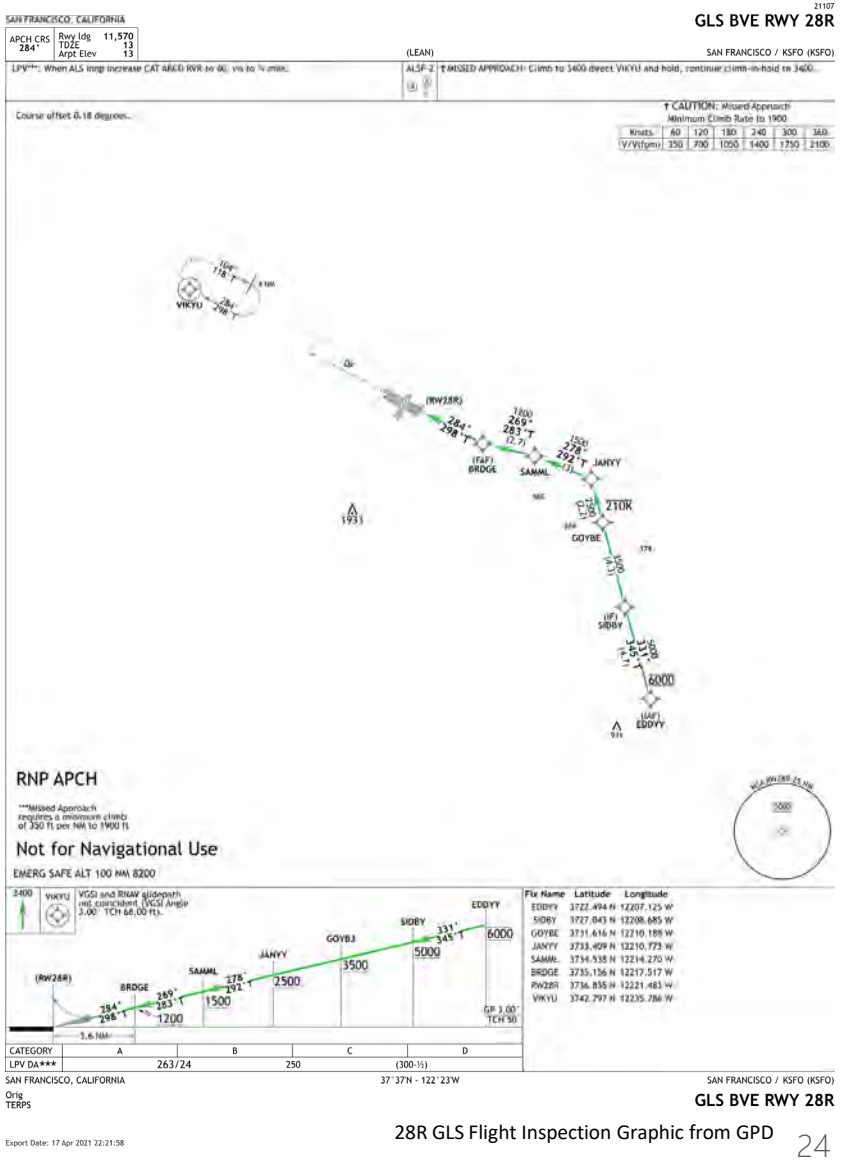
SFO GLS Concept: 28R “Bridge Visual” EDDYY



28R GLS Procedure Image TARGETS, Background Image Google Earth

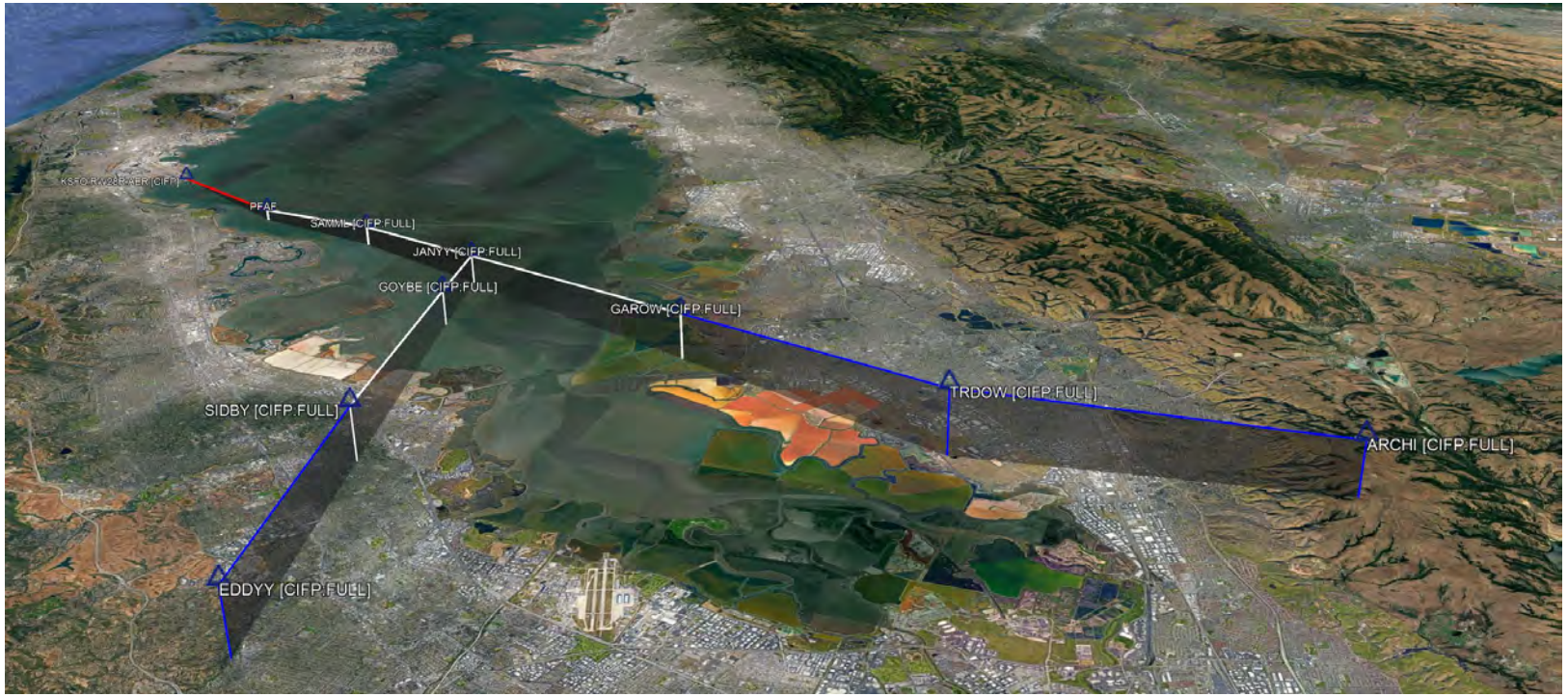
GLS BVE RWY 28R “Bridge Visual” EDDYY

- GPA: 3.00°
- Expected Arrivals Per Day: >50 (2023)
- CSPR: No
- GLS Conversion of FMS Bridge Visual
- Use of GOYBE Waypoint considered to reduce “early turns” from SIDBY
- Charts are divided into two for review with community, but will be combined into a single procedure if FAA were to develop



28R GLS Flight Inspection Graphic from GPD

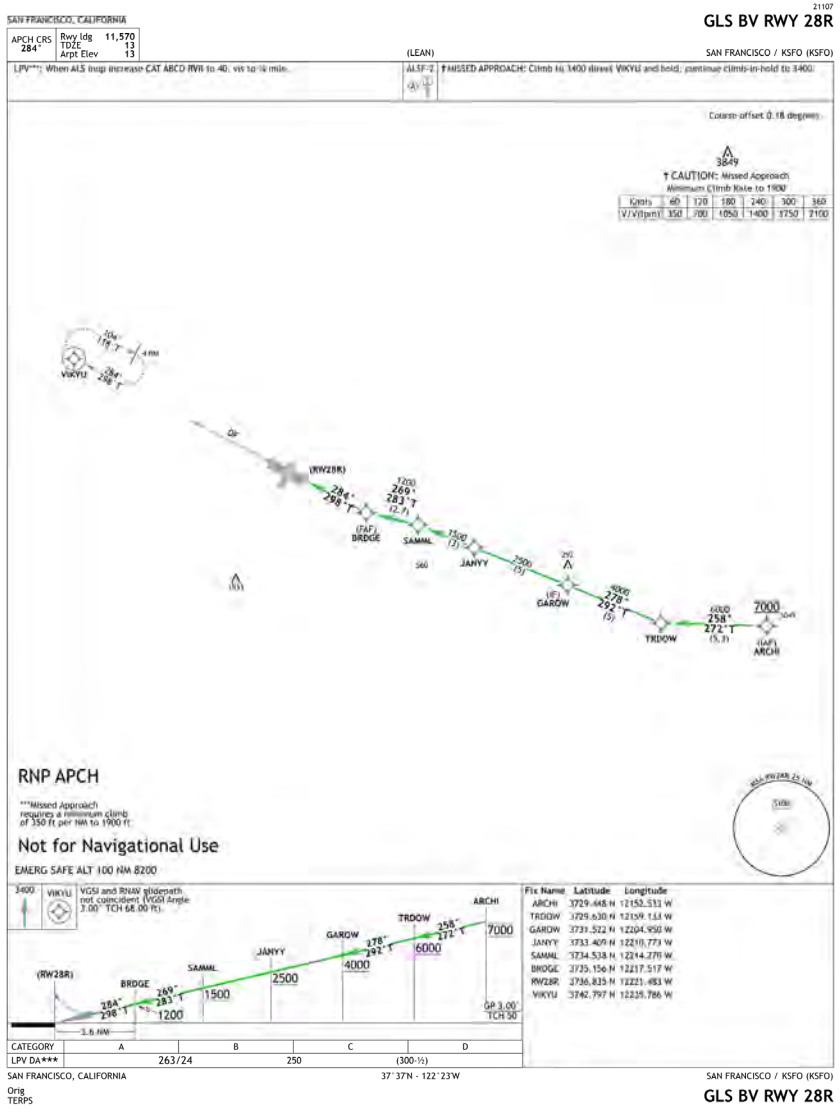
SFO GLS Concept: 28R “Bridge Visual” ARCHI



28R GLS Procedure Image TARGETS, Background Image Google Earth

GLS BVE RWY 28R “Bridge Visual” ARCHI

- GPA: 3.00^{o}
- Expected Arrivals Per Day: >50 (2023)
- CSPR: No
- GLS Conversion of FMS Bridge Visual
- Charts are divided into two for review with community, but will be combined into a single procedure if FAA were to develop



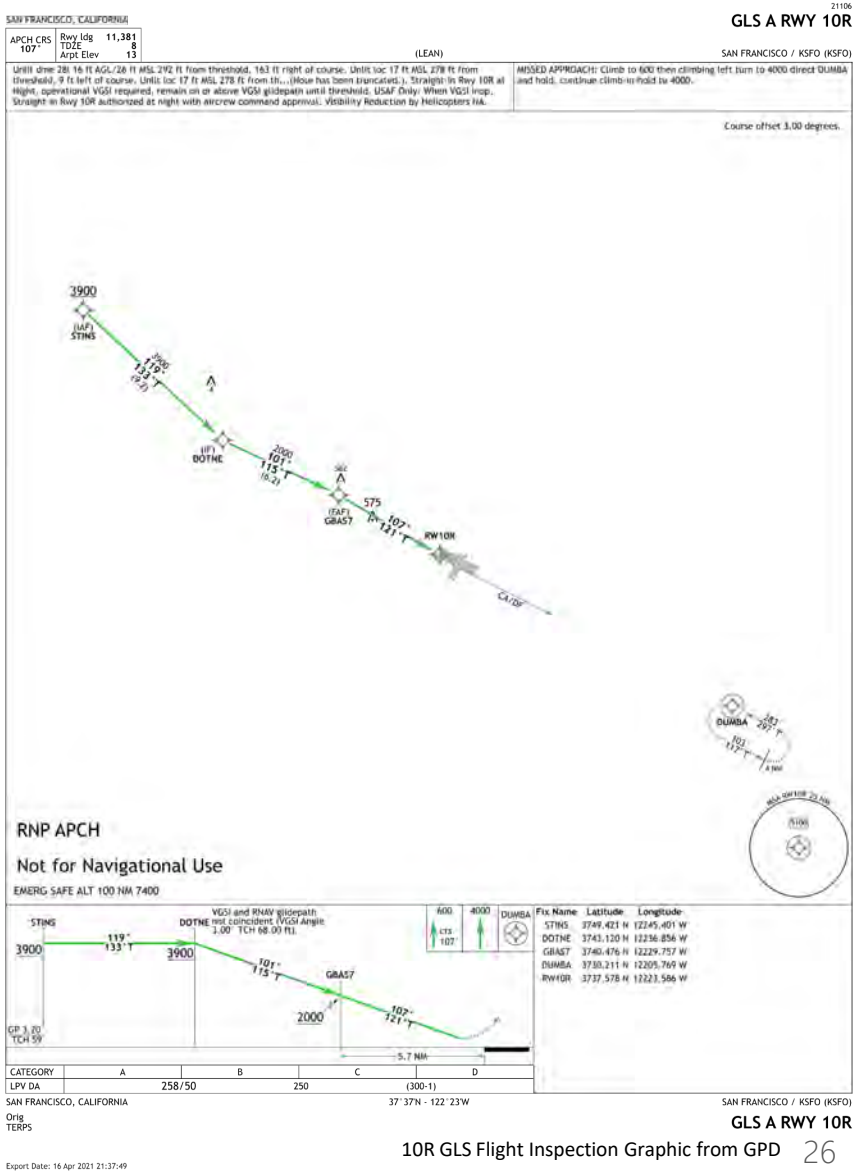
28R GLS Flight Inspection Graphic from GPD

SFO GLS Concept: 10R

10R GLS Procedure Image TARGETS, Background Image Google Earth

GLS A RWY 10R

- GPA: 3.20°
- Expected Arrivals Per Day: <1 (2023)
- CSPR: No
- Final approach course is offset 3.00 degrees north of the centerline to achieve lowest possible minimums
- This procedure is not considered to reduce noise impact



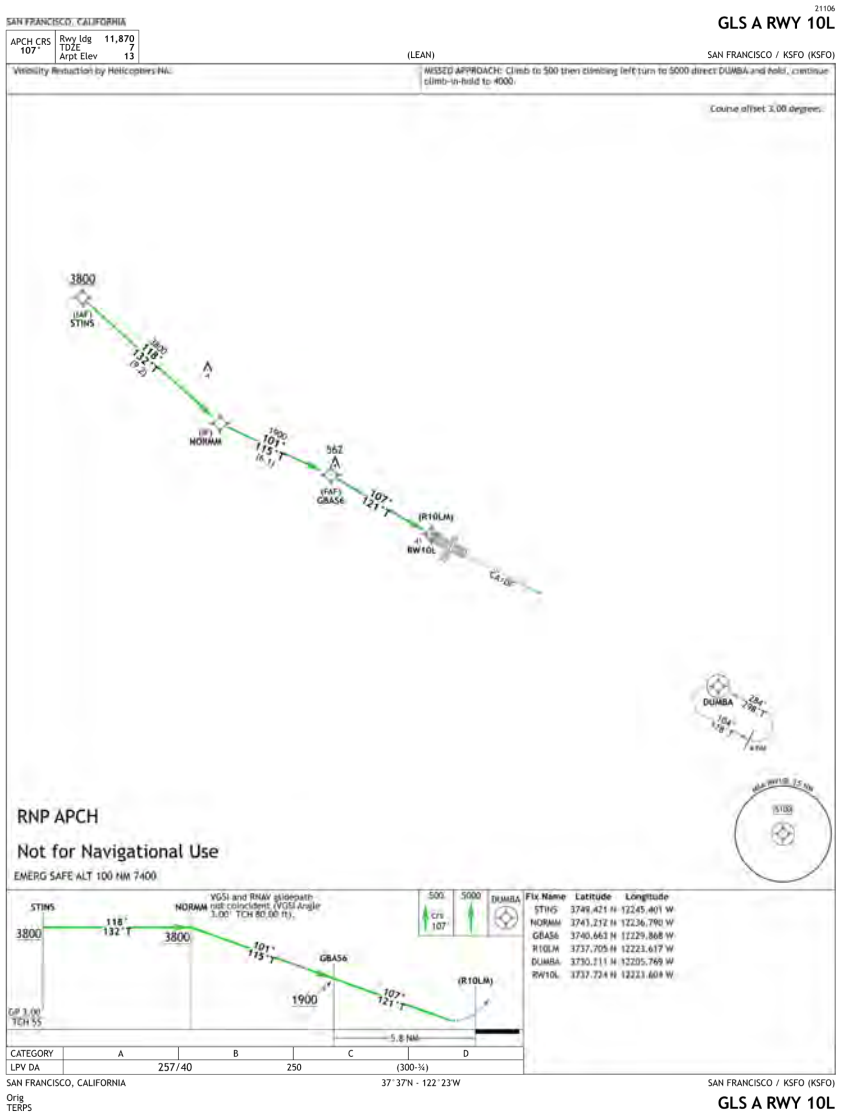
10R GLS Flight Inspection Graphic from GPD

SFO GLS Concept: 10L

10L GLS Procedure Image TARGETS, Background Image Google Earth

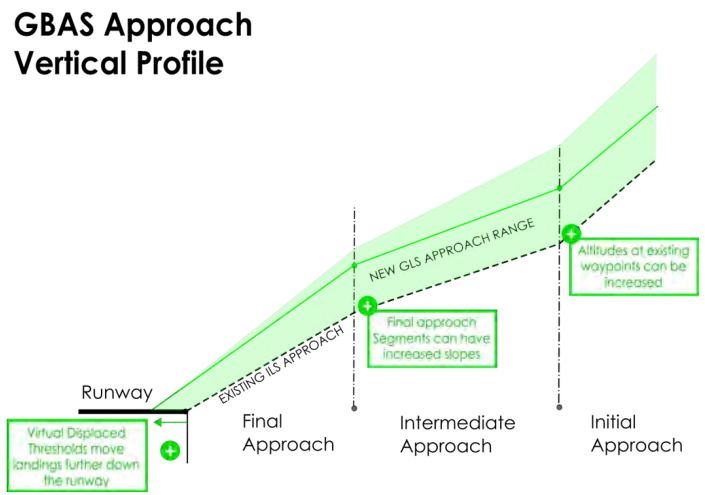
GLS RWY 10L

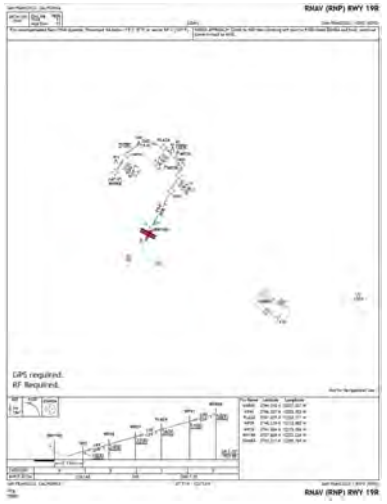
- GPA: 3.00°
- Expected Arrivals Per Day: <1 (2023)
- CSPR: No
- Final approach course is offset 3.00 degrees north of the centerline to achieve lowest possible minimums
- This procedure is not considered to reduce noise impact

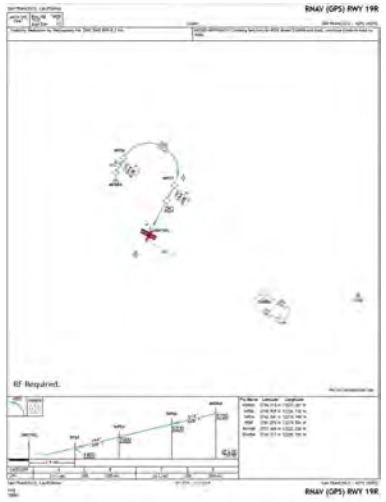


10L GLS Flight Inspection Graphic from GPD

GBAS Innovative Approach Evaluation Status







Group 2 Innovative Approach Concepts (Beyond 5 Years)

- GLS CAT II with a 3.00^{o} or 3.10^{o} GPA
- 19R RNP to GLS
- Virtually Displaced Threshold
- Short final RNP to GLS
- Use of terminal area path for additional GBAS augmented paths and possible automated initial approach dispersion
- Additional concepts that emerge from exploration with residents, airlines and air traffic

San Francisco International Airport GBAS and GLS Procedures

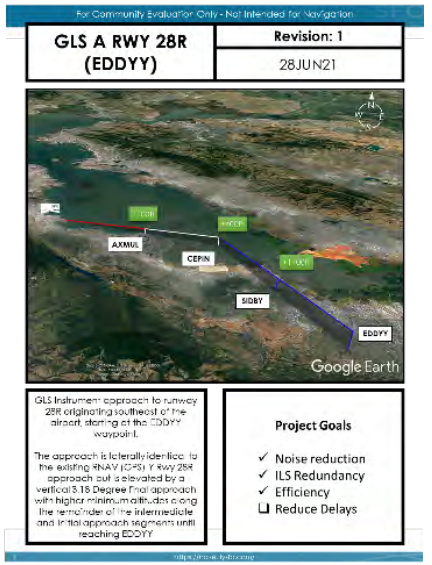
Palo Alto Workshop

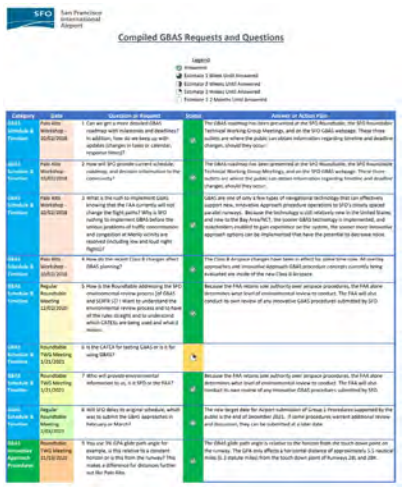
August 26, 2021

SFO

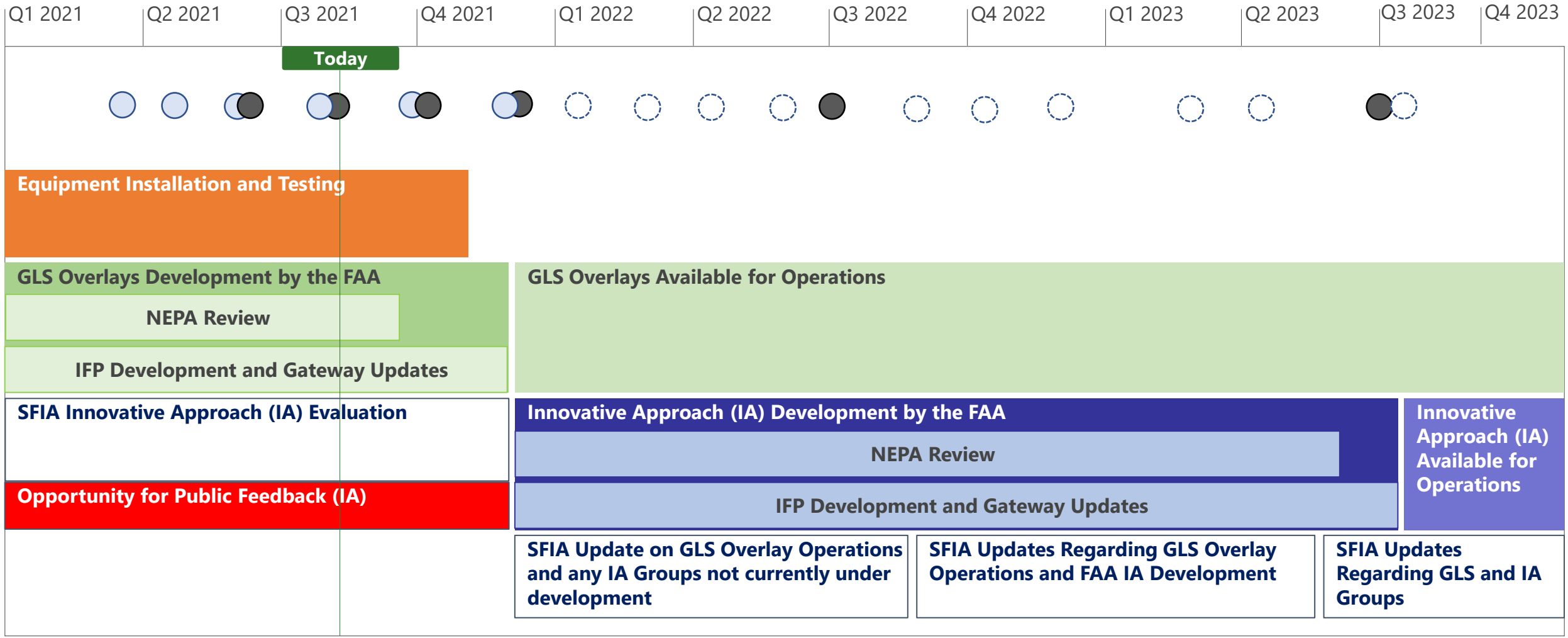
Topics Covered

1. **Current GBAS Project Timeline**
2. **United Airlines Simulator Event and Upcoming Flight Evaluation**
3. **Possible Noise Monitoring Locations**
4. **Tracking GBAS Q&A**
5. **Review of latest CFPPs**
6. **Questions**





SFO GBAS Estimated Schedule and Planned Outreach



Important SFO GBAS Milestones

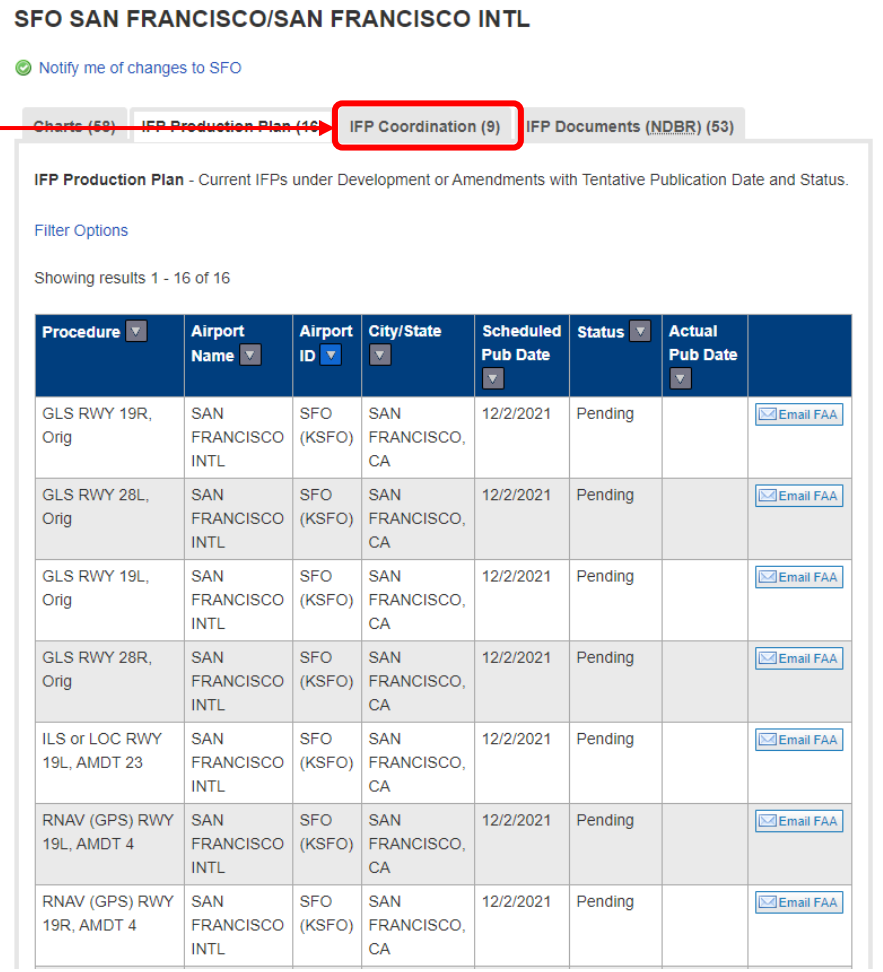
SEP21 – Anticipated date for FAA Instrument Procedure Gateway Update to introduce GLS Overlay Procedures

SEP21 – Opportunity for UAL Flight Evaluation

OCT21 – FAA Flight Inspection/Validation of GBAS and Overlay GLS Approaches

02DEC21 – Earliest start date for GLS Overlay Approach Procedures

DEC21 – Target date for SFO to request FAA Development of Group 1 Innovative GLS Procedures



SFO SAN FRANCISCO/SAN FRANCISCO INTL

Notify me of changes to SFO

Charts (58) | IFP Production Plan (16) | IFP Coordination (9) | IFP Documents (NDBR) (53)

IFP Production Plan - Current IFPs under Development or Amendments with Tentative Publication Date and Status.

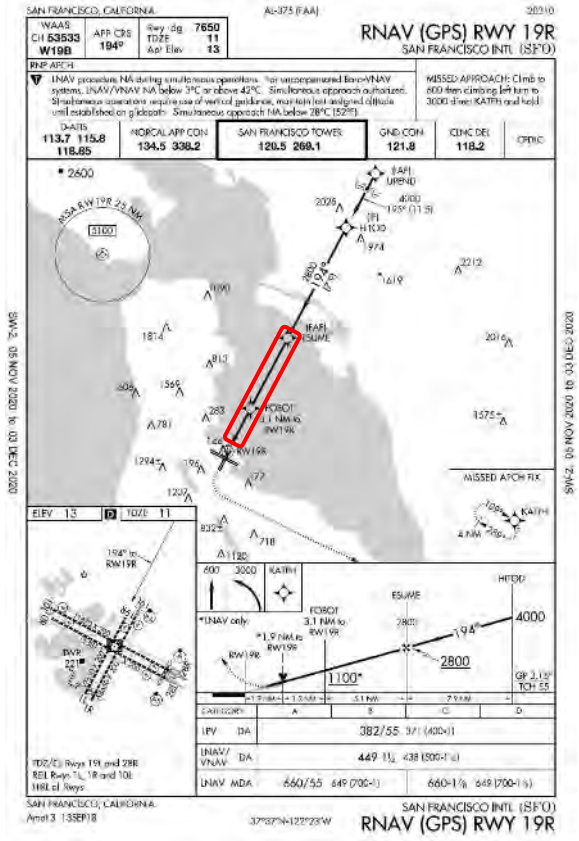
Filter Options

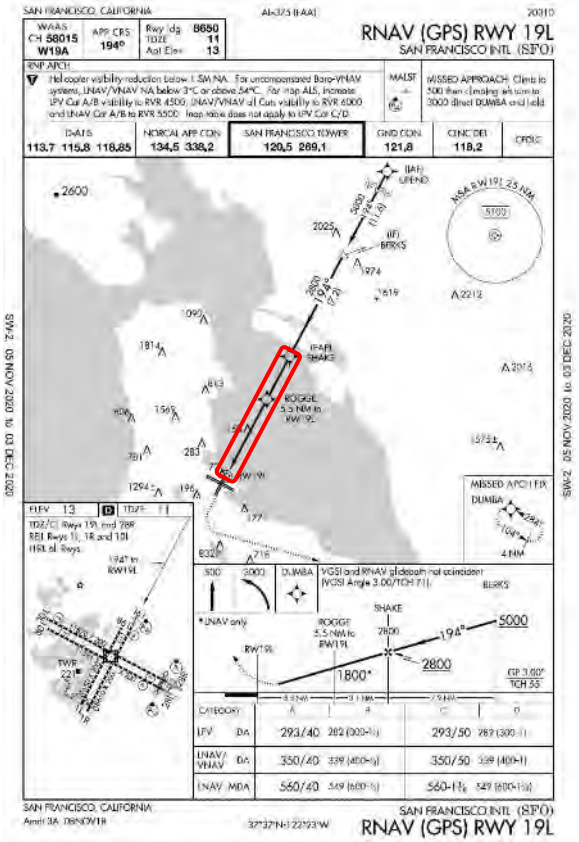
Showing results 1 - 16 of 16

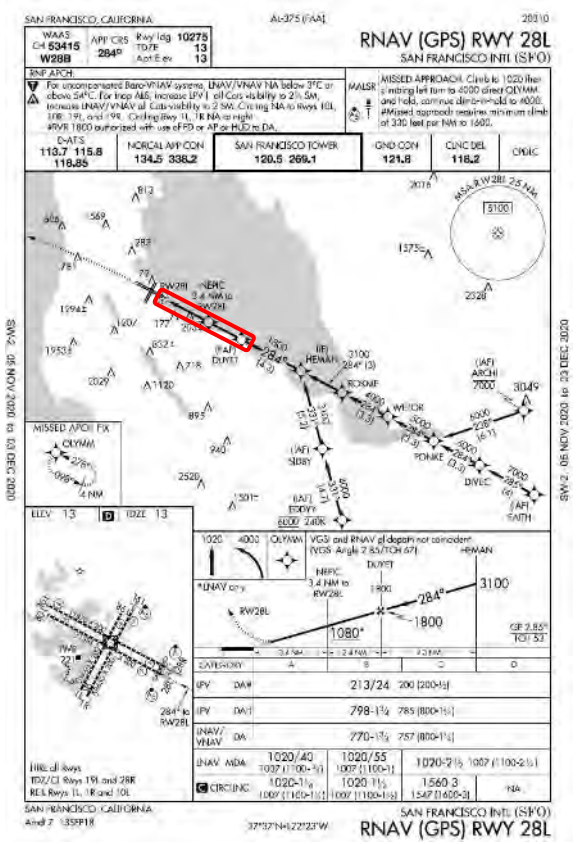
Procedure	Airport Name	Airport ID	City/State	Scheduled Pub Date	Status	Actual Pub Date	
GLS RWY 19R, Orig	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
GLS RWY 28L, Orig	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
GLS RWY 19L, Orig	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
GLS RWY 28R, Orig	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
ILS or LOC RWY 19L, AMDT 23	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
RNAV (GPS) RWY 19L, AMDT 4	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
RNAV (GPS) RWY 19R, AMDT 4	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA

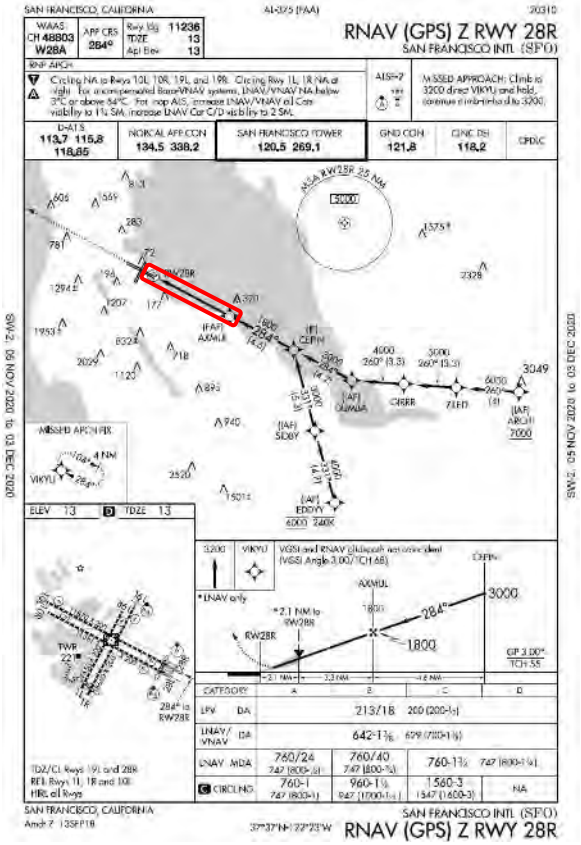
https://www.faa.gov/air_traffic/flight_info/aeronav/procedures/application/?event=procedure.results&tab=productionPlan&nasrId=SFO#searchResultsTop

SFO GLS Overlay Approaches









GLS RWY 19R

- RNAV (GPS) RWY 19R
- GPA: 3.15°
- Opportunity: 5%
- CSPR: TBD

GLS RWY 19L

- RNAV (GPS) RWY 19L
- GPA: 3.00°
- Opportunity: 5%
- CSPR: TBD

GLS RWY 28L

- RNAV (GPS) RWY 28L
- GPA: 2.85°
- Opportunity: 95%
- CSPR: Yes

GLS RWY 28R

- RNAV (GPS) Z RWY 28R
- GPA: 3.00°
- Opportunity: 95%
- CSPR: Yes

UAL Flight Simulator Evaluation

Flight Simulator Evaluation of SFO GLS Approaches

UAL, Boeing, Honeywell and the SFO GBAS Project team met at the UAL Flight Technical Center in Denver, CO on 22JUN21 to conduct simulator evaluations of Innovative GLS Procedure Concepts and an existing procedure

- GLS DB RWY 28R (Encoded as RNP 0.30)
- RNAV (GPS) Z Rwy 28R
- GLS A RWY 28R (Encoded as RNP 0.30)

Procedures were tested to evaluate aircraft configuration, thrust and speed management along with general flyability

UNITED

BOEING

Honeywell

UAL Flight Simulator Evaluation - Results

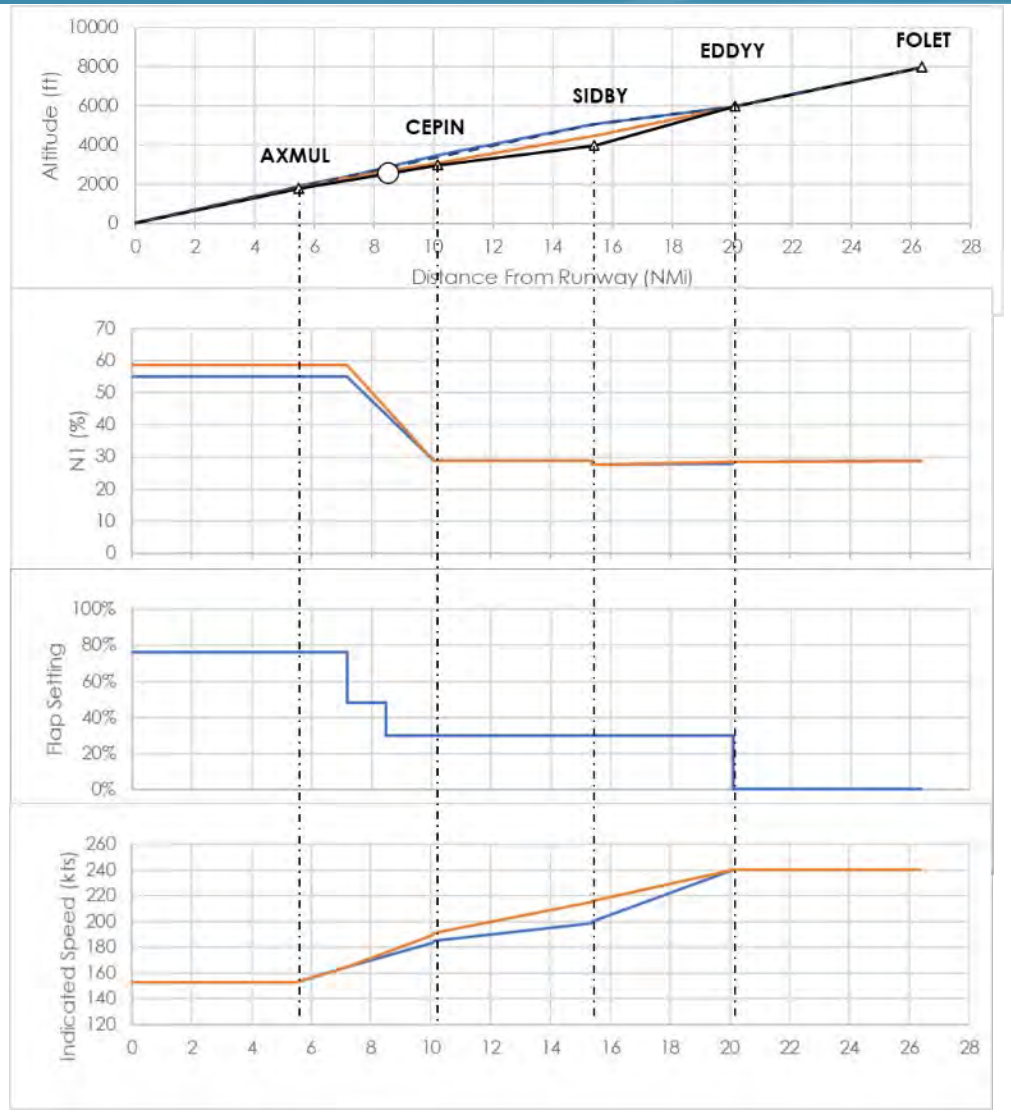
Flight Simulator Findings

GLS-DB Rwy 28R Innovative Approach Concept (Down the Bay) was stable and was modified to prevent usage of supplemental aerodynamic deceleration (speed brakes)

RNAV (GPS) Z Rwy 28R was relatively challenging for flight crew to reduce speed immediately after EDDYY and requires more significant flap or aerodynamic deceleration devices to be used

GLS A Rwy 28R innovative concept was easier to achieve the speed reduction

Flight evaluation of RNAV (GPS) Z and GLS A can proceed



Flight Test and Validation of CFPP Noise Modeling

Flight Evaluation of SFO GLS Approaches

United Airlines has offered to support the community evaluation of both the overlay and innovative GLS approach concepts by performing evaluation flights for the purposes of noise data collection*, **

The flights will occur between September and October of 2021

Summary report of results made available via https://noise.flysfo.com

The Flight Procedures Subcommittee, aided by the SFO GBAS Project Team, will use the information from the test flights to

1. Verify that overlay GLS approaches are not louder than current approaches
2. Evaluate initial AEDT v3D / BADA 4 SEL noise predictions (presented in the CFPPs) vs noise monitor results
3. Make adjustments to the AEDT v3D / BADA 4 noise predictions where applicable

**UAL flight test information may not precisely reflect the current AEDT/BADA modeling assumptions*
***SFO GBAS Project team may not be able to modify the BADA 4 models to take advantage of detected noise results due to differences in aircraft weight, pilot technique, ambient conditions and data samples per procedure*

Planned Noise Monitoring Locations for UAL Flight Evaluation

Locations

- A — Location on Tevis Pl, Palo Alto (near SIDBY)
- B — Jesuit Retreat Center of Los Altos (Prior to EDDYY)
- C — Juana Briones Elementary School, Orme St, Palo Alto
- D — Alta Mesa Memorial Park, Arastradero Rd, Palo Alto
- E — Walter Hayes Elementary School, Palo Alto
- F — Belle Haven Child Development Center in Menlo Park

Confirmed Locations

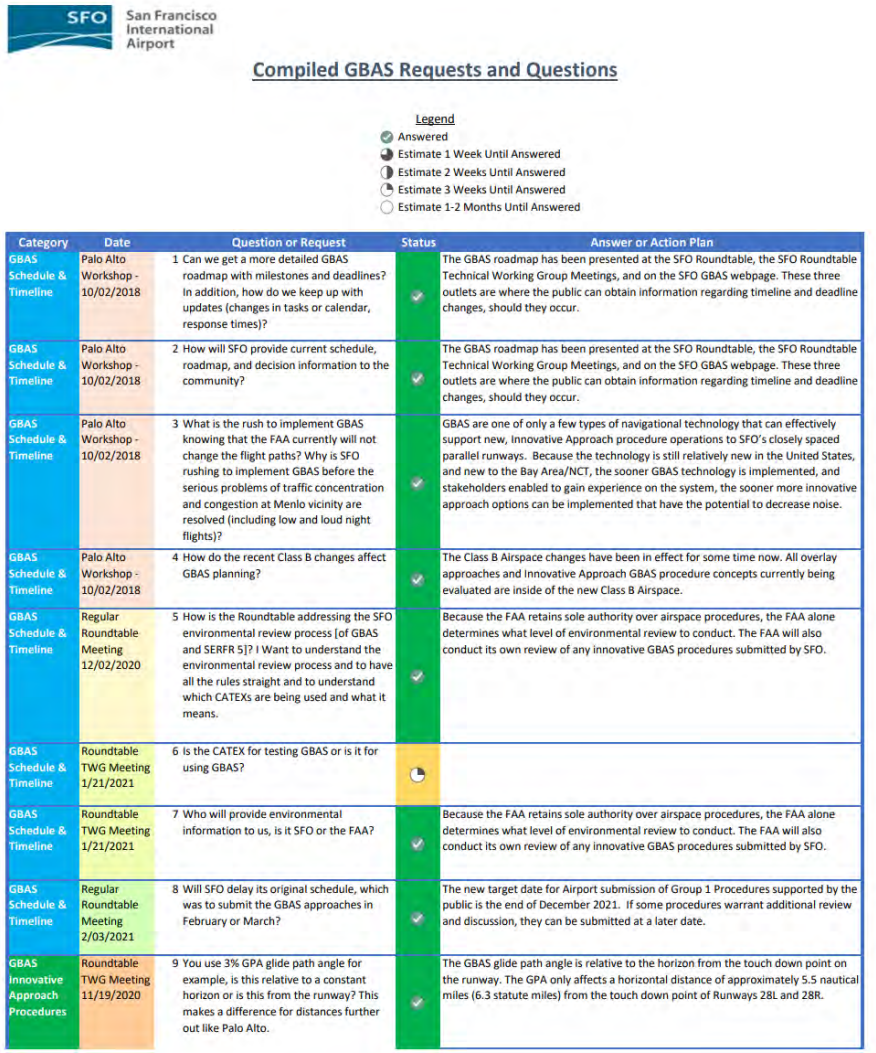
Need to Select Two Locations From These Three

Location Will Be Selected Unless Alternative Site, Closer to the Flight Path, Is Identified

Tracking GBAS Question and Answers

SFO GBAS Website Q&A Section

- All questions received from the public
  - Verbally during SFO TWG Roundtable, Full SFO Roundtable and/or During Palo Alto Workshop
  - Electronically in advance, during or immediately following SFO TWG RT, SFO RT and/or Palo Alto Workshop
  - Via email: SFO.GBAS@flysfo.com
- Questions are compiled by category and include additional information about the date when the question was first posed and from which
- Where a response is is yet to be provided, the estimated time until an answer will be posted is provided



SFO San Francisco International Airport

Compiled GBAS Requests and Questions

Legend
- Answered
- Estimate 1 Week Until Answered
- Estimate 2 Weeks Until Answered
- Estimate 3 Weeks Until Answered
- Estimate 1-2 Months Until Answered

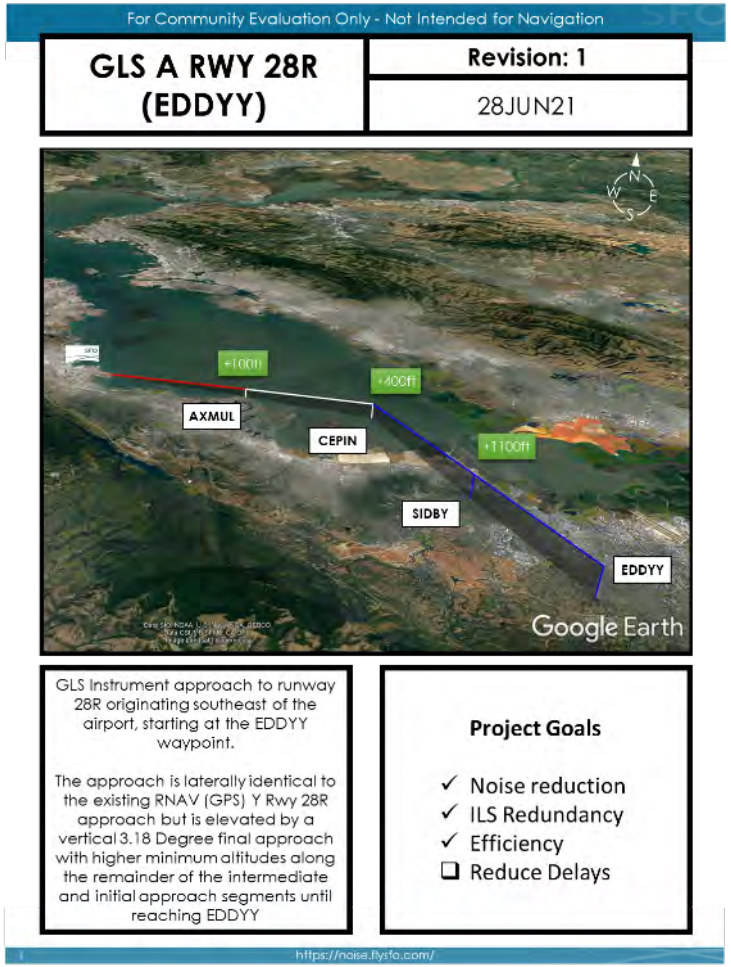
Category	Date		Question or Request	Status	Answer or Action Plan
GBAS Schedule & Timeline	Palo Alto Workshop - 10/02/2018	1	Can we get a more detailed GBAS roadmap with milestones and deadlines? In addition, how do we keep up with updates (changes in tasks or calendar, response times)?	✓	The GBAS roadmap has been presented at the SFO Roundtable, the SFO Roundtable Technical Working Group Meetings, and on the SFO GBAS webpage. These three outlets are where the public can obtain information regarding timeline and deadline changes, should they occur.
GBAS Schedule & Timeline	Palo Alto Workshop - 10/02/2018	2	How will SFO provide current schedule, roadmap, and decision information to the community?	✓	The GBAS roadmap has been presented at the SFO Roundtable, the SFO Roundtable Technical Working Group Meetings, and on the SFO GBAS webpage. These three outlets are where the public can obtain information regarding timeline and deadline changes, should they occur.
GBAS Schedule & Timeline	Palo Alto Workshop - 10/02/2018	3	What is the rush to implement GBAS knowing that the FAA currently will not change the flight paths? Why is SFO rushing to implement GBAS before the serious problems of traffic concentration and congestion at Menlo vicinity are resolved (including low and loud night flights)?	✓	GBAS are one of only a few types of navigational technology that can effectively support new, innovative Approach procedure operations to SFO's closely spaced parallel runways. Because the technology is still relatively new in the United States, and new to the Bay Area/NCT, the sooner GBAS technology is implemented, and stakeholders enabled to gain experience on the system, the sooner more innovative approach options can be implemented that have the potential to decrease noise.
GBAS Schedule & Timeline	Palo Alto Workshop - 10/02/2018	4	How do the recent Class B changes affect GBAS planning?	✓	The Class B Airspace changes have been in effect for some time now. All overlay approaches and Innovative Approach GBAS procedure concepts currently being evaluated are inside of the new Class B Airspace.
GBAS Schedule & Timeline	Regular Roundtable Meeting 12/02/2020	5	How is the Roundtable addressing the SFO environmental review process [of GBAS and SERFR 5]? I Want to understand the environmental review process and to have all the rules straight and to understand which CATEXs are being used and what it means.	✓	Because the FAA retains sole authority over airspace procedures, the FAA alone determines what level of environmental review to conduct. The FAA will also conduct its own review of any innovative GBAS procedures submitted by SFO.
GBAS Schedule & Timeline	Roundtable TWG Meeting 1/21/2021	6	Is the CATEX for testing GBAS or is it for using GBAS?	◔	
GBAS Schedule & Timeline	Roundtable TWG Meeting 1/21/2021	7	Who will provide environmental information to us, is it SFO or the FAA?	✓	Because the FAA retains sole authority over airspace procedures, the FAA alone determines what level of environmental review to conduct. The FAA will also conduct its own review of any innovative GBAS procedures submitted by SFO.
GBAS Schedule & Timeline	Regular Roundtable Meeting 2/03/2021	8	Will SFO delay its original schedule, which was to submit the GBAS approaches in February or March?	✓	The new target date for Airport submission of Group 1 Procedures supported by the public is the end of December 2021. If some procedures warrant additional review and discussion, they can be submitted at a later date.
GBAS Innovative Approach Procedures	Roundtable TWG Meeting 11/19/2020	9	You use 3% GPA glide path angle for example, is this relative to a constant horizon or is this from the runway? This makes a difference for distances further out like Palo Alto.	✓	The GBAS glide path angle is relative to the horizon from the touch down point on the runway. The GPA only affects a horizontal distance of approximately 5.5 nautical miles (6.3 statute miles) from the touch down point of Runways 28L and 28R.

https://noise.flysfo.com/2021/05/17/presentations-and-answers-to-public-questions-regarding-gbas/

Group 1 Innovative Approach Community Flight Procedure Packages

SFO GBAS Project Team has uploaded new CFPPs for Innovative GLS Procedure Concepts

- The SFO GBAS Project team is uploading Community Flight Procedure Packages (CFPPs) to evaluate the difference between Innovative GLS Approach concepts and the nearest existing approaches
  - 12 CFPPs (1 for each Innovative GLS Approach and Starting Point)
  - 4 Aircraft Types
- SFO GBAS Project team is developing 2 additional CFPPs for conversion of CVFP Tipp Toe into a GLS Overlay to 28L and 28R
- The CFPPs will continue to be updated based on flight evaluation results, potential changes to the procedures or additional supporting information



https://noise.flysfo.com/2021/05/14/gbas-innovative-approach-procedures/

Next Steps

Public Feedback

- Review the CFPPs
- Compare impacts and benefits
- Identify procedures that may negatively impact the public near the flight paths
- Submit feedback to SFO by Q4 2021

Questions

https://noise.flysfo.com

Backup Material

CFPPs For Review

Group 1 CFPPs For Review

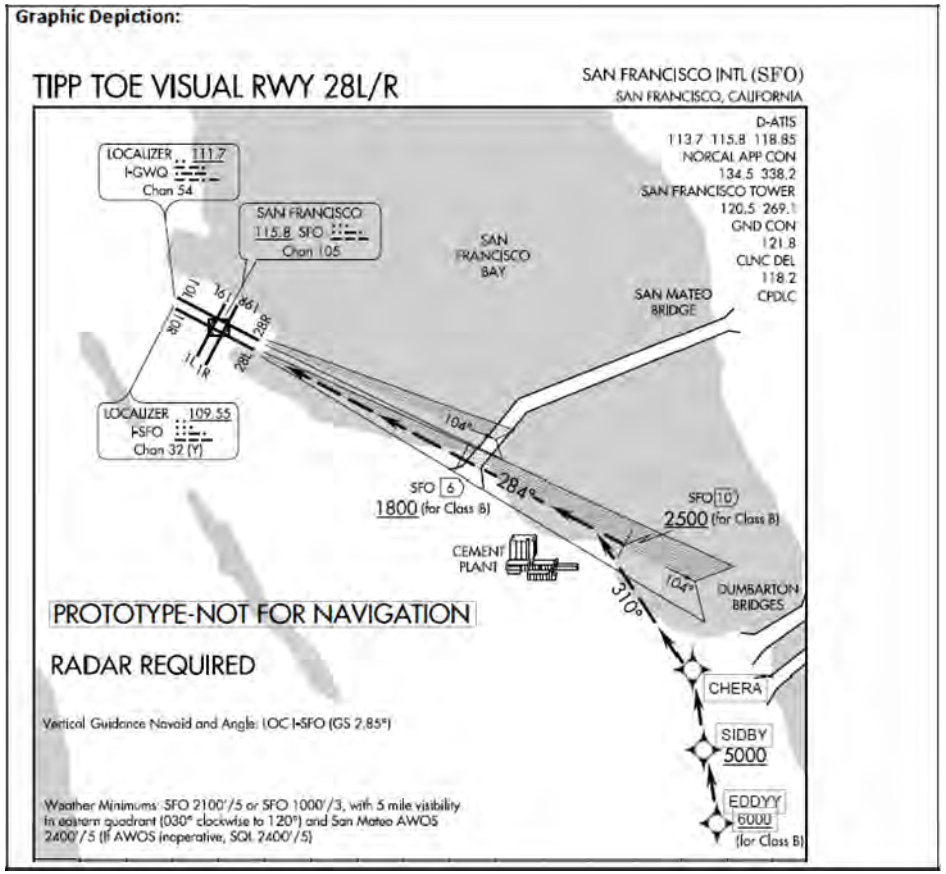
2 Draft IA CFPPs Updated Following Feedback from the Community

5 New IA CFPPs With Unique Flight Tracks and/or Vertical Profiles

5 New IA CFPPs that are overlays to existing Flight Procedures

Group 1 CFPPs Under Development

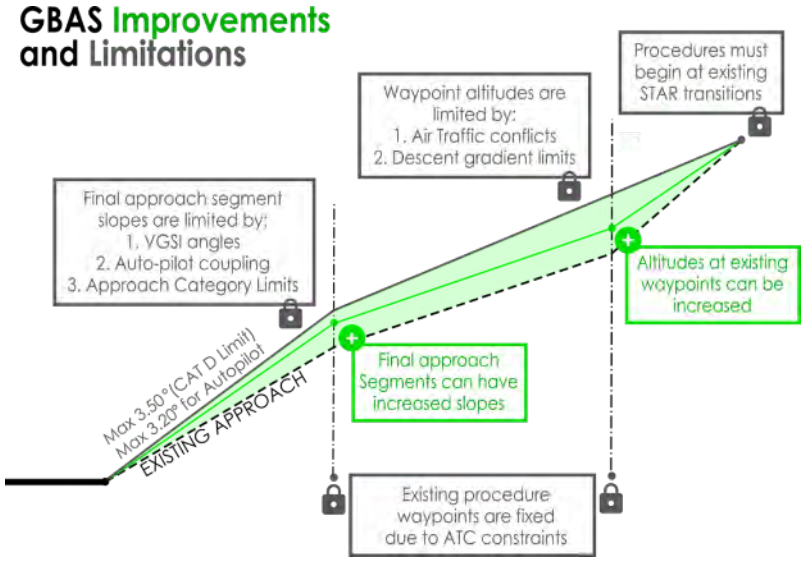
2 CFPPs for conversion of the Tipp Toe Visual Rwy 28L/R into GLS-TT Rwy 28L and GLS-TT Rwy 28R

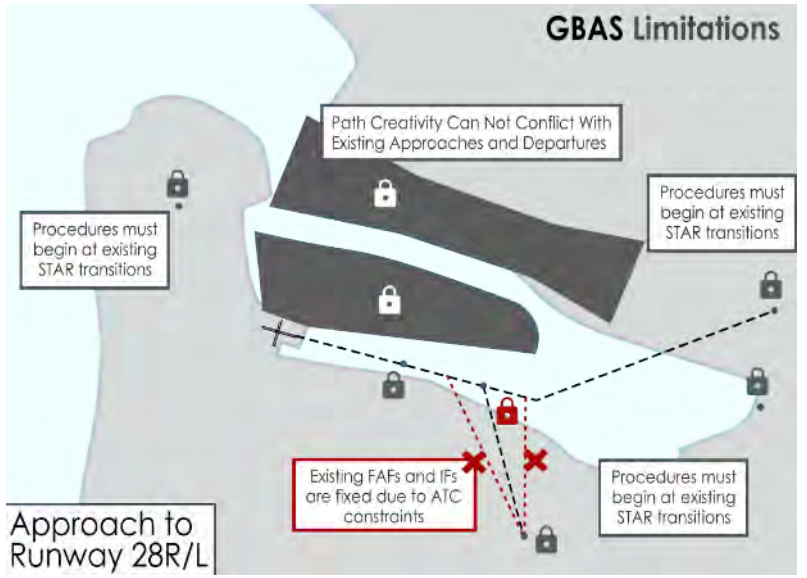


GBAS Innovative Approach Evaluation Status

SFO GBAS Project Team Has 8 Innovative GLS Concepts For Evaluation

- Developed through a flight procedures subcommittee to identify criteria, ATC and flyability challenges
- 23 initial concepts were reduced to 8
- Resulted in two "groups" of concept approaches to pursue
- Group 1 focusses on what can be published and flown within the next 5 years
  - 28R – 5 Concepts
  - 28L – 2 Concepts
  - 10R – 1 Concept
  - 10L – 1 Concept
- Group 2 procedures may have more substantial noise benefits, but will require further coordination for FAA to implement





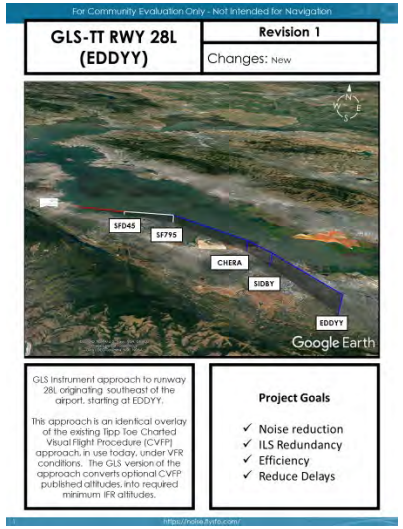
San Francisco International Airport GBAS Overlay and Innovative GLS

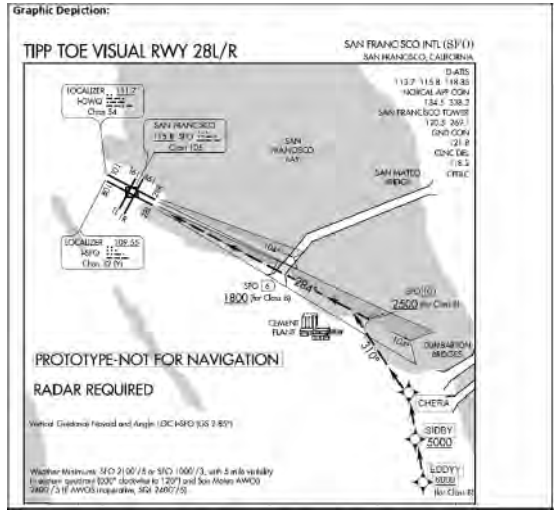
SFO Roundtable Technical Working Group

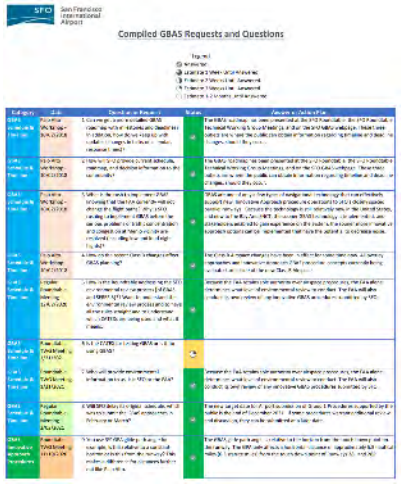
September 22, 2021

Topics Covered

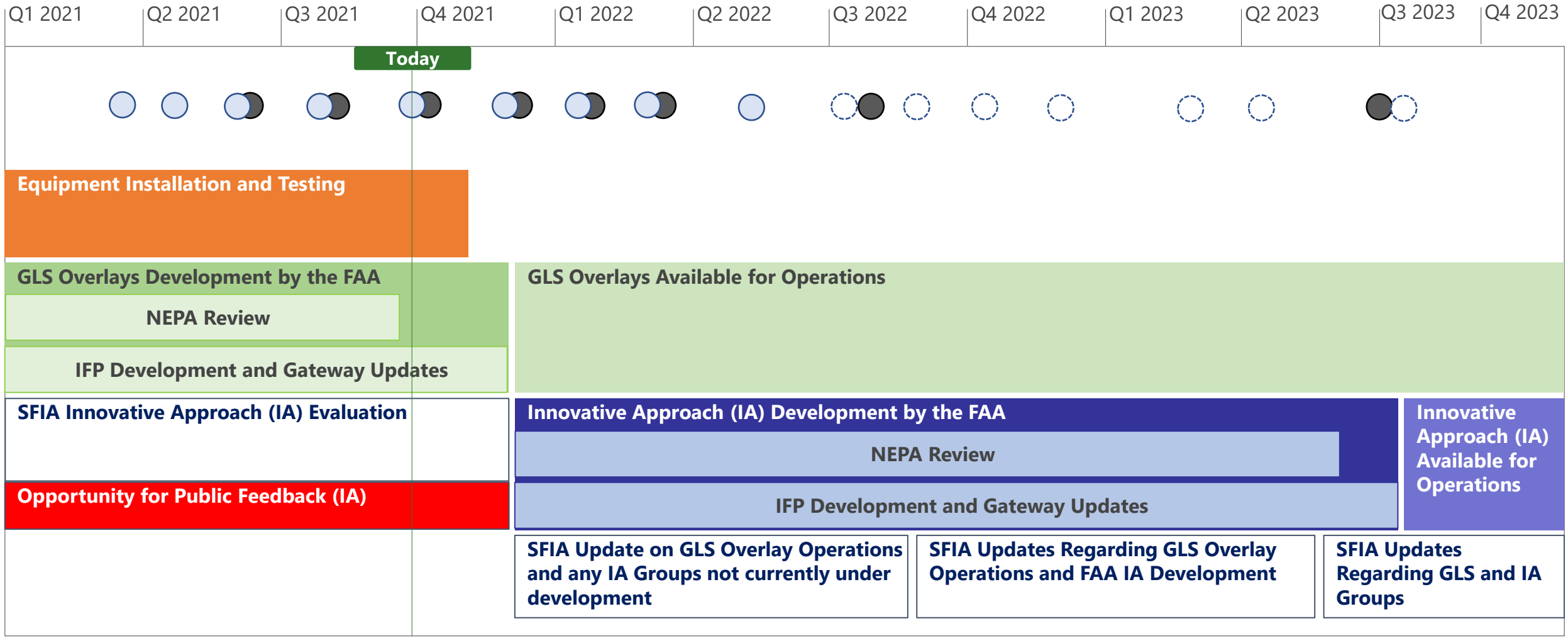
1. Current GBAS Project Timeline
2. United Airlines Flight Evaluation
3. Possible Noise Monitoring Locations
4. Tracking GBAS Q&A
5. Review of GLS-TT Rwy 28L and GLS-TT Rwy 28R
6. Questions







SFO GBAS Estimated Schedule and Planned Outreach



Important SFO GBAS Milestones (Updated 17SEP21)

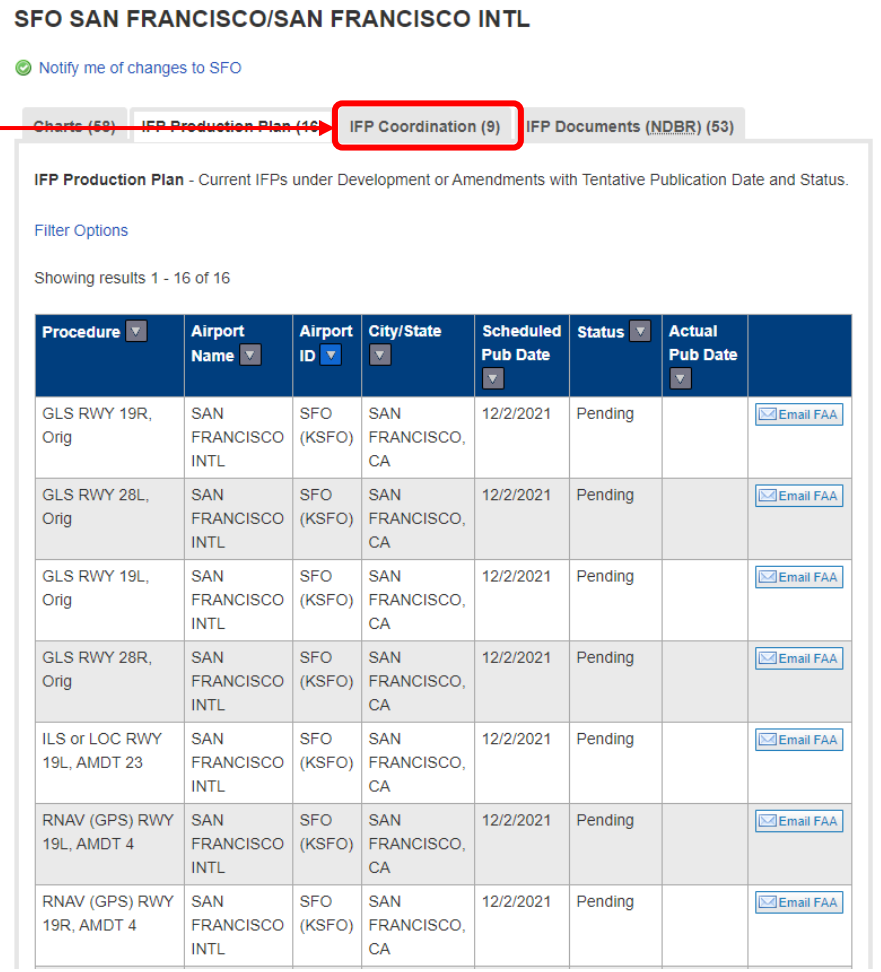
SEP21 – Anticipated date for FAA Instrument Procedure Gateway Update to introduce GLS Overlay Procedures

OCT21 – Opportunity for UAL Flight Evaluation

18-21OCT21 – FAA Flight Inspection/Validation of GBAS and Overlay GLS Approaches

02DEC21 – Earliest start date for GLS Overlay Approach Procedures

DEC21 – Target date for SFO to request FAA Development of Group 1 Innovative GLS Procedures



SFO SAN FRANCISCO/SAN FRANCISCO INTL

Notify me of changes to SFO

Charts (58) | IFP Production Plan (16) | IFP Coordination (9) | IFP Documents (NDBR) (53)

IFP Production Plan - Current IFPs under Development or Amendments with Tentative Publication Date and Status.

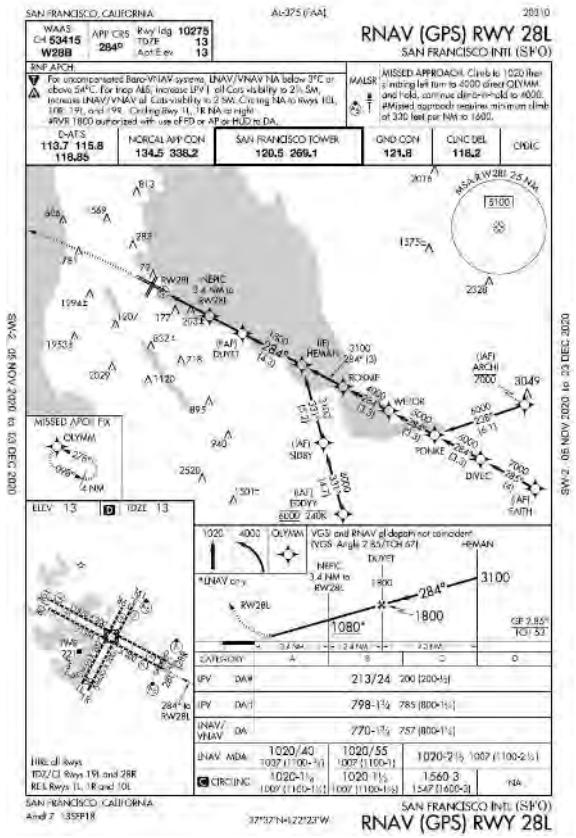
Filter Options

Showing results 1 - 16 of 16

Procedure	Airport Name	Airport ID	City/State	Scheduled Pub Date	Status	Actual Pub Date	
GLS RWY 19R, Orig	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
GLS RWY 28L, Orig	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
GLS RWY 19L, Orig	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
GLS RWY 28R, Orig	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
ILS or LOC RWY 19L, AMDT 23	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
RNAV (GPS) RWY 19L, AMDT 4	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
RNAV (GPS) RWY 19R, AMDT 4	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA

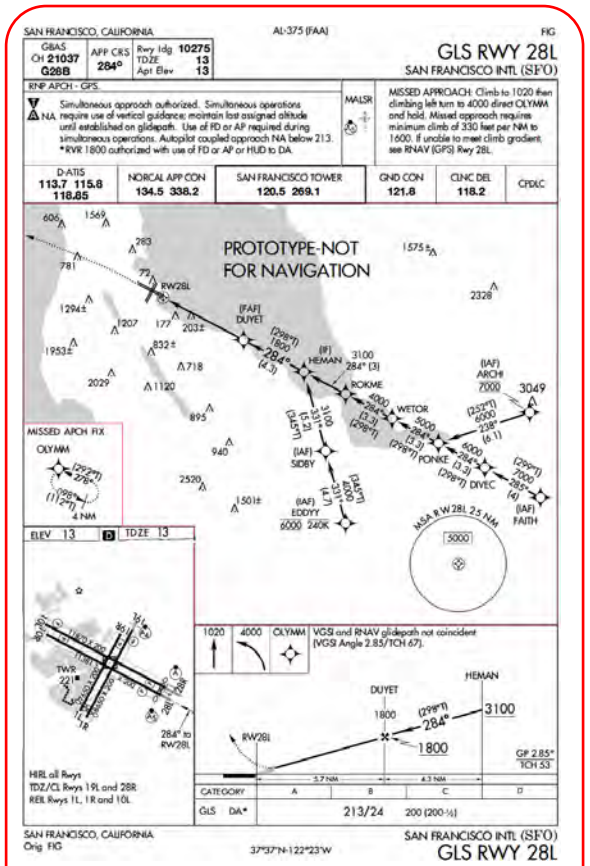
https://www.faa.gov/air_traffic/flight_info/aeronav/procedures/application/?event=procedure.results&tab=productionPlan&nasrId=SFO#searchResultsTop

SFO GLS Overlay Approach Comparison: 28L/28R



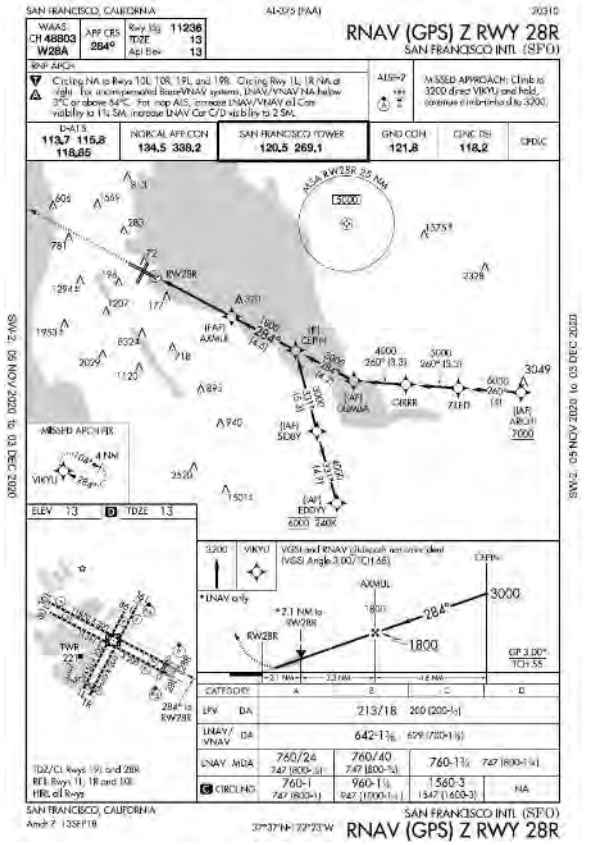
RNAV (GPS) RWY 28L

- GPA: 2.85°
- FAF: DUYET 1,800ft
- IAF: EDDYY 6,000ft @ 240KIAS



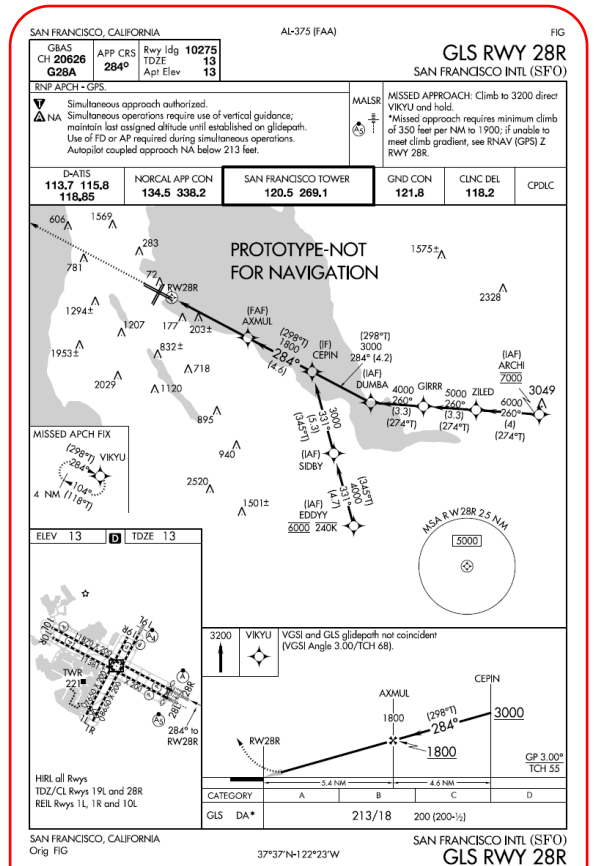
GLS RWY 28L

- GPA: 2.85°
- FAF: DUYET 1,800ft
- IAF: EDDYY 6,000ft @ 240KIAS



RNAV (GPS) Z RWY 28R

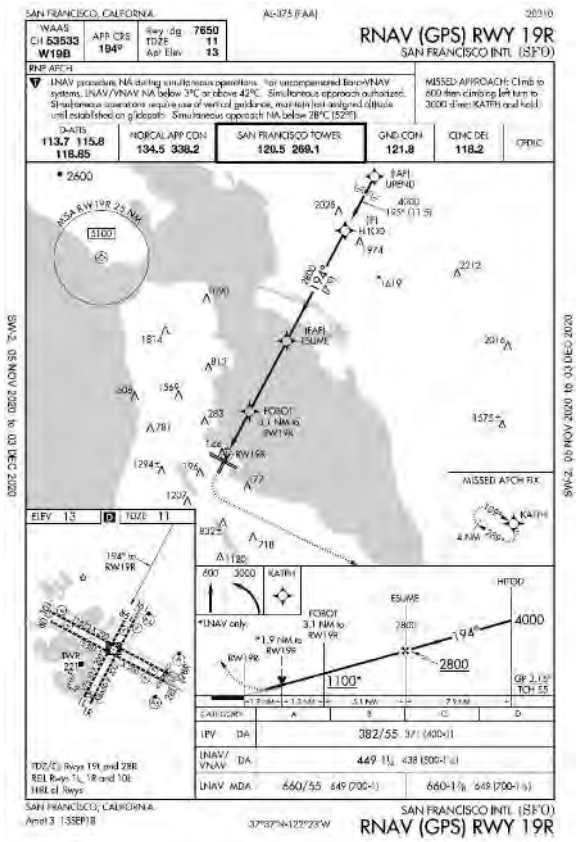
- GPA: 3.00°
- FAF: AXMUL 1,800ft
- IAF: EDDYY 6,000ft @ 240KIAS



GLS RWY 28R

- GPA: 3.00°
- FAF: AXMUL 1,800ft
- IAF: EDDYY 6,000ft @ 240KIAS

SFO GLS Overlay Approach Comparison: 19R/19L



GLS RWY 19R

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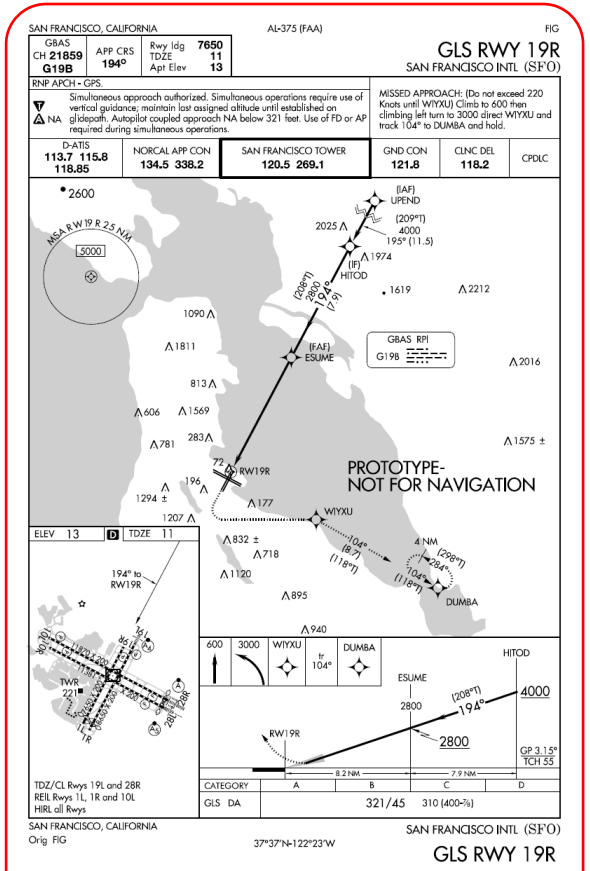
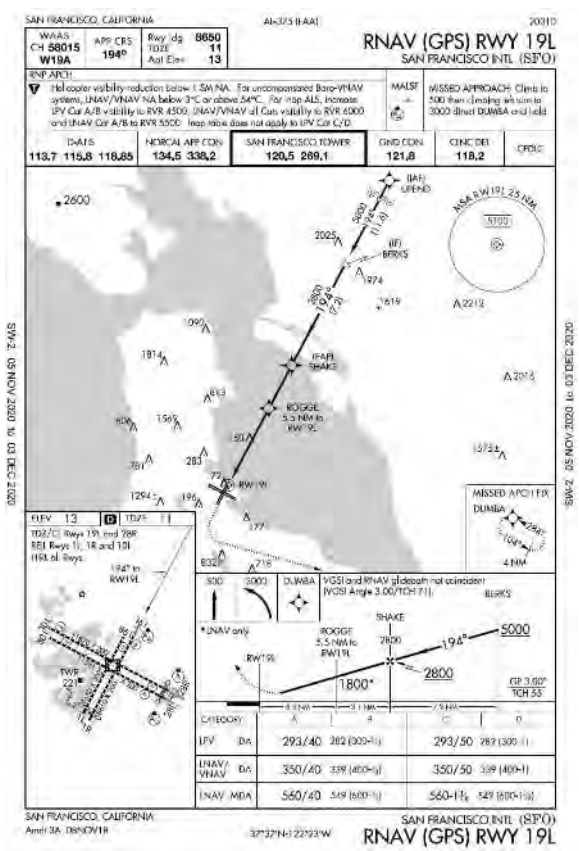
- FAF: ESUME 2,800ft
- IAF: UPEND 5,000ft



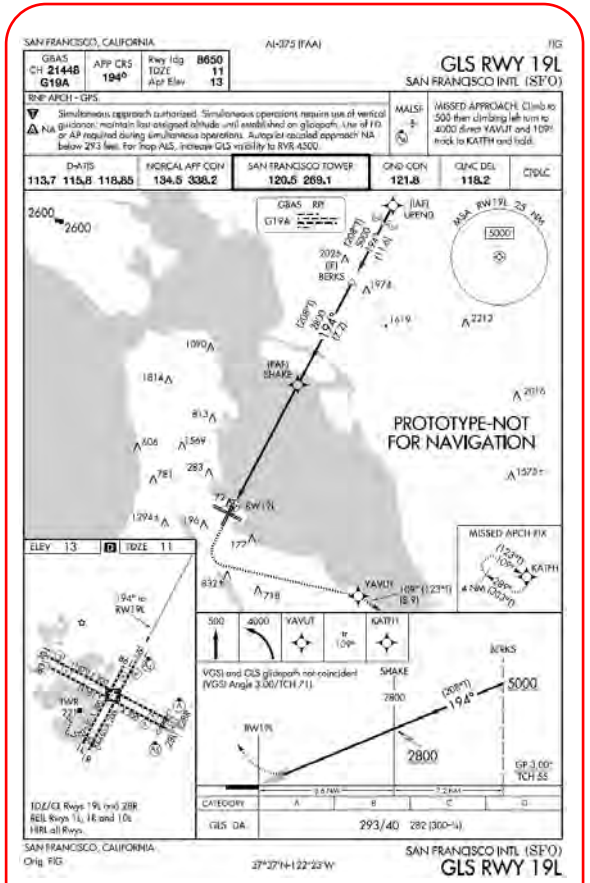
GLS RWY 19R

- GPA: 3.15°
- FAF: ESUME 2,800ft
- IAF: UPEND 5,000ft



RNAV (GPS) RWY 19L

- GPA: 3.00°
- FAF: SHAKE 2,800ft
- IAF: UPEND 5,000ft



GLS RWY 19L

- GPA: 3.00°
- FAF: SHAKE 2,800ft
- IAF: UPEND 5,000ft

Flight Test and Validation of CFPP Noise Modeling (To Be Updated Prior to TWG)

Flight Evaluation of SFO GLS Approaches

United Airlines has offered to support the community evaluation of both the overlay and innovative GLS approach concepts by performing evaluation flights for the purposes of noise data collection*, **

The flights will occur between September and October of 2021

Summary report of results made available via https://noise.flysfo.com

The Flight Procedures Subcommittee, aided by the SFO GBAS Project Team, will use the information from the test flights to

1. Verify that overlay GLS approaches will not introduce "new" noise when compared to current approaches
2. Evaluate initial AEDT v3D / BADA 4 SEL noise predictions (presented in the CFPPs) vs noise monitor results
3. Make adjustments to the AEDT v3D / BADA 4 noise predictions where applicable

**UAL flight test information may not precisely reflect the current AEDT/BADA modeling assumptions*
***SFO GBAS Project team may not be able to modify the BADA 4 models to take advantage of detected noise results due to differences in aircraft weight, pilot technique, ambient conditions and data samples per procedure*

Planned Noise Monitoring Locations for UAL Flight Evaluation (Update Prior to TWG)

Locations

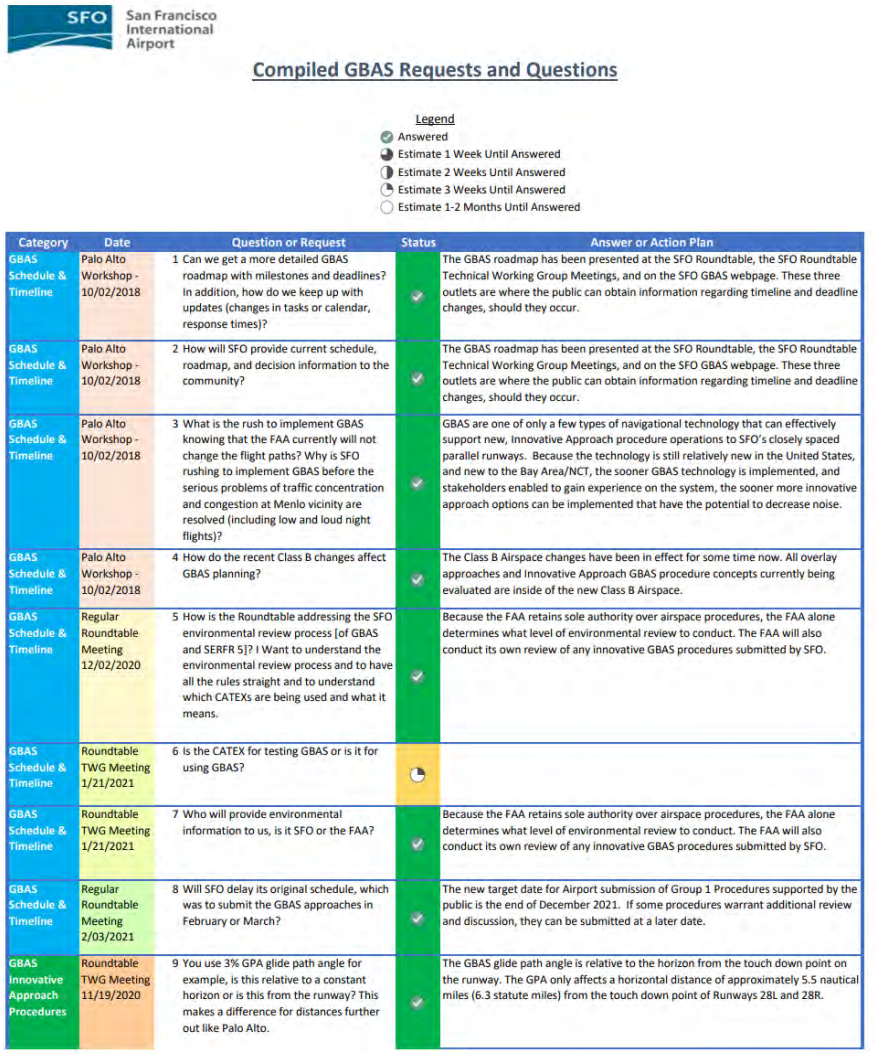
- A — Location on Tevis Pl, Palo Alto (near SIDBY)
- B — Jesuit Retreat Center of Los Altos (Prior to EDDYY)
- C — Private Residence near Arastradero Rd & Donald Dr
- D — TBD
- E — TBD
- F — Belle Haven Child Development Center in Menlo Park

Confirmed Locations Need to Select Two Locations From These Three

Tracking GBAS Question and Answers

SFO GBAS Website Q&A Section

- All questions received from the public
  - Verbally during SFO TWG Roundtable, Full SFO Roundtable and/or During Palo Alto Workshop
  - Electronically in advance, during or immediately following SFO TWG RT, SFO RT and/or Palo Alto Workshop
  - Via email: SFO.GBAS@flysfo.com
- Questions are compiled by category and include additional information about the date when the question was first posed and from which
- Where a response is is yet to be provided, the estimated time until an answer will be posted is provided



SFO San Francisco International Airport

Compiled GBAS Requests and Questions

Legend
- Answered
- Estimate 1 Week Until Answered
- Estimate 2 Weeks Until Answered
- Estimate 3 Weeks Until Answered
- Estimate 1-2 Months Until Answered

Category	Date		Question or Request	Status	Answer or Action Plan
GBAS Schedule & Timeline	Palo Alto Workshop - 10/02/2018	1	Can we get a more detailed GBAS roadmap with milestones and deadlines? In addition, how do we keep up with updates (changes in tasks or calendar, response times)?	✓	The GBAS roadmap has been presented at the SFO Roundtable, the SFO Roundtable Technical Working Group Meetings, and on the SFO GBAS webpage. These three outlets are where the public can obtain information regarding timeline and deadline changes, should they occur.
GBAS Schedule & Timeline	Palo Alto Workshop - 10/02/2018	2	How will SFO provide current schedule, roadmap, and decision information to the community?	✓	The GBAS roadmap has been presented at the SFO Roundtable, the SFO Roundtable Technical Working Group Meetings, and on the SFO GBAS webpage. These three outlets are where the public can obtain information regarding timeline and deadline changes, should they occur.
GBAS Schedule & Timeline	Palo Alto Workshop - 10/02/2018	3	What is the rush to implement GBAS knowing that the FAA currently will not change the flight paths? Why is SFO rushing to implement GBAS before the serious problems of traffic concentration and congestion at Menlo vicinity are resolved (including low and loud night flights)?	✓	GBAS are one of only a few types of navigational technology that can effectively support new, innovative Approach procedure operations to SFO's closely spaced parallel runways. Because the technology is still relatively new in the United States, and new to the Bay Area/NCT, the sooner GBAS technology is implemented, and stakeholders enabled to gain experience on the system, the sooner more innovative approach options can be implemented that have the potential to decrease noise.
GBAS Schedule & Timeline	Palo Alto Workshop - 10/02/2018	4	How do the recent Class B changes affect GBAS planning?	✓	The Class B Airspace changes have been in effect for some time now. All overlay approaches and Innovative Approach GBAS procedure concepts currently being evaluated are inside of the new Class B Airspace.
GBAS Schedule & Timeline	Regular Roundtable Meeting 12/02/2020	5	How is the Roundtable addressing the SFO environmental review process [of GBAS and SERFR 5]? I Want to understand the environmental review process and to have all the rules straight and to understand which CATEXs are being used and what it means.	✓	Because the FAA retains sole authority over airspace procedures, the FAA alone determines what level of environmental review to conduct. The FAA will also conduct its own review of any innovative GBAS procedures submitted by SFO.
GBAS Schedule & Timeline	Roundtable TWG Meeting 1/21/2021	6	Is the CATEX for testing GBAS or is it for using GBAS?	◔	
GBAS Schedule & Timeline	Roundtable TWG Meeting 1/21/2021	7	Who will provide environmental information to us, is it SFO or the FAA?	✓	Because the FAA retains sole authority over airspace procedures, the FAA alone determines what level of environmental review to conduct. The FAA will also conduct its own review of any innovative GBAS procedures submitted by SFO.
GBAS Schedule & Timeline	Regular Roundtable Meeting 2/03/2021	8	Will SFO delay its original schedule, which was to submit the GBAS approaches in February or March?	✓	The new target date for Airport submission of Group 1 Procedures supported by the public is the end of December 2021. If some procedures warrant additional review and discussion, they can be submitted at a later date.
GBAS Innovative Approach Procedures	Roundtable TWG Meeting 11/19/2020	9	You use 3% GPA glide path angle for example, is this relative to a constant horizon or is this from the runway? This makes a difference for distances further out like Palo Alto.	✓	The GBAS glide path angle is relative to the horizon from the touch down point on the runway. The GPA only affects a horizontal distance of approximately 5.5 nautical miles (6.3 statute miles) from the touch down point of Runways 28L and 28R.

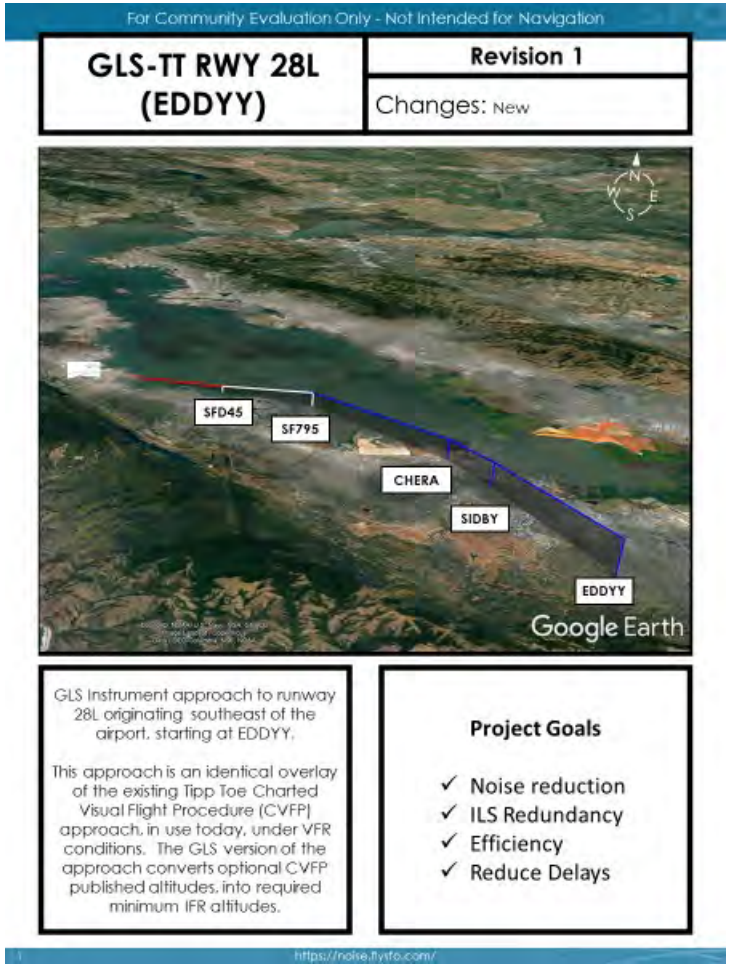
https://noise.flysfo.com/2021/05/17/presentations-and-answers-to-public-questions-regarding-gbas/

Group 1 Innovative Approach Completed and Planning for Group 2

SFO GBAS Project Team has uploaded new CFPPs for Innovative GLS Procedure Concepts

- The SFO GBAS Project team is uploading Community Flight Procedure Packages (CFPPs) to evaluate the difference between Innovative GLS Approach concepts and the nearest existing approaches
  - 14 CFPPs (1 for each Innovative GLS Approach and Starting Point)
  - Includes 2 New CFPPs for Tipp Toe
  - 4 Aircraft Types
- The CFPPs will continue to be updated based on flight evaluation results, potential changes to the procedures or additional supporting information

SFO GBAS Project Team is beginning evaluation of Group 2 Procedures for discussion at the next TWG



https://noise.flysfo.com/2021/05/14/gbas-innovative-approach-procedures/

New CFPPs: GLS-TT Rwy 28L and 28R

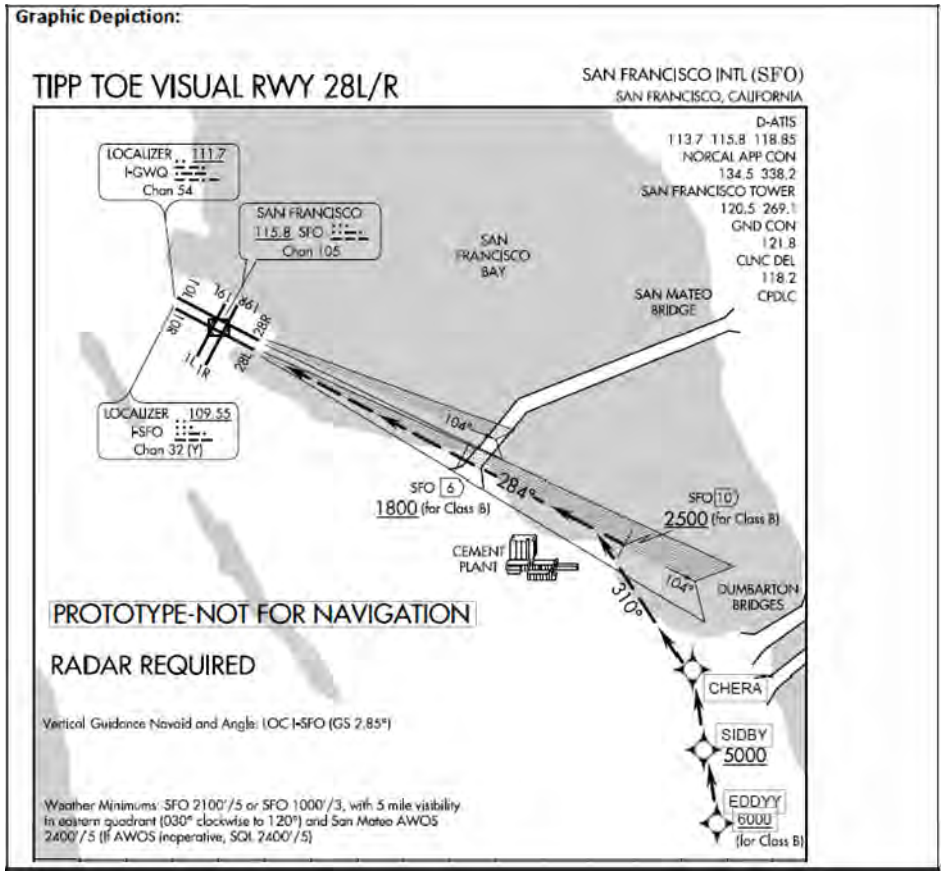
Conversion of Tipp Toe Visual Rwy 28L/R

Community feedback from SFO Roundtable TWG indicated a desire to explore additional innovative GLS approach options to runway 28L

- Achieve noise reduction through higher GPA and altitudes over residential areas
- Increase likelihood of aircraft and ATC usage under VFR conditions
- Provide opportunities in the future to enable some level of path dispersion

SFO GBAS Flight Procedures Subcommittee evaluated the existing, and soon to be updated, CVFP and identified a conversion to GLS for 28L and 28R

Procedure is part of Group 1 Innovative approach options for consideration by residents of the Bay Area in 2021



Questions

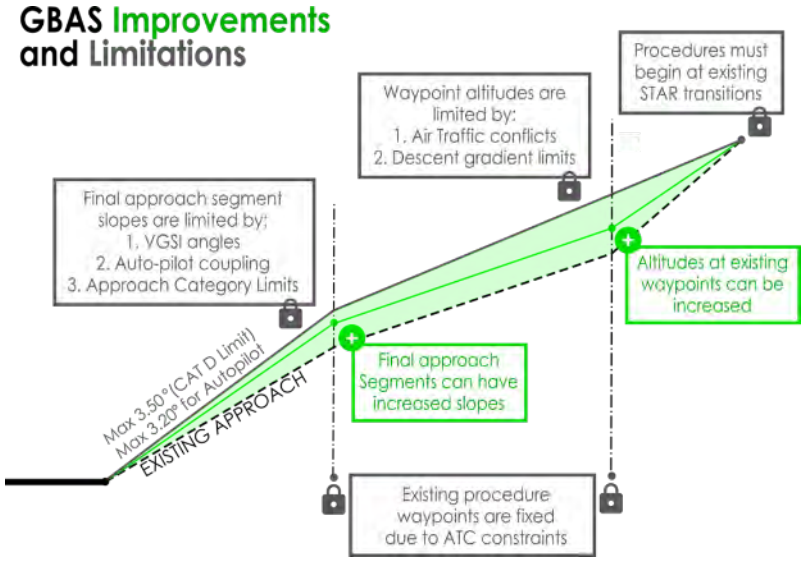
https://noise.flysfo.com

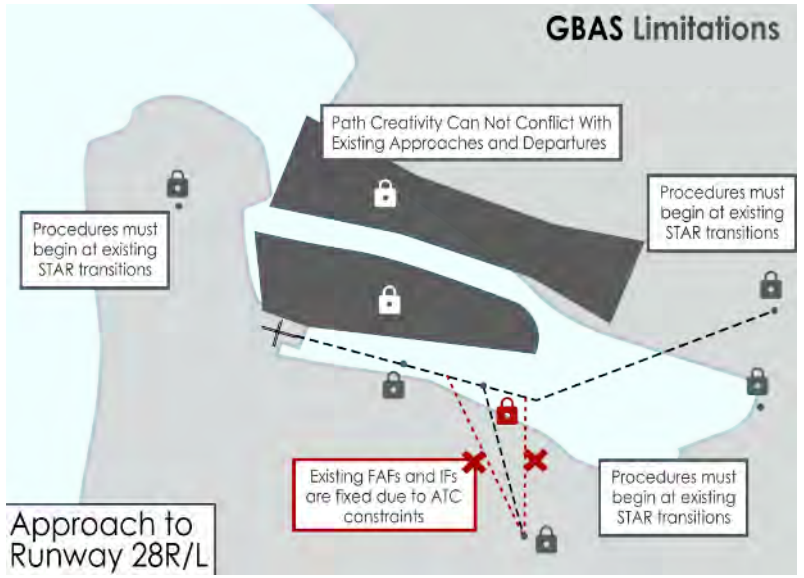
Backup Material

GBAS Innovative Approach Evaluation Status

SFO GBAS Project Team Has 8 Innovative GLS Concepts For Evaluation

- Developed through a flight procedures subcommittee to identify criteria, ATC and flyability challenges
- 23 initial concepts were reduced to 8
- Resulted in two "groups" of concept approaches to pursue
- Group 1 focusses on what can be published and flown within the next 5 years
  - 28R – 5 Concepts
  - 28L – 2 Concepts
  - 10R – 1 Concept
  - 10L – 1 Concept
- Group 2 procedures may have more substantial noise benefits, but will require further coordination for FAA to implement





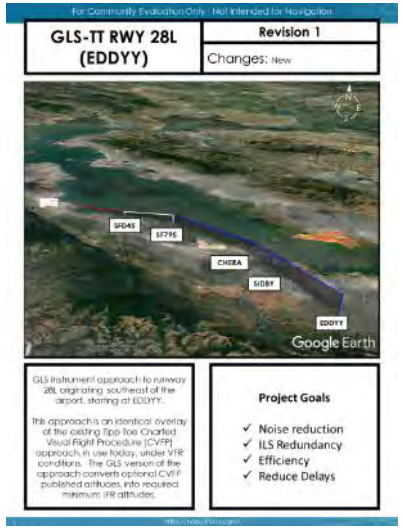
San Francisco International Airport GBAS and GLS

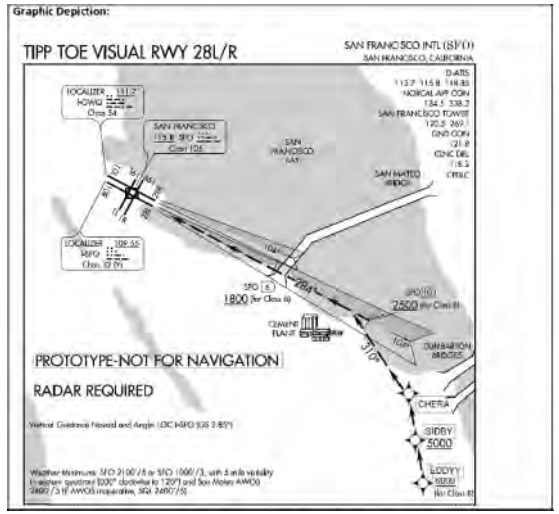
SFO Roundtable Technical Working Group

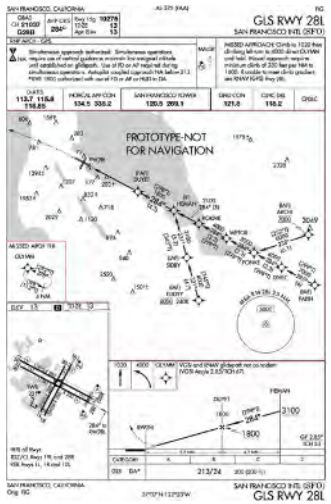
November 24, 2021

Topics Covered

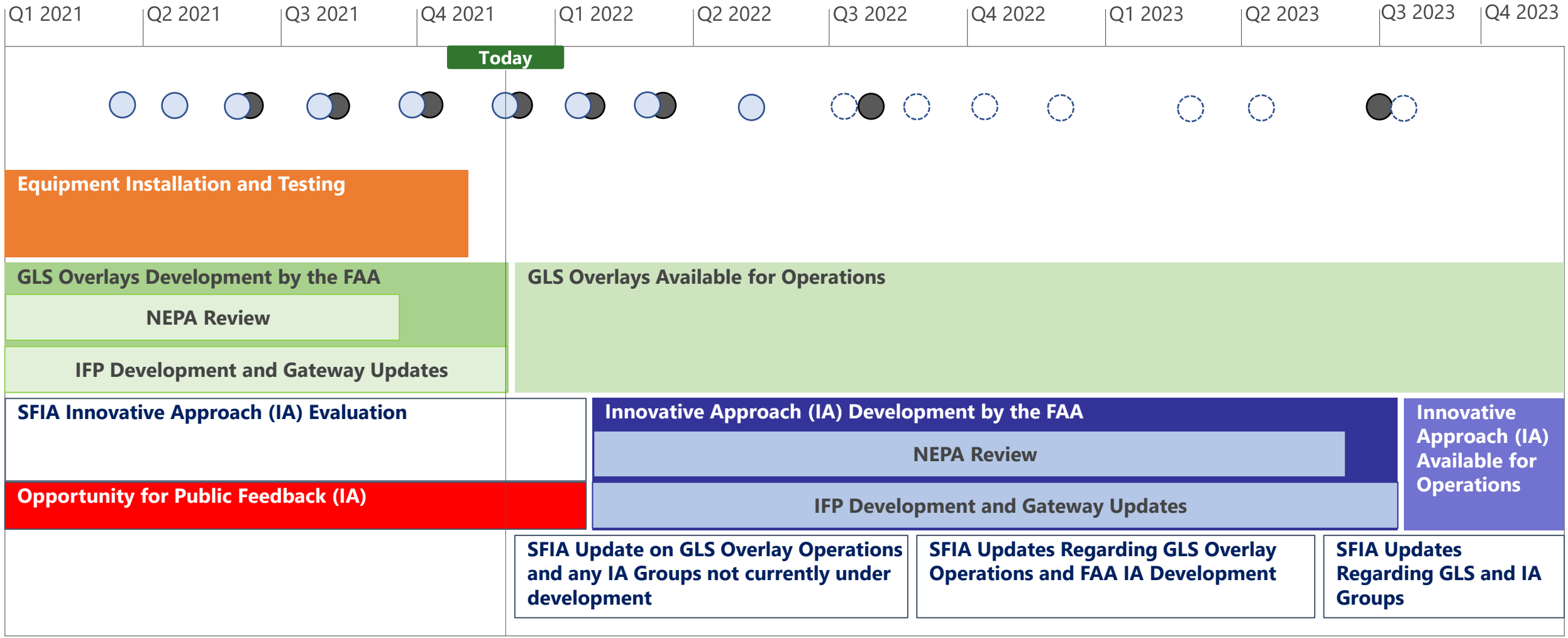
1. **Current GBAS Project Timeline**
2. **Interpreting Innovative Group 1 Procedures**
3. **Interpreting AEDT Results in CFPPs**
4. **GBAS/GLS Vision (Group 2 Procedure Development Process)**







SFO GBAS Estimated Schedule and Planned Outreach



GBAS Innovative Approach Evaluation Status

Group 1 Innovative GLS Concepts For Evaluation

Developed through a flight procedures subcommittee to identify criteria, ATC and flyability challenges

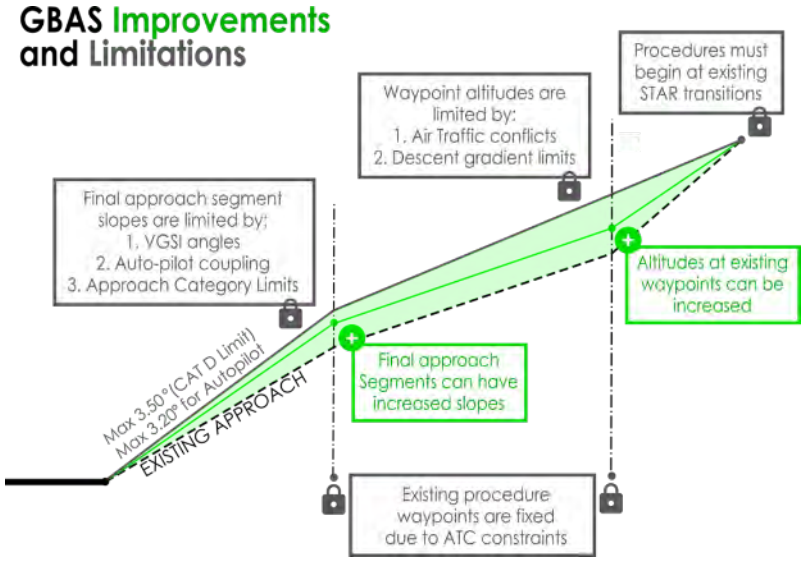
23 initial concepts were divided into three “groups” of conceptual approaches

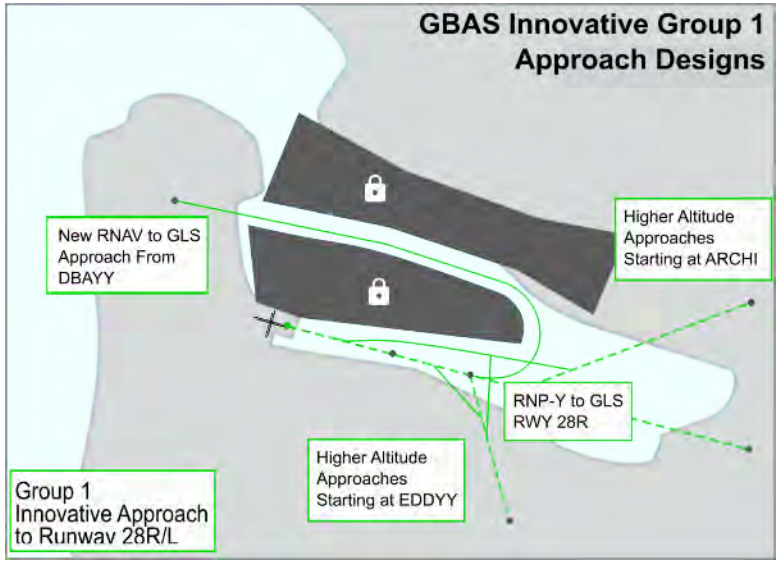
Group 1 focuses on what can be published and flown within the next 3 years*

- 28R – 5 Concepts
- 28L – 2 Concepts
- 10R – 1 Concept
- 10L – 1 Concept

Procedures are divided into 14 CFPPs, but if all were acceptable to the community then only 9 total SIAP for development would be requested via the FAA IFP Gateway

*Estimated development timeline is dependent on promptly making a submission through the FAA IFP Gateway





Group 1 Innovative GLS Approaches

Runway	Community Package	Description	Project Goals	Approval Group	Submitted to IFP Gateway
28R	GLS-DB Rwy 28R (DBAYY)	Overwater/Dispersion Opportunity		A	0 of 1
28R	GLS-BVE Rwy 28R (EDDYY)	Visual approaches that currently provide noise benefits converted to GLS		B	0 of 3
28R	GLS-BV Rwy 28R (ARCHI)				
28L	GLS-TT Rwy 28L (EDDYY)				
28R	GLS-TT Rwy 28R (EDDYY)				
28R	GLS-R Rwy 28R (EDDYY)	Highest possible altitudes over South Bay Cities		C	0 of 1
28R	GLS-R Rwy 28R (ARCHI)				
28L	GLS-A Rwy 28L (EDDYY)	Higher altitude versions of existing RNAV approaches		D	0 of 2
28L	GLS-A Rwy 28L (FAITH)				
28L	GLS-A Rwy 28L (ARCHI)				
28R	GLS-A Rwy 28R (EDDYY)				
28R	GLS-A Rwy 28R (ARCHI)				
10L	GLS-A Rwy 10L (STINS)	Introduces first precision approach to runway 10L/R		E	0 of 2
10R	GLS-A Rwy 10R (STINS)				

Noise Reduction

ILS Redundancy

Efficiency

Reduce Delays

Group 1 Innovative GLS Approaches

Runway	Community Package	Description	Project Goals	Approval Group	Submitted to IFP Gateway
28R	GLS-DB Rwy 28R (DBAYY)	Overwater/Dispersion Opportunity		A	0 of 1
28R	*GLS-BVE Rwy 28R (EDDYY)	Visual approaches that currently provide noise benefits converted to GLS		B	0 of 3
28R	*GLS-BV Rwy 28R (ARCHI)				
28L	*GLS-TT Rwy 28L (EDDYY)				
28R	*GLS-TT Rwy 28R (EDDYY)				
28R	**GLS-R Rwy 28R (EDDYY)	Highest possible altitudes over South Bay Cities		C	0 of 1
28R	**GLS-R Rwy 28R (ARCHI)				
28L	GLS-A Rwy 28L (EDDYY)	Higher altitude versions of existing RNAV approaches		D	0 of 2
28L	GLS-A Rwy 28L (FAITH)				
28L	GLS-A Rwy 28L (ARCHI)				
28R	GLS-A Rwy 28R (EDDYY)				
28R	GLS-A Rwy 28R (ARCHI)				
10L	***GLS-A Rwy 10L (STINS)	Introduces first precision approach to runway 10L/R		E	0 of 2
10R	***GLS-A Rwy 10R (STINS)				

CFPP Modeled Noise Reduction

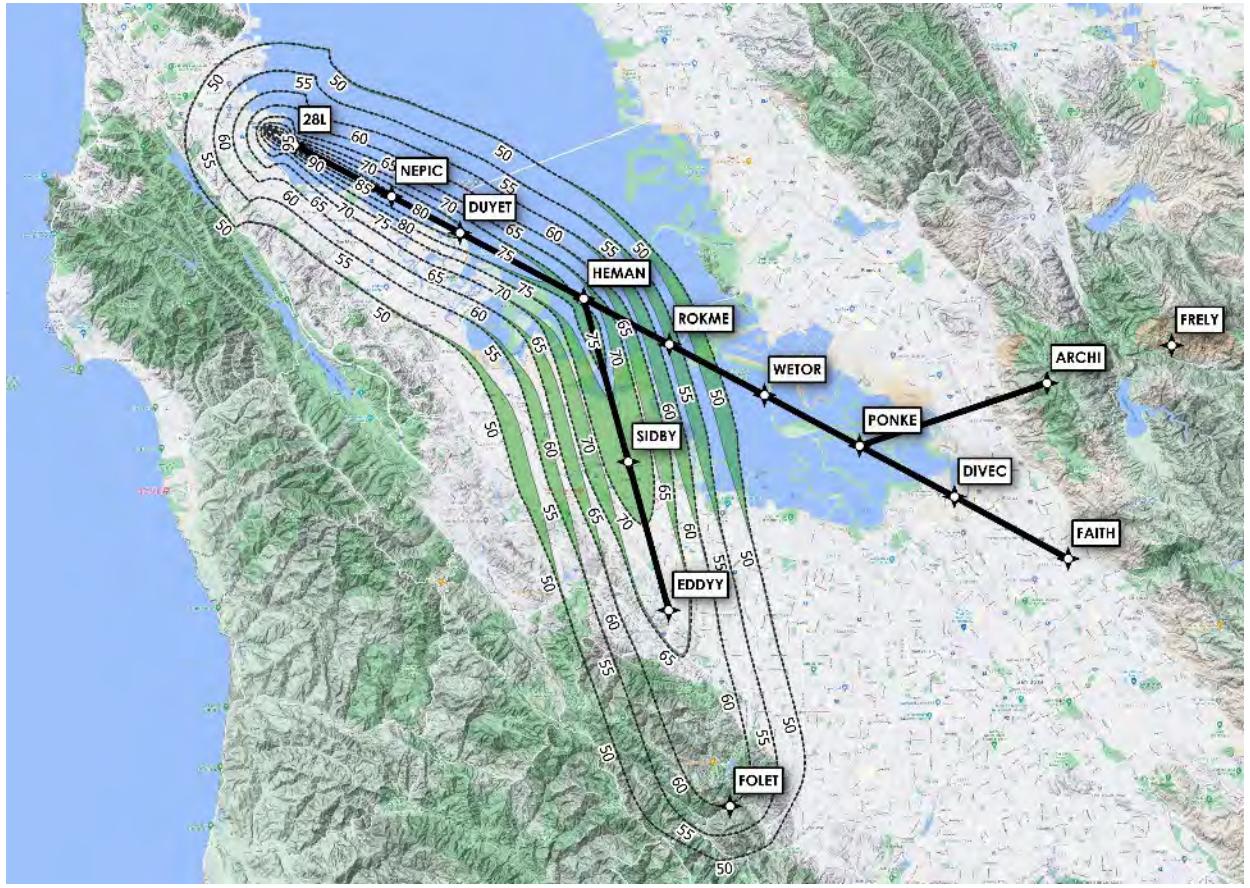
CFPP Modeled Noise Neutral

CFPP Modeled Noise Reduction with small Noise Increases

*Enabling existing noise reduction procedure to be more frequently used by aircrafts
**CFPP pdf is being updated
***Extremely infrequently used procedure

Insight on Interpreting CFPP SEL Noise

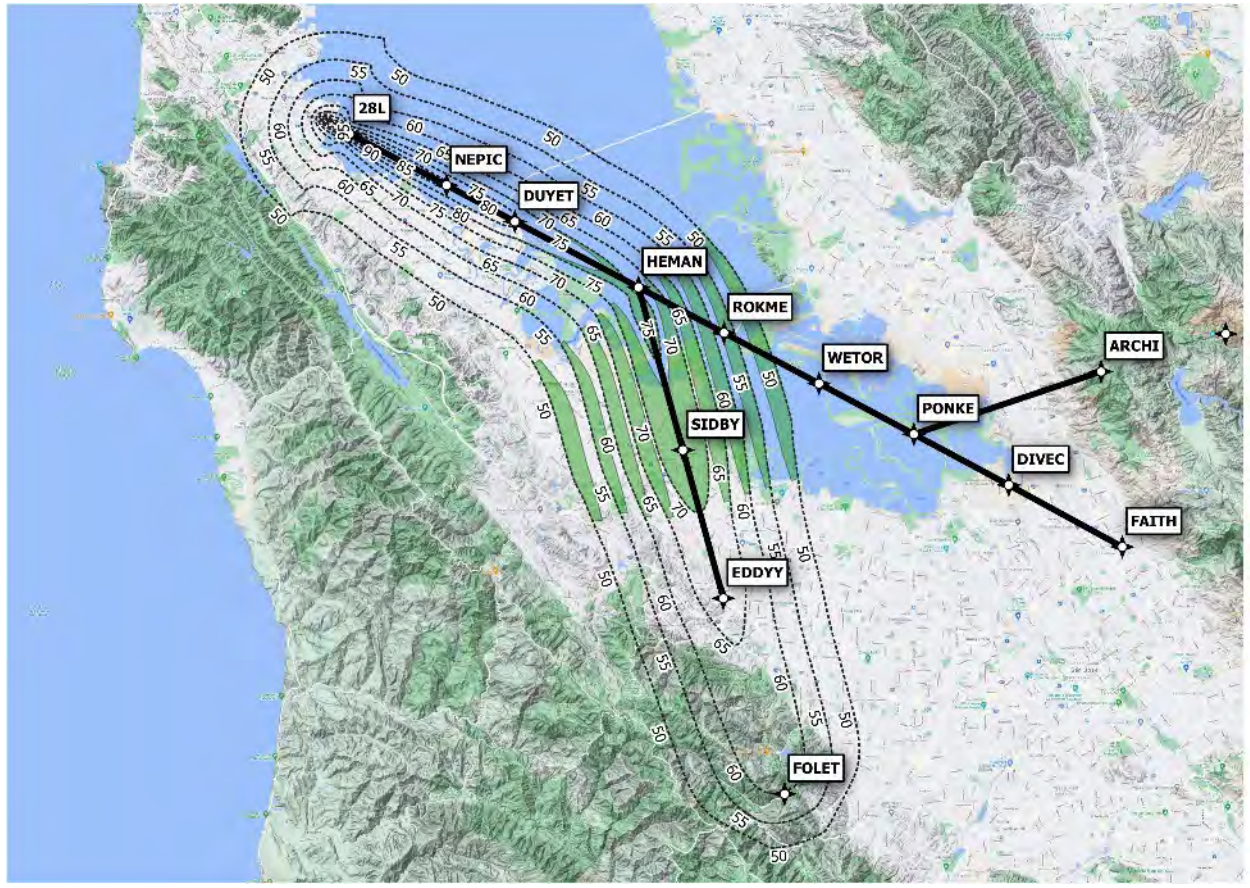
GLS-A Rwy 28L EDDYY/FOLET Transition for Narrowbody 1



Dashed Lines = 5 dBA SEL

Green Regions <= -0.1 dBA (Quieter)

Purple Regions >= +0.1 dBA (Louder)



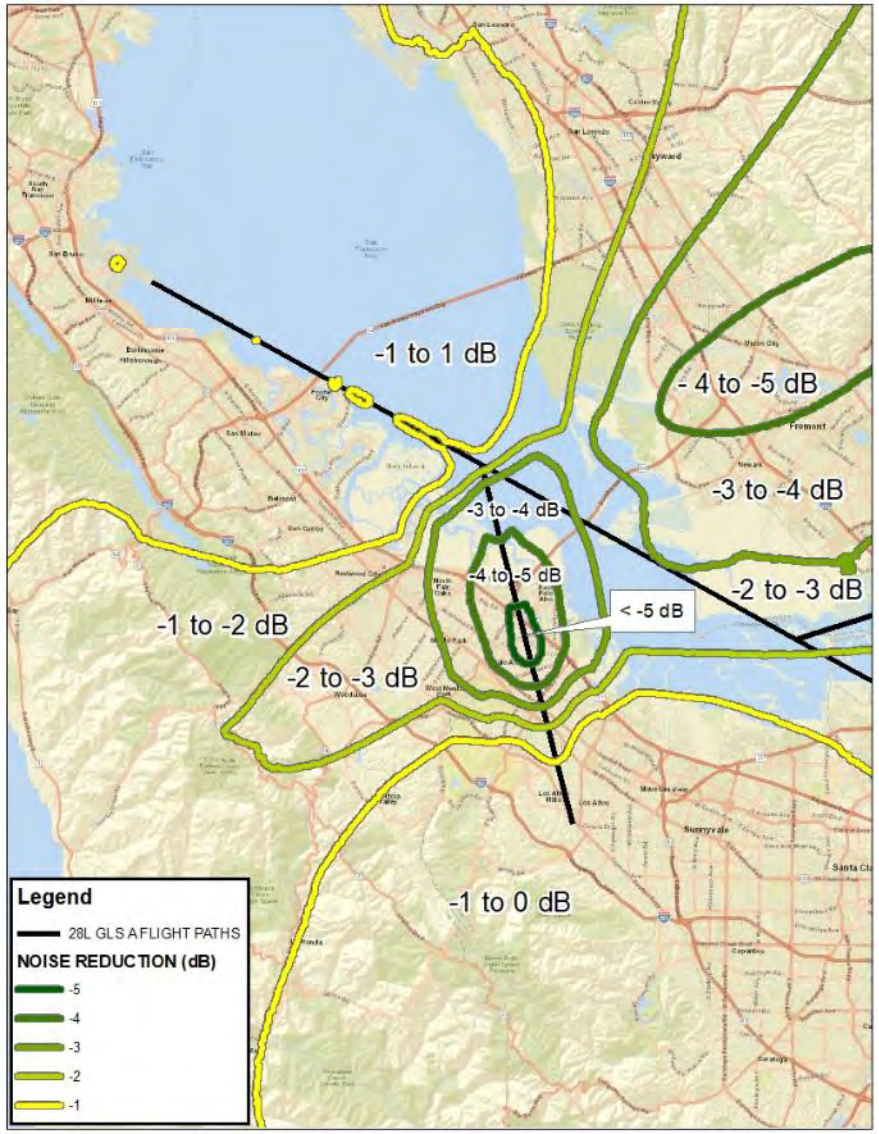
Dashed Lines = 5 dBA SEL

Green Regions < -1.0 dBA (Quieter)

Purple Regions > +1.0 dBA (Louder)

Insight on Interpreting CFPP SEL Noise

GLS-A Rwy 28L EDDYY/FOLET Transition for Narrowbody 1



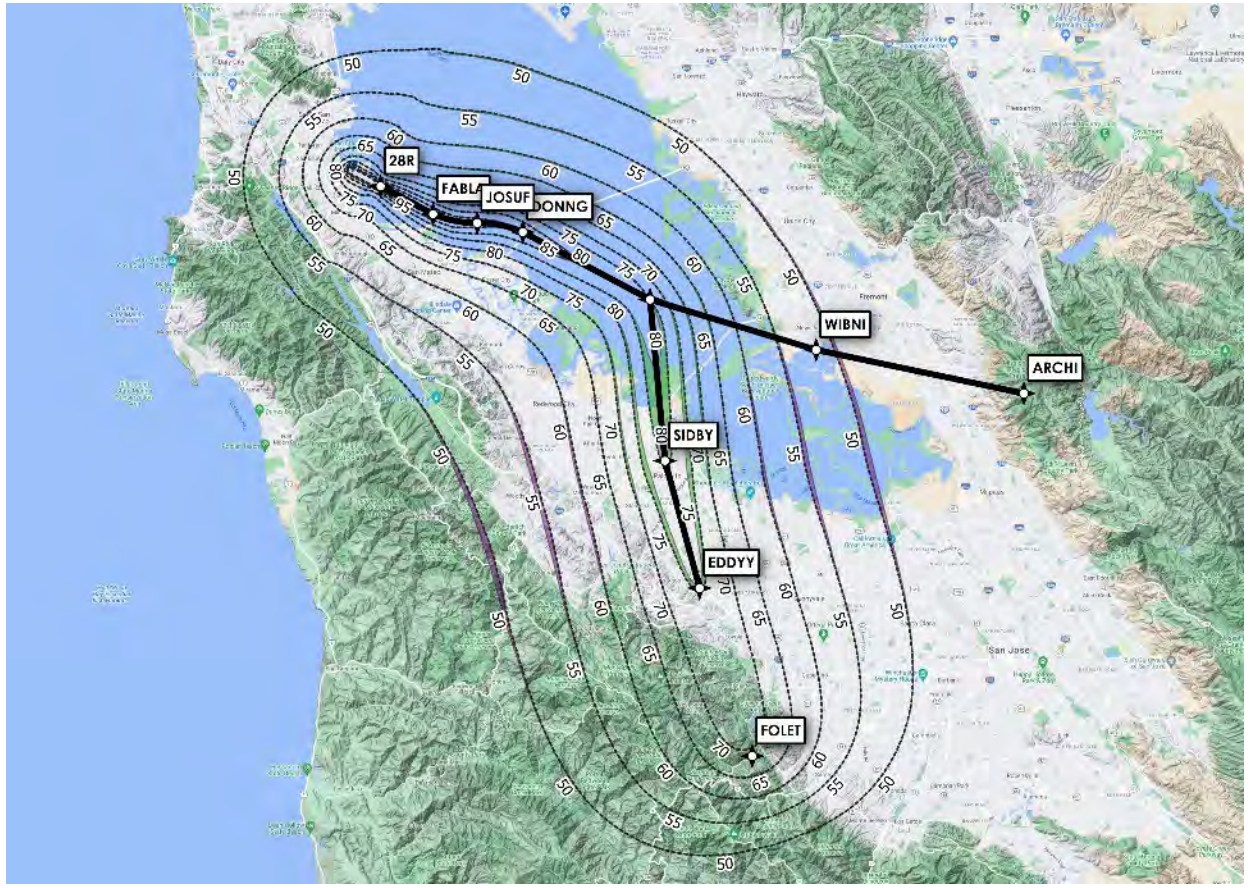
Narrowbody Difference Contours

No areas with a noise increase > 1.0 dB

Greatest noise reduction is 5.3 dB

Insight on Interpreting CFPP SEL Noise

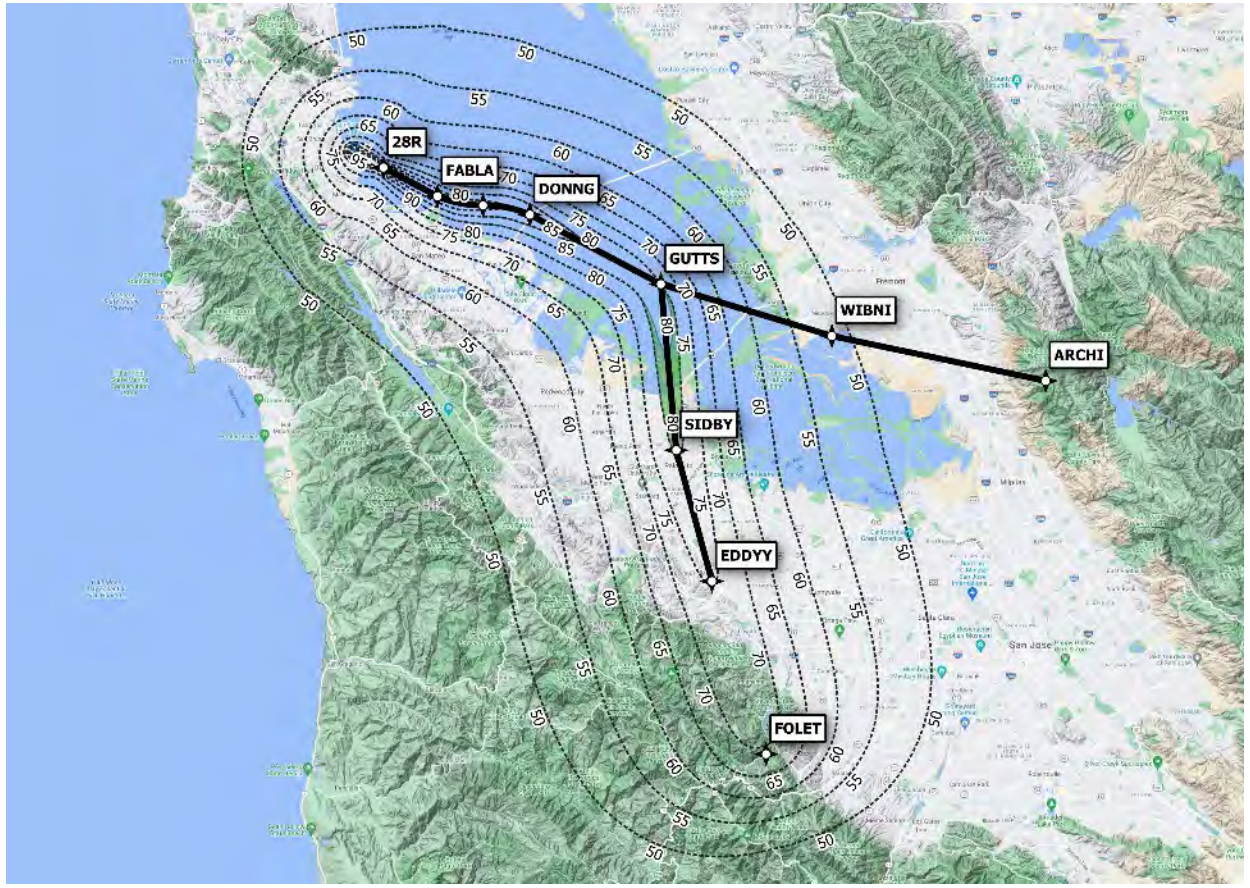
GLS-R Rwy 28R EDDYY/FOLET Transition for Widebody 2



Dashed Lines = 5 dBA SEL

Green Regions <= -0.1 dBA (Quieter)

Purple Regions >= +0.1 dBA (Louder)



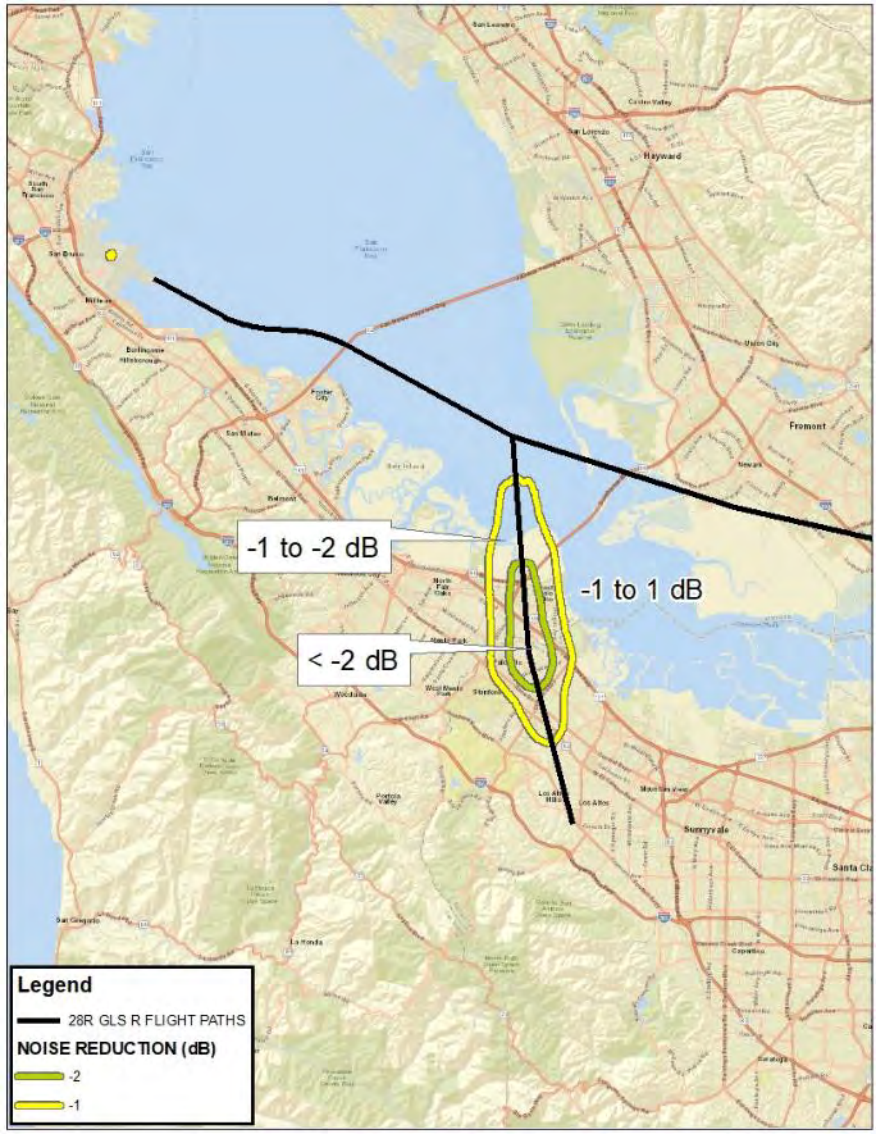
Dashed Lines = 5 dBA SEL

Green Regions < -1.0 dBA (Quieter)

Purple Regions > +1.0 dBA (Louder)

Insight on Interpreting CFPP SEL Noise

GLS-R Rwy 28R EDDYY/FOLET Transition for Widebody 2



Widebody Difference Contours

No areas with a noise increase > 1.0 dB

Greatest noise reduction is 2.8 dB

SFO GBAS/GLS Vision

SFO GBAS Project Team Estimated Implementation Date for Procedure Group

2021	2023/24*	2025/26*		2026-28**	2030+**
Gain Experience (Overlays) Overlay Approaches Stakeholder Training and Operations Maintain Non-Federal NAVAID	**Expand Capabilities (Group 1)** Down the Bay Approach Higher GPA Approaches GLS in CSPR Autopilot to Touchdown	**Increase Utilization** Nighttime GLS Ops Implement A-RNP with GLS **Innovate & Improve (Group 2A)** Higher altitude approach/arrivals GLS CAT II	FAA ATCT Staffing/Technology	**Innovate & Improve (Group 2B)** Utilize SFO A-RNP and GLS in Multiple Airport Route Separation (MARS) for Bay Area Airports Enhanced Dispersion with TBFM for SFO Enhanced Dispersion with TBFM for Bay Area	**Innovate & Improve (Group 3)** Virtual Displaced Threshold Terminal Area Path (GLS Precision for Aircraft Separation) Automated Dispersion (with TAP) GLS CAT III

Measure Utilization, System Availability, Noise, ATCT Feedback and Pilot Feedback

Collaborate Research, Technology, Criteria, Infrastructure and Experience through interactions with FAA, Global Aviation Community, Academia and Residents of the Bay Area

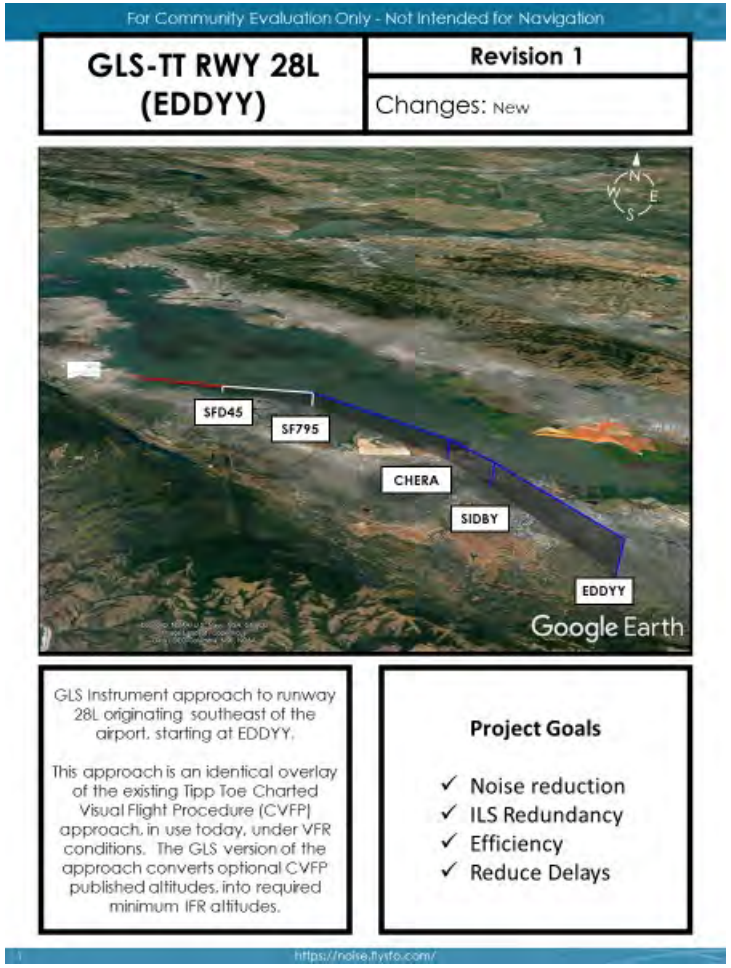
*Timeline estimates are based on FAA Production Capabilities and Feedback From Communities
**Timeline estimates are based on generalized feedback from Flight Procedures Subcommittee Participants and may increase or decrease depending on factors beyond the GBAS project

Group 1 Innovative Approach Completed and Planning for Group 2A

SFO GBAS Project Team has uploaded new CFPPs for Innovative GLS Procedure Concepts

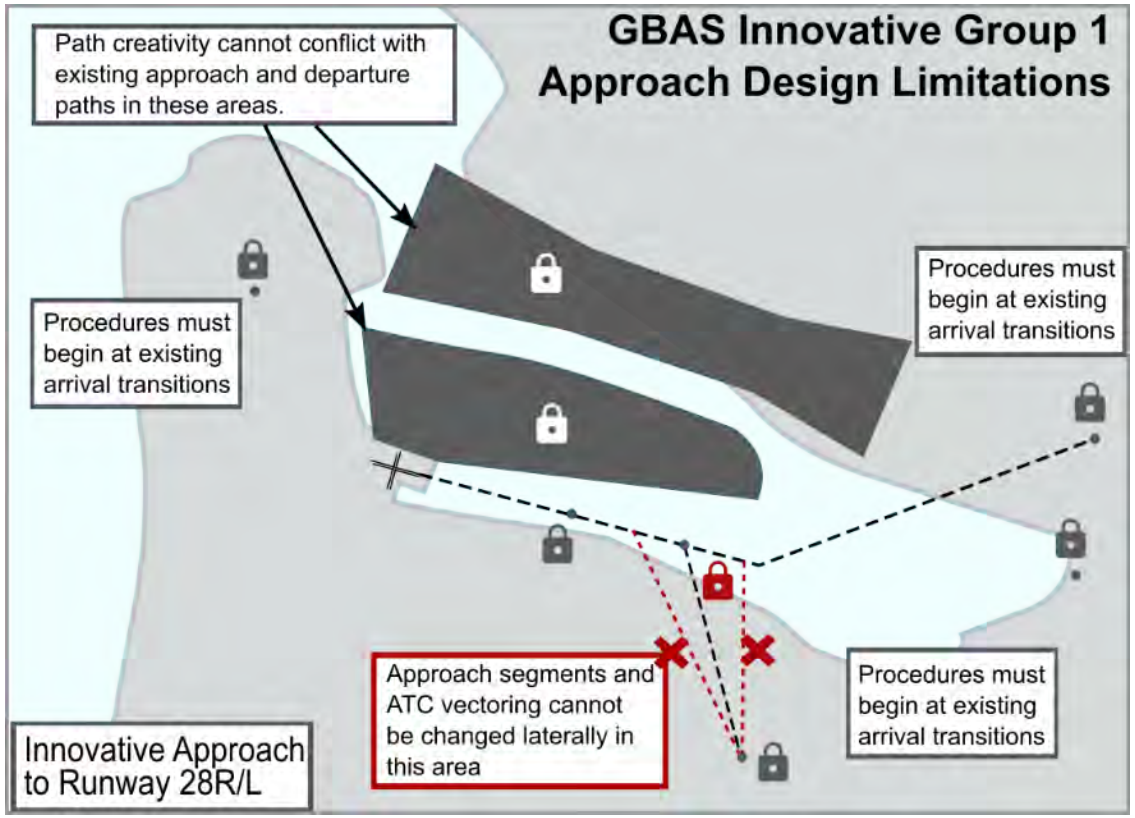
- The SFO GBAS Project team is uploading Community Flight Procedure Packages (CFPPs) to evaluate the difference between Innovative GLS Approach concepts and the nearest existing approaches
  - 14 CFPPs (1 for each Innovative GLS Approach and Starting Point)
  - Includes 2 New CFPPs for Tipp Toe
  - 4 Aircraft Types
- The CFPPs will continue to be updated based on flight evaluation results, potential changes to the procedures or additional supporting information
  - GLS-R Rwy 28R is being updated to match recommendations by residents and TWG participants to eliminate possible noise increases near Foster City

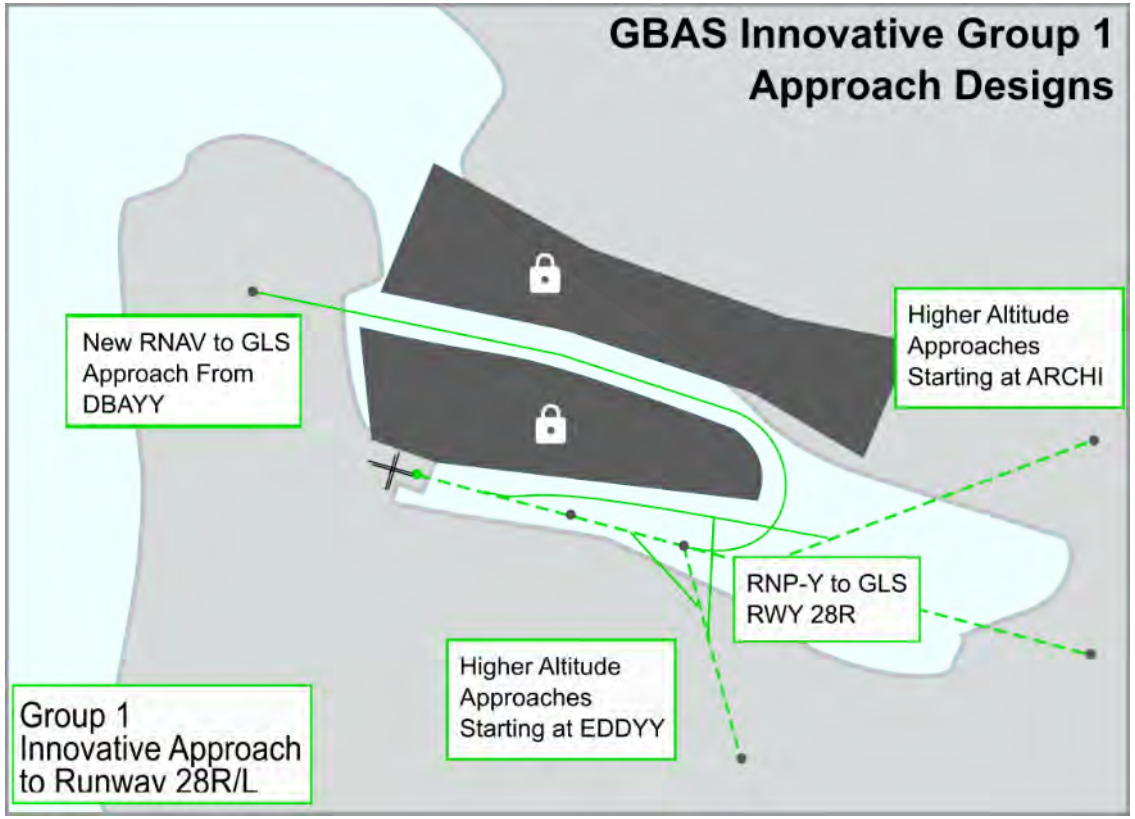
SFO GBAS Project Team is beginning evaluation of Group 2A Procedures



https://noise.flysfo.com/2021/05/14/gbas-innovative-approach-procedures/

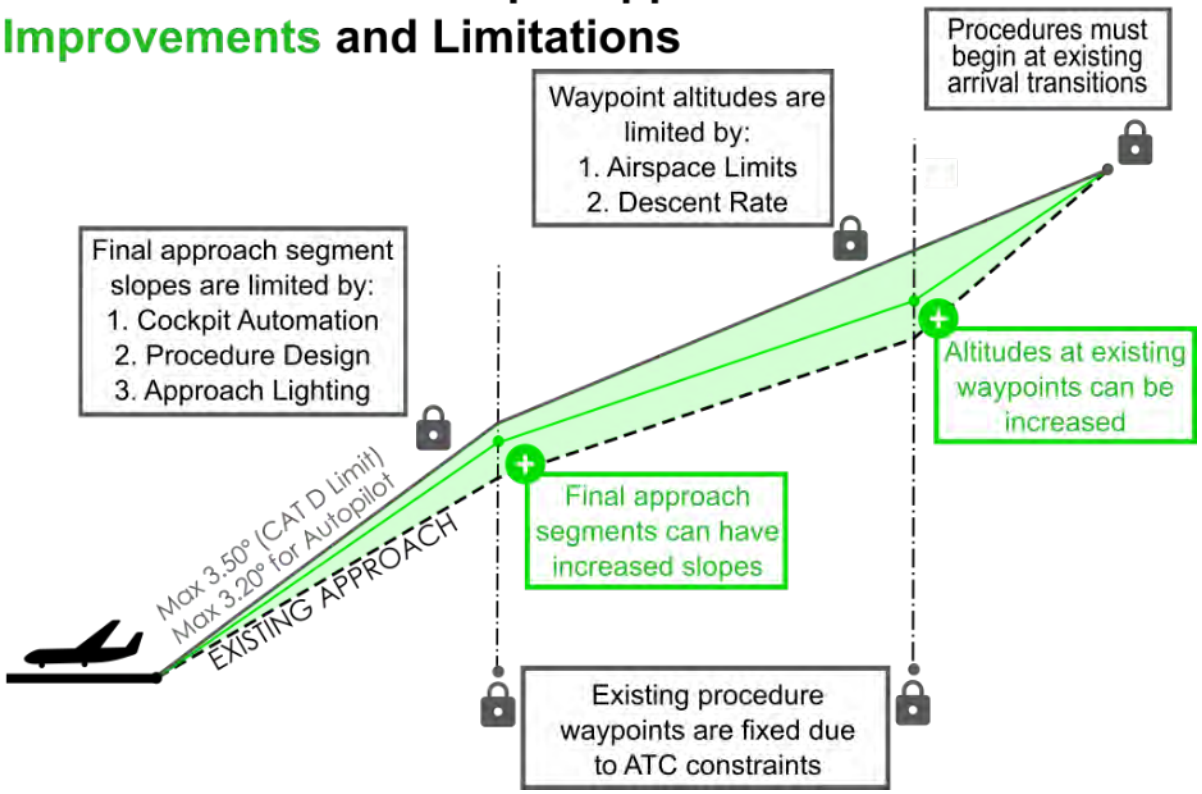
Group 1 Innovative Approaches



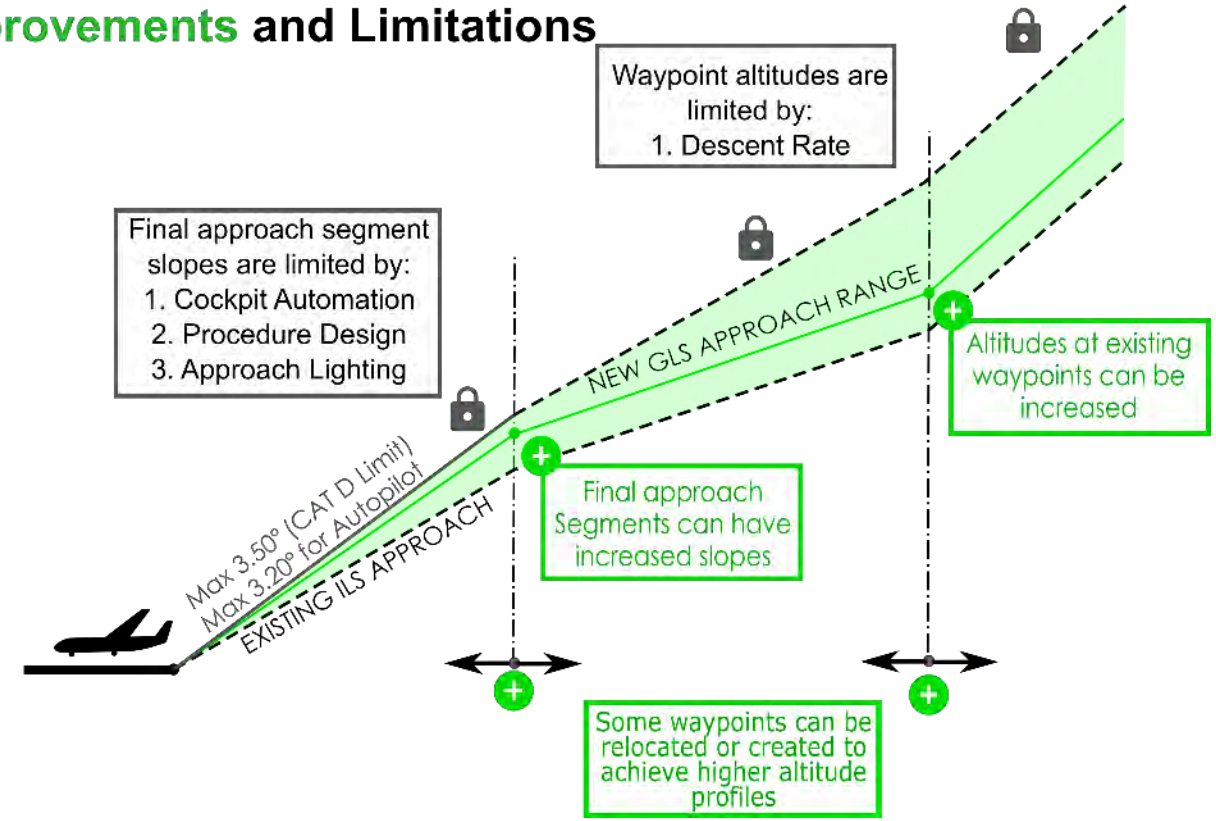


Comparison of Group 1 Innovative Approaches to Group 2A

GBAS Innovative Group 1 Approach
Improvements and Limitations



GBAS Innovative Group 2A Approach
Improvements and Limitations



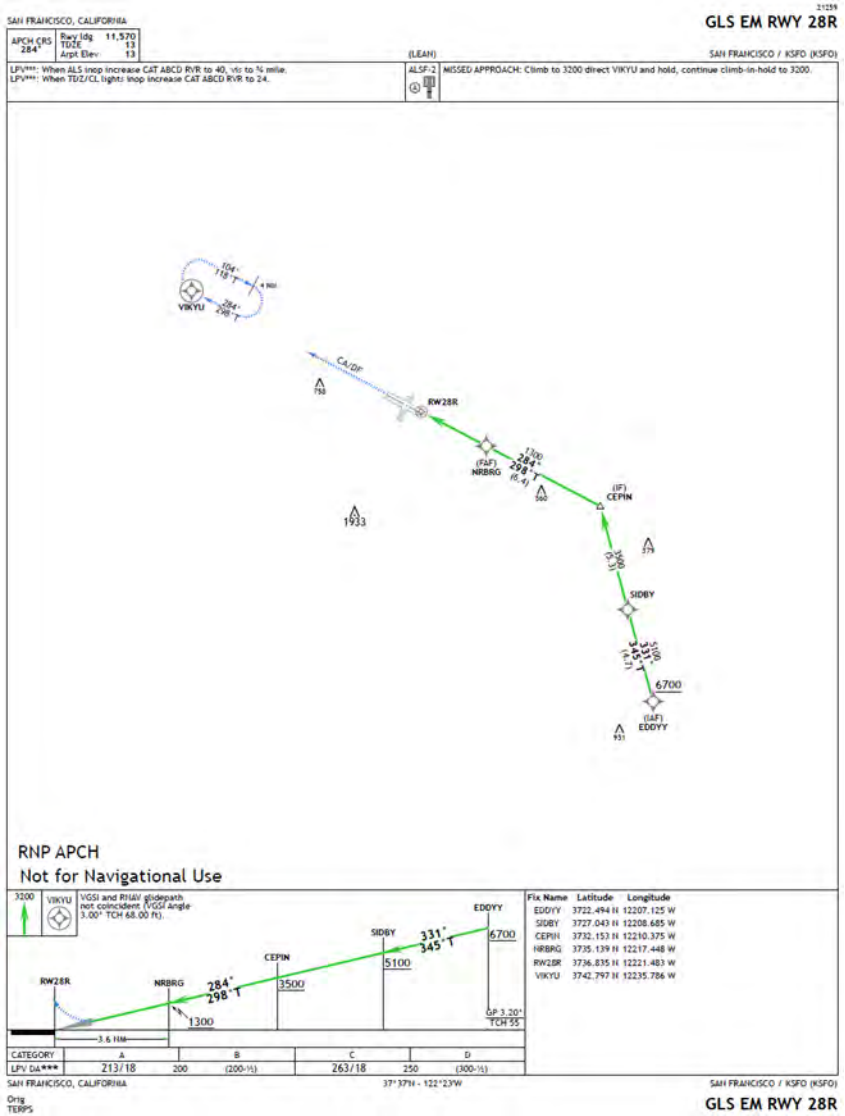
Preliminary Group 2A Concepts

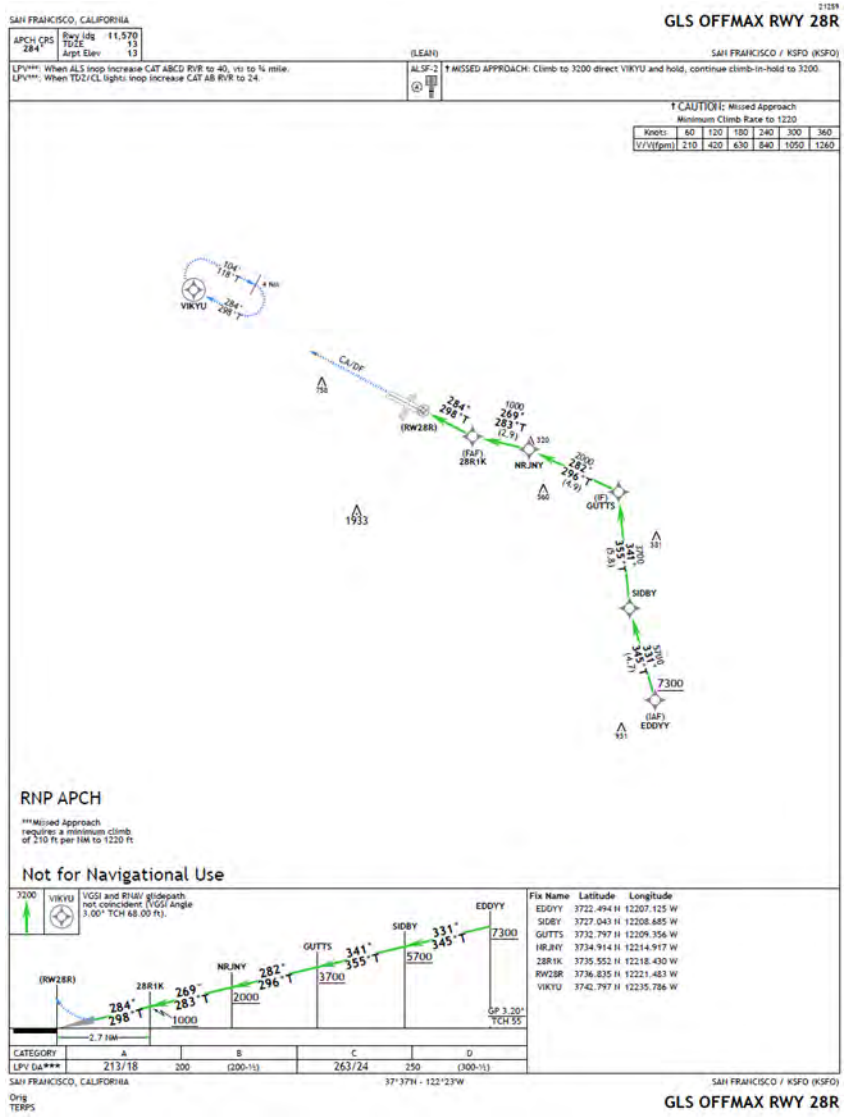
Altitudes at EDDYY between 6700ft and 7300ft

Higher altitudes require

Would require changes to SERFR (Either higher altitude at EDDYY or new parallel offset to FOLET-EDDYY terminating at a new waypoint)

Higher altitudes over residential areas are achieved by aircraft initially descending along RNP-Y path over the Bay





Next Up

SFO GBAS Project Team is Working On

- Update GLS-R Rwy 28R to eliminate potential noise increase near Foster City
- UAL Flight Evaluations
- Noise Measurement Reports
- Commissioning and Operation of GBAS
- Group 2A Procedure Examples and Potential Noise Reduction Analysis

SFO GBAS Project Team is Seeking

- Feedback on Group 1 Innovative GLS Approach Concepts
- Approval for Community Flight Procedure Packages (CFPP) to proceed to IFP Gateway

Questions

https://noise.flysfo.com

Backup Material

Important SFO GBAS Milestones

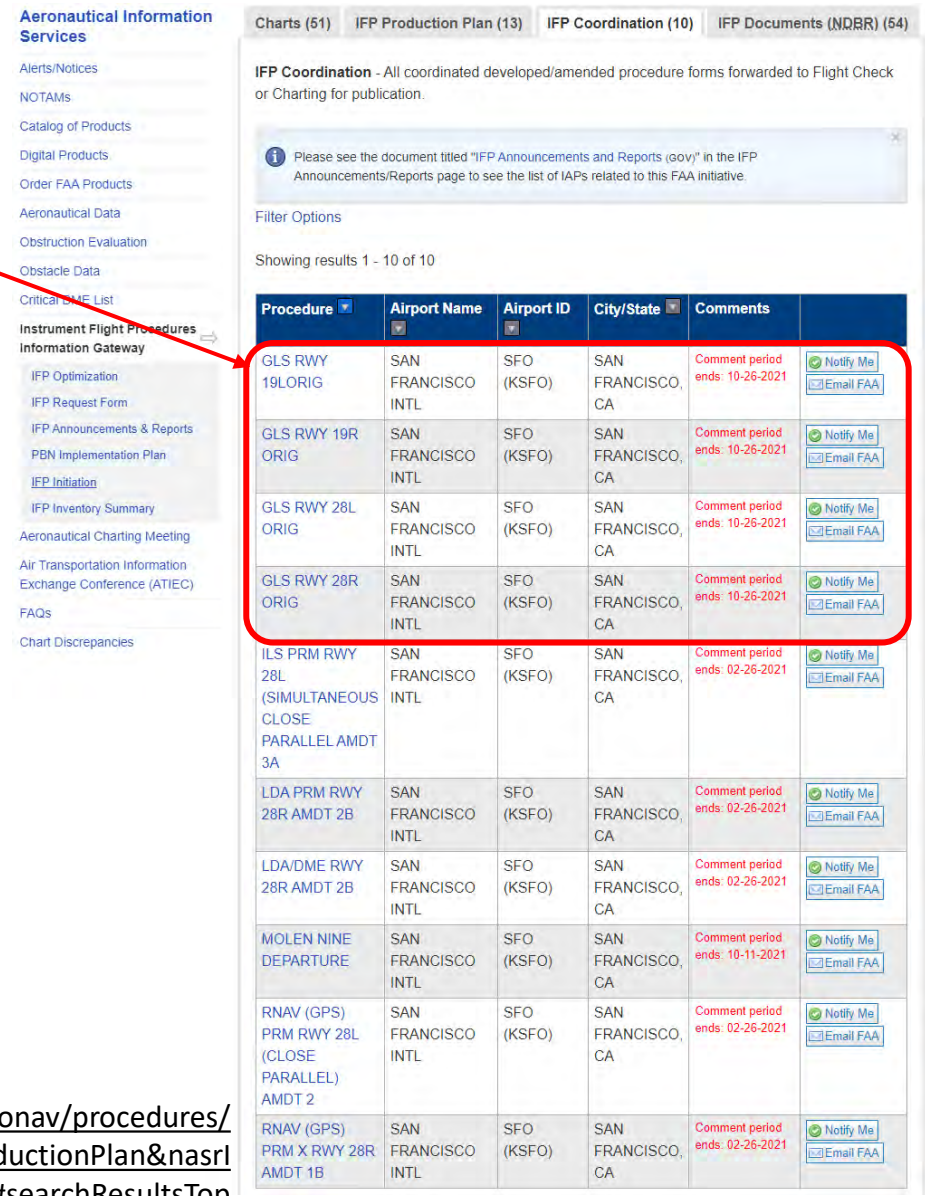
28SEP21 – FAA Instrument Procedure Gateway Updated with GLS Overlay Procedures

25-28OCT21 – FAA Flight Inspection/Validation of GBAS and Overlay GLS Approaches

DEC21 – Opportunity for UAL Flight Evaluation

02DEC21 – Earliest start date for GLS Overlay Approach Procedures

DEC21 – Target date for SFO to request FAA Development of Group 1 Innovative GLS Procedures



Aeronautical Information Services

- Alerts/Notices
- NOTAMs
- Catalog of Products
- Digital Products
- Order FAA Products
- Aeronautical Data
- Obstruction Evaluation
- Obstacle Data
- Critical DME List
- **Instrument Flight Procedures Information Gateway**
  - IFP Optimization
  - IFP Request Form
  - IFP Announcements & Reports
  - PBN Implementation Plan
  - IFP Initiation
  - IFP Inventory Summary
- Aeronautical Charting Meeting
- Air Transportation Information Exchange Conference (ATIEC)
- FAQs
- Chart Discrepancies

Charts (51) | IFP Production Plan (13) | IFP Coordination (10) | IFP Documents (NDBR) (54)

IFP Coordination - All coordinated developed/amended procedure forms forwarded to Flight Check or Charting for publication.

Please see the document titled "IFP Announcements and Reports (GOV)" in the IFP Announcements/Reports page to see the list of IAPs related to this FAA initiative.

Filter Options

Showing results 1 - 10 of 10

Procedure	Airport Name	Airport ID	City/State	Comments	
GLS RWY 19LORIG	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	Comment period ends: 10-26-2021	Notify Me / Email FAA
GLS RWY 19R ORIG	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	Comment period ends: 10-26-2021	Notify Me / Email FAA
GLS RWY 28L ORIG	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	Comment period ends: 10-26-2021	Notify Me / Email FAA
GLS RWY 28R ORIG	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	Comment period ends: 10-26-2021	Notify Me / Email FAA
ILS PRM RWY 28L (SIMULTANEOUS CLOSE PARALLEL AMDT 3A	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	Comment period ends: 02-26-2021	Notify Me / Email FAA
LDA PRM RWY 28R AMDT 2B	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	Comment period ends: 02-26-2021	Notify Me / Email FAA
LDA/DME RWY 28R AMDT 2B	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	Comment period ends: 02-26-2021	Notify Me / Email FAA
MOLEN NINE DEPARTURE	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	Comment period ends: 10-11-2021	Notify Me / Email FAA
RNAV (GPS) PRM RWY 28L (CLOSE PARALLEL) AMDT 2	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	Comment period ends: 02-26-2021	Notify Me / Email FAA
RNAV (GPS) PRM X RWY 28R AMDT 1B	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	Comment period ends: 02-26-2021	Notify Me / Email FAA

https://www.faa.gov/air_traffic/flight_info/aeronav/procedures/application/?event=procedure.results&tab=productionPlan&nasrId=SFO#searchResultsTop

GLS Overlay – FAA CATEX

Aeronautical Information Services

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- Obstruction Evaluation
- Obstacle Data
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Filter Options

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Procedure	Airport Name	Airport ID	City/State	Comments	
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GLS RWY 19R ORIG	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	Comment period ends: 10-26-2021	Notify Me / Email FAA
GLS RWY 28L ORIG	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	Comment period ends: 10-26-2021	Notify Me / Email FAA
GLS RWY 28R ORIG	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	Comment period ends: 10-26-2021	Notify Me / Email FAA
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LDA PRM RWY 28R AMDT 2B	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	Comment period ends: 02-26-2021	Notify Me / Email FAA
LDA/DME RWY 28R AMDT 2B	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	Comment period ends: 02-26-2021	Notify Me / Email FAA
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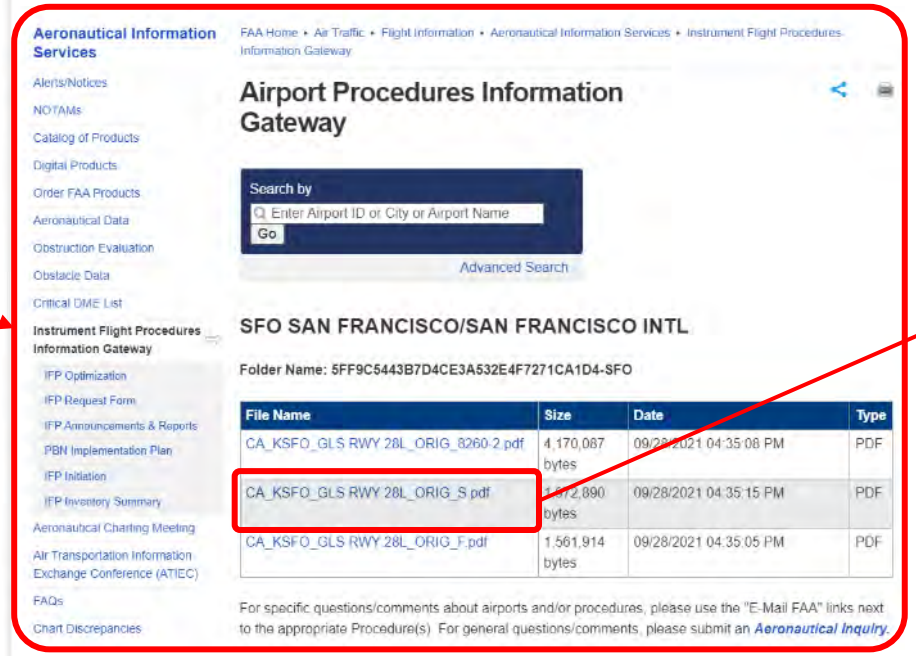
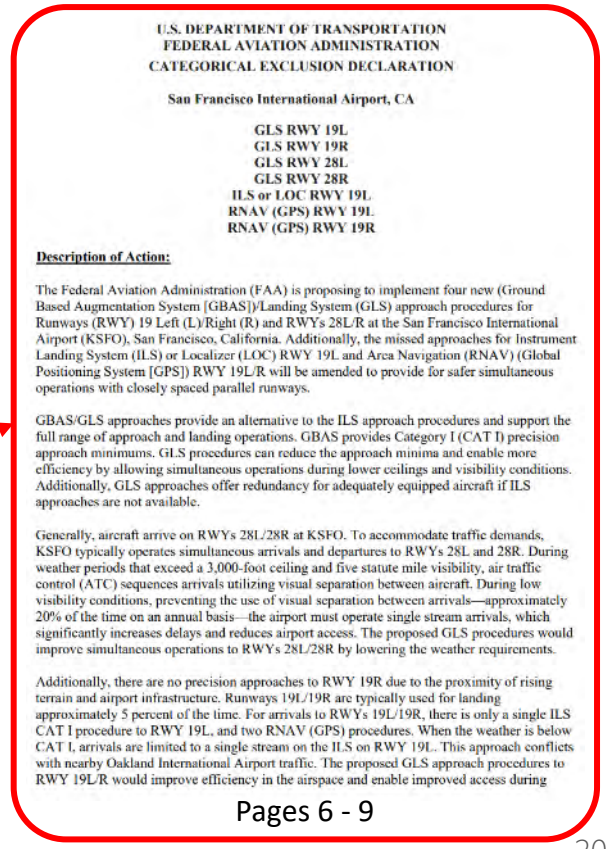
RNAV (GPS) PRM RWY 28L (CLOSE PARALLEL) AMDT 2	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	Comment period ends: 02-26-2021	Notify Me / Email FAA
RNAV (GPS) PRM X RWY 28R AMDT 1B	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	Comment period ends: 02-26-2021	Notify Me / Email FAA

FAA has published the basis for their decision to use a Categorical Exclusion from pursuing additional environmental analysis in accordance with FAA Order 1050.1F



https://www.faa.gov/air_traffic/flight_info/aeronav/procedures/application/?event=procedure.results&tab=productionPlan&nasrId=SFO#searchResultsTop



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
CATEGORICAL EXCLUSION DECLARATION

San Francisco International Airport, CA

GLS RWY 19L
GLS RWY 19R
GLS RWY 28L
GLS RWY 28R
ILS or LOC RWY 19L
RNAV (GPS) RWY 19L
RNAV (GPS) RWY 19R

Description of Action:

The Federal Aviation Administration (FAA) is proposing to implement four new (Ground Based Augmentation System [GBAS])/Landing System (GLS) approach procedures for Runways (RWY) 19 Left (L)/Right (R) and RWYs 28L/R at the San Francisco International Airport (KSFO), San Francisco, California. Additionally, the missed approaches for Instrument Landing System (ILS) or Localizer (LOC) RWY 19L and Area Navigation (RNAV) (Global Positioning System [GPS]) RWY 19L/R will be amended to provide for safer simultaneous operations with closely spaced parallel runways.

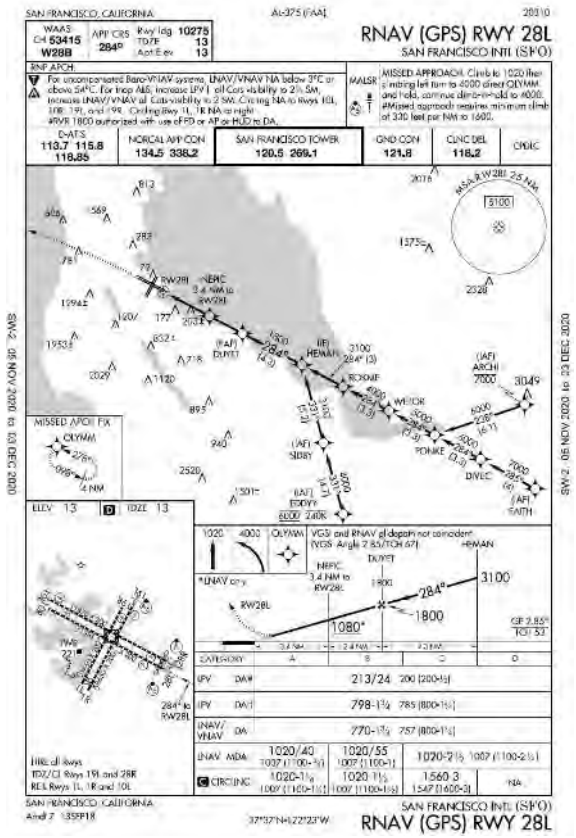
GBAS/GLS approaches provide an alternative to the ILS approach procedures and support the full range of approach and landing operations. GBAS provides Category I (CAT I) precision approach minimums. GLS procedures can reduce the approach minima and enable more efficiency by allowing simultaneous operations during lower ceilings and visibility conditions. Additionally, GLS approaches offer redundancy for adequately equipped aircraft if ILS approaches are not available.

Generally, aircraft arrive on RWYs 28L/28R at KSFO. To accommodate traffic demands, KSFO typically operates simultaneous arrivals and departures to RWYs 28L and 28R. During weather periods that exceed a 3,000-foot ceiling and five statute mile visibility, air traffic control (ATC) sequences arrivals utilizing visual separation between aircraft. During low visibility conditions, preventing the use of visual separation between arrivals—approximately 20% of the time on an annual basis—the airport must operate single stream arrivals, which significantly increases delays and reduces airport access. The proposed GLS procedures would improve simultaneous operations to RWYs 28L/28R by lowering the weather requirements.

Additionally, there are no precision approaches to RWY 19R due to the proximity of rising terrain and airport infrastructure. Runways 19L/19R are typically used for landing approximately 5 percent of the time. For arrivals to RWYs 19L/19R, there is only a single ILS CAT I procedure to RWY 19L, and two RNAV (GPS) procedures. When the weather is below CAT I, arrivals are limited to a single stream on the ILS on RWY 19L. This approach conflicts with nearby Oakland International Airport traffic. The proposed GLS approach procedures to RWY 19L/R would improve efficiency in the airspace and enable improved access during

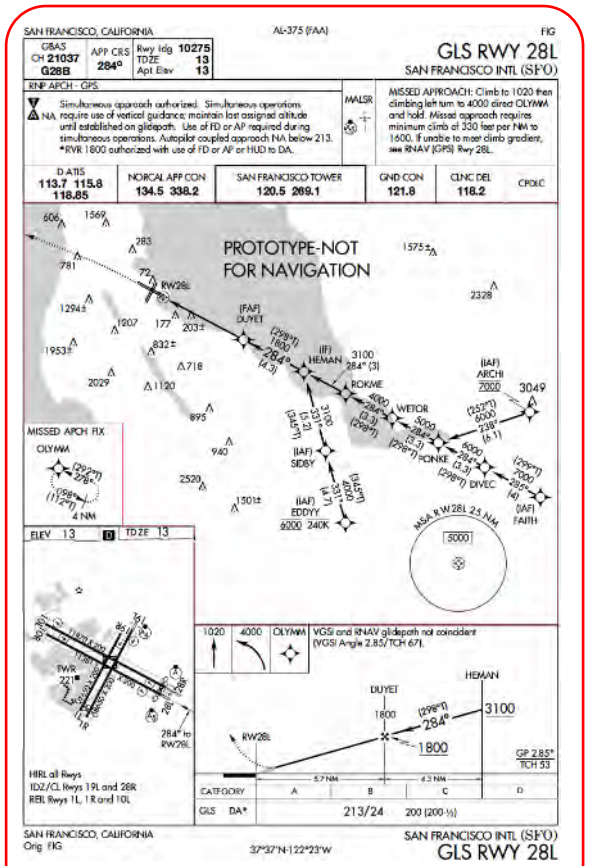
Pages 6 - 9

SFO GLS Overlay Approach Comparison: 28L/28R



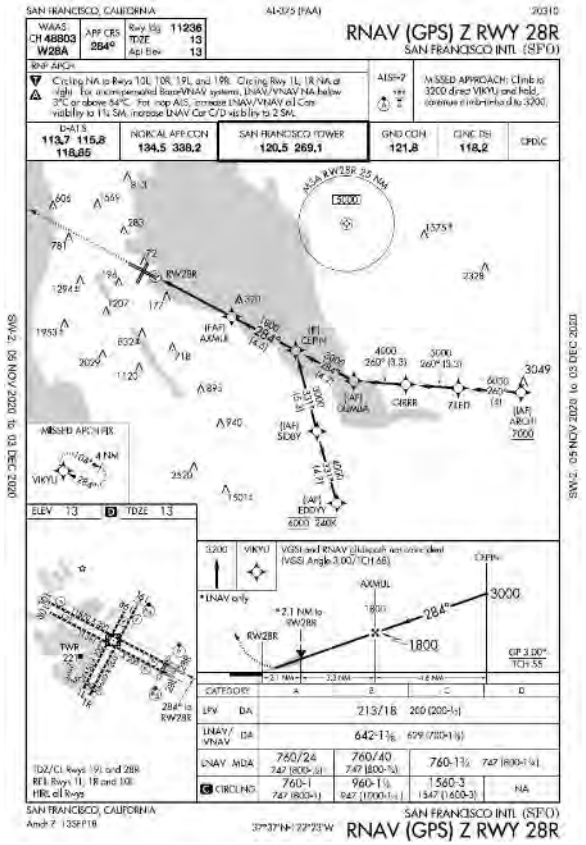
RNAV (GPS) RWY 28L

- GPA: 2.85°
- FAF: DUYET 1,800ft
- IAF: EDDYY 6,000ft @ 240KIAS



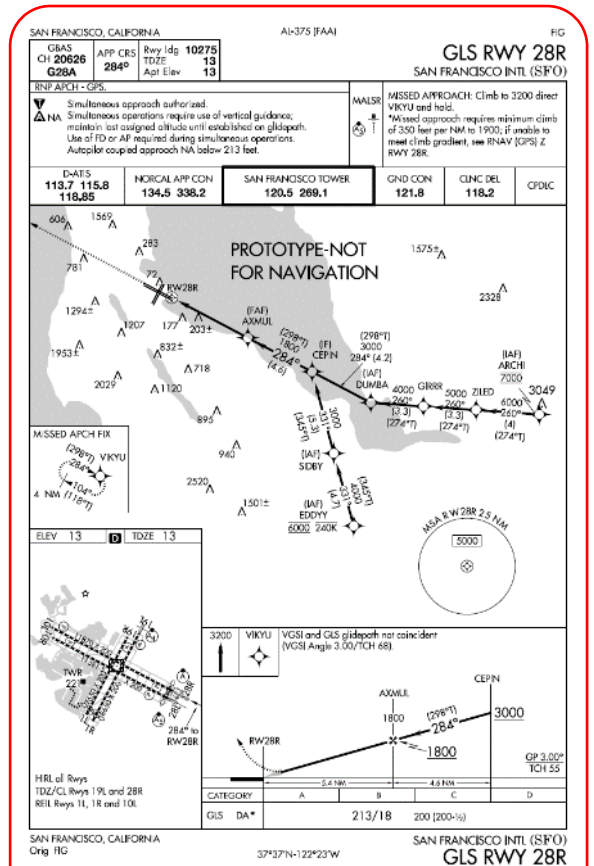
GLS RWY 28L

- GPA: 2.85°
- FAF: DUYET 1,800ft
- IAF: EDDYY 6,000ft @ 240KIAS



RNAV (GPS) Z RWY 28R

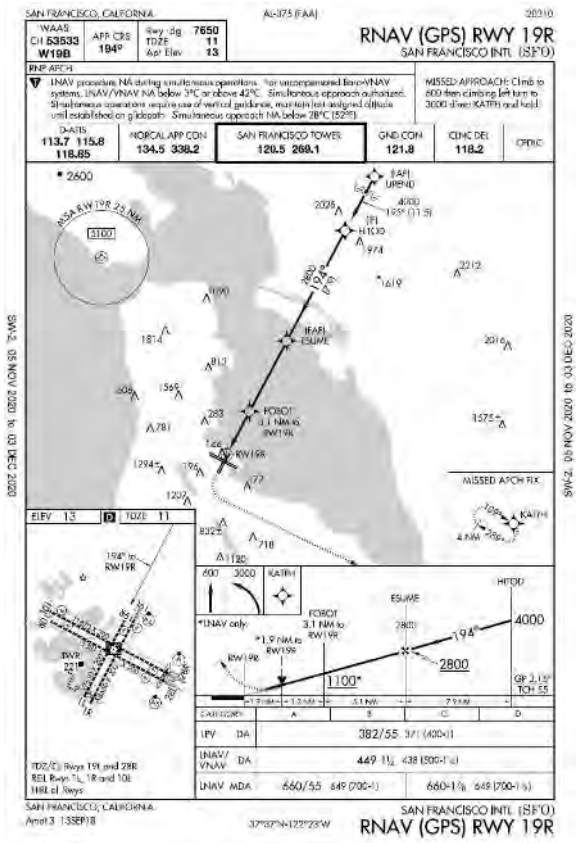
- GPA: 3.00°
- FAF: AXMUL 1,800ft
- IAF: EDDYY 6,000ft @ 240KIAS



GLS RWY 28R

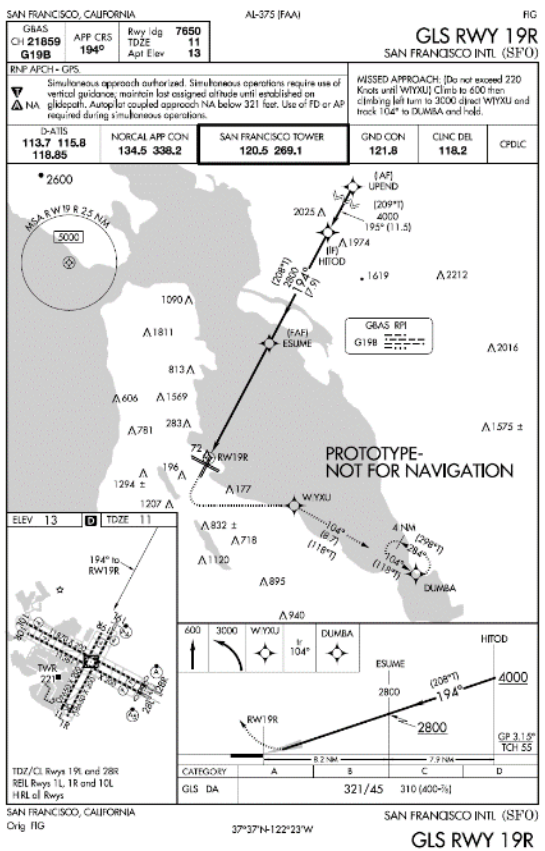
- GPA: 3.00°
- FAF: AXMUL 1,800ft
- IAF: EDDYY 6,000ft @ 240KIAS

SFO GLS Overlay Approach Comparison: 19R/19L



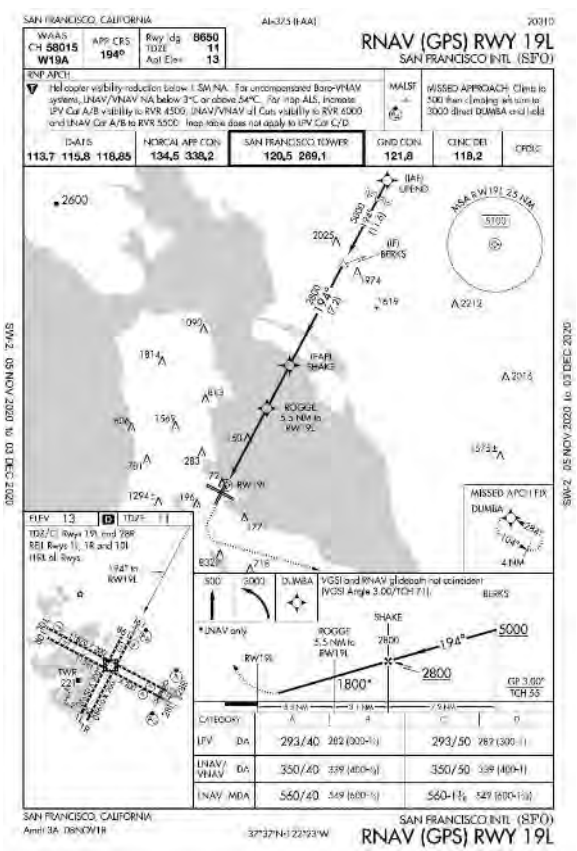
GLS RWY 19R

- GPA: 3.15°
- FAF: ESUME 2,800ft
- IAF: UPEND 5,000ft



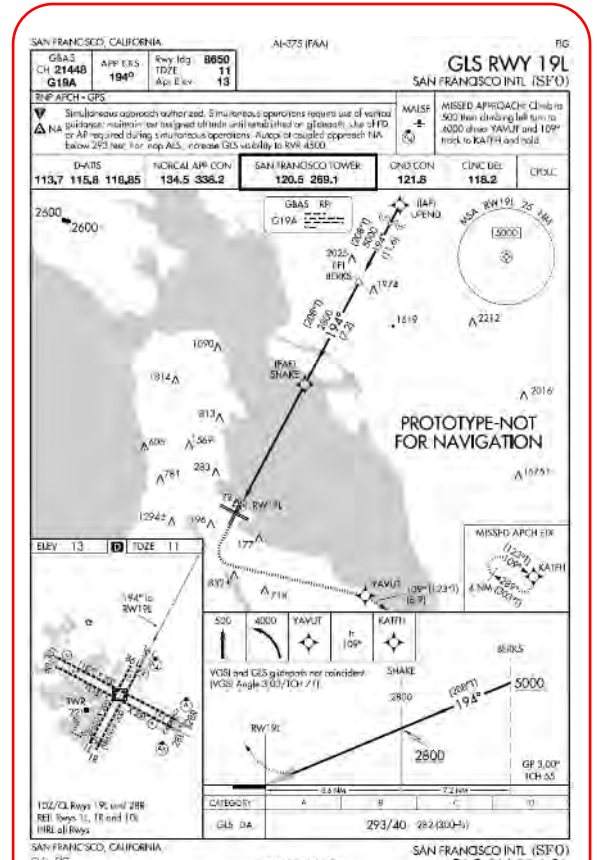
GLS RWY 19R

- GPA: 3.15°
- FAF: ESUME 2,800ft
- IAF: UPEND 5,000ft



RNAV (GPS) RWY 19L

- GPA: 3.00°
- FAF: SHAKE 2,800ft
- IAF: UPEND 5,000ft



GLS RWY 19L

- GPA: 3.00°
- FAF: SHAKE 2,800ft
- IAF: UPEND 5,000ft

New CFPPs: GLS-TT Rwy 28L and 28R

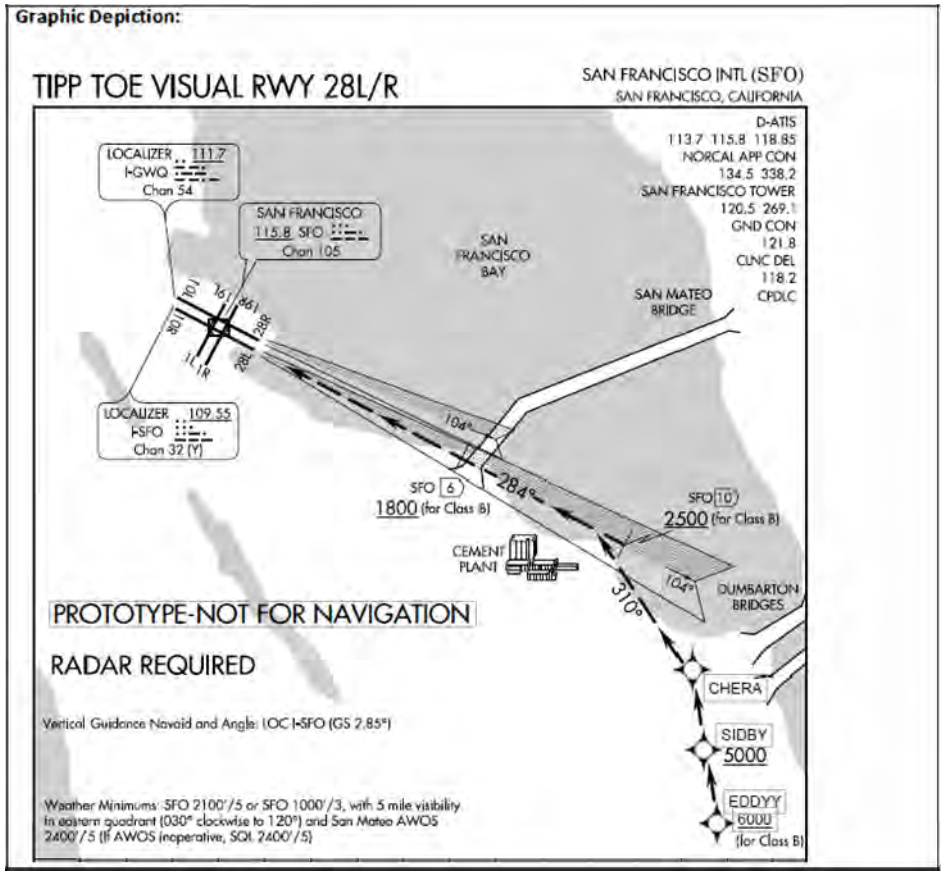
Conversion of Tipp Toe Visual Rwy 28L/R

Community feedback from SFO Roundtable TWG indicated a desire to explore additional innovative GLS approach options to runway 28L

- Achieve noise reduction through higher GPA and altitudes over residential areas
- Increase likelihood of aircraft and ATC usage under VFR conditions
- Provide opportunities in the future to enable some level of path dispersion

SFO GBAS Flight Procedures Subcommittee evaluated the existing, and soon to be updated, CVFP and identified a conversion to GLS for 28L and 28R

Procedure is part of Group 1 Innovative approach options for consideration by residents of the Bay Area in 2021



Flight Test and Validation of CFPP Noise Modeling

Flight Evaluation of SFO GLS Approaches

United Airlines has offered to support the community evaluation of both the overlay and innovative GLS approach concepts by performing evaluation flights for the purposes of noise data collection*, **

The flights will occur in November of 2021

The Flight Procedures Subcommittee, aided by the SFO GBAS Project Team, will use the information from the test flights to

1. Verify that overlay GLS approaches are not louder than current approaches
2. Evaluate initial AEDT v3D / BADA 4 SEL noise predictions (presented in the CFPPs) vs noise monitor results
3. Make adjustments to the AEDT v3D / BADA 4 noise predictions where applicable

**UAL flight test information may not precisely reflect the current AEDT/BADA modeling assumptions*
***SFO GBAS Project team may not be able to modify the BADA 4 models to take advantage of detected noise results due to differences in aircraft weight, pilot technique, ambient conditions and data samples per procedure*

Group 1 Innovative GLS Approach Evaluation with United Airlines

Measure Sound Near Downtown San Francisco

Measure Sound Near Noise Monitor Locations (A – F)

Measure Sound Near San Bruno Gap

UNITED

Runway	Community Package	Approval Group	Submitted to IFP Gateway
28R	GLS-DB Rwy 28R (DBAYY)	A	0 of 1
28R	GLS-BVE Rwy 28R (EDDYY)	B	0 of 3
28R	GLS-BV Rwy 28R (ARCHI)		
28L	GLS-TT Rwy 28L (EDDYY)		
28R	GLS-TT Rwy 28R (EDDYY)		
28R	GLS-R Rwy 28R (EDDYY)	C	0 of 1
28R	GLS-R Rwy 28R (ARCHI)		
28L	GLS-A Rwy 28L (EDDYY)	D	0 of 2
28L	GLS-A Rwy 28L (FAITH)		
28L	GLS-A Rwy 28L (ARCHI)		
28R	GLS-A Rwy 28R (EDDYY)		
28R	GLS-A Rwy 28R (FAITH)		
10L	GLS-A Rwy 10L (STINS)	E	0 of 2
10R	GLS-A Rwy 10R (STINS)		

Additional Noise Monitoring Locations for UAL Flight Evaluation

Locations

- A — Tevis Pl. & Center Dr., Palo Alto (near SIDBY)
- B — Jesuit Retreat Center of Los Altos (Prior to EDDYY)
- C — Donald Dr. & Arastradero Rd., Palo Alto
- D — Yerba Santa Ave. & Los Altos Ave., Los Altos
- E — Cowper St. & Santa Rita Ave, Palo Alto
- F — Hollyburne Ave. & Hamilton Ave., Menlo Park

GBAS Noise Measurement Reports will be made available underneath the associated CFPP via https://noise.flysfo.com/2021/05/14/gbas-innovative-approach-procedures/

Noise Monitoring Reports

- GBAS Noise Measurement Report will include:
  - Portable Noise Monitoring Terminal (PNMT) Report information
  - Detailed comparison of existing approaches and GLS approaches by test aircraft

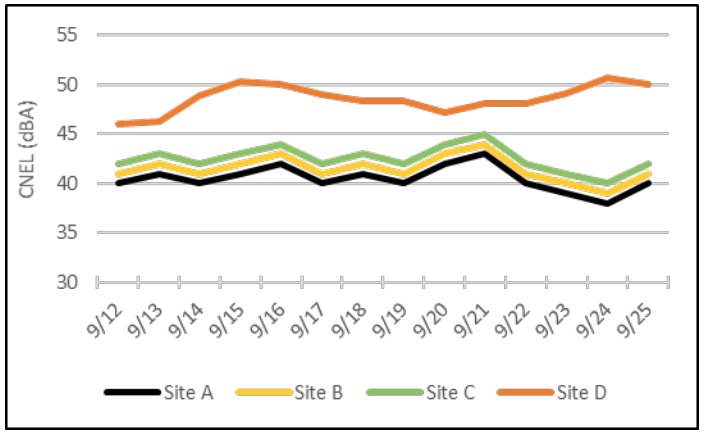
Daily Noise Event Averages

Date	Site A			
	Noise Events	Avg SEL (dB)	Avg Lmax (dB)	Community Ambient (dB)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
Daily Average				
Total Count				

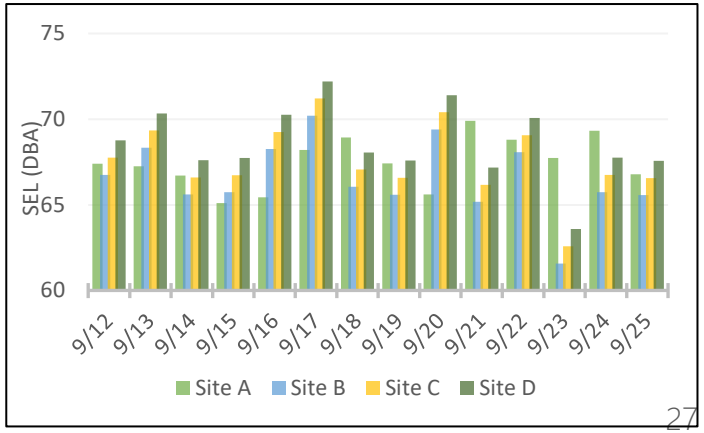
SFO Aircraft by Time of Day

		Aircraft Noise Events								Community Noise
Site	Time of Day	Noise Events	Noise Events %	Avg SEL (dBA)	Min SEL (dBA)	Max SEL (dBA)	Avg Lmax (dBA)	Min Max (dBA)	Max Lmax (dBA)	Community Ambient (dB)
Site A	Day (7am–7pm)									
	Evening (7pm-10pm)									
	Night (10pm-7am)									

CNEL Graphs



Average SEL Graphs



Noise Monitoring Reports

Noise Levels of the Most Frequent Aircraft

		Site A		
Aircraft Type	Number of Arrivals	Ave Lmax (dB)	Ave SEL (dB)	Ave Duration (s)
Aircraft A				
Aircraft B				
Aircraft C				

Noise Levels of the Loudest Aircraft Events

		Site A		
Airline / Aircraft Type	Time of Arrival	Ave Lmax (dB)	Ave SEL (dB)	Ave Duration (s)
Airline / Aircraft A				
Airline / Aircraft B				
Airline / Aircraft C				

Comparison of Existing and GLS Approach Procedures

		Site A		
Aircraft Type	Number of Arrivals	Ave SEL (dB)	Ave Altitude (ft)	Ave Speed (knts)
Existing Procedure				
Test GLS Procedure				
Modeled GLS Procedure				

- Altitude and Gate Penetration Analysis
- Appendix and Glossary

SOUND LEVEL DESCRIPTORS

in Alphabetical Order

FHWA-HEP-17-053

The **$L_{10}(t)$** is a statistical descriptor of the sound level exceeded for 10% of the time of the measurement period (t). It can be obtained using short-term measurements; however, it cannot be accurately added to or subtracted from other L_{10} measures or other descriptors. Typically, the L_{10} is about 3 dB(A) above the $L_{EQ}(t)$. This measurement is permitted for use by the Federal Highway Administration.

The **$L_{50}(t)$** is a statistical descriptor of the sound level exceeded for 50% of the time of the measurement period (t).

The **$L_{90}(t)$** is a statistical descriptor of the sound level exceeded 90% of the time of the measurement period (t). This is considered to represent the background noise without the source in question. Where the noise emissions from a source of interest are constant (such as noise from a fan, air conditioner or pool pump) and the ambient noise level has a degree of variability (for example, due to traffic noise), the L_{90} descriptor may adequately describe the noise source.

The **L_{DEN} or CNEL** (Community Noise Exposure Level) descriptor describes a receiver's cumulative noise exposure from all events over a full 24 hours [$L_{EQ}(24)$], with a 5-dB penalty applied to evening hours (between 7 PM and 10 PM), and a 10-dB penalty applied to nighttime hours (between 10 PM and 7 AM). The L_{DEN} is computed as follows:

$$L_{DEN} = L_{AE} + 10*\log_{10}(N_{DAY} + 3*N_{EVE} + 10*N_{NIGHT}) - 49.4\ (dB)$$

N_{DAY} = Number of vehicle pass-bys between 7 AM and 7 PM
N_{EVE} = Number of vehicle pass-bys between 7 PM and 10 PM
N_{NIGHT} = Number of vehicle pass-bys between 10 PM and 7 AM
49.4 = A normalization constant which spreads the acoustic energy associated with highway vehicle pass-bys over a 24-hour period, i.e., $10*\log_{10}$ (86,400 seconds per day) = 49.4 dB.

[1]The **L_{DN} or DNL** (Day-Night Average Sound Level) descriptor describes a receiver's cumulative noise exposure from all events over a full 24 hours [$L_{EQ}(24)$], with a 10 decibel (dB) penalty applied to nighttime hours (between 10pm and 7am). This metric corresponds well to human annoyance levels; however, it does not lend itself to intuitive interpretation. An L_{DN} at or below 65 dB is commonly used for noise planning purposes to denote areas suitable for residential use. An accurate L_{DN} requires 24-hour measurements although there are methods available to obtain it by extrapolating short term measurements. These methods have varying degrees of accuracy. The L_{DN} computed with C-weighting is denoted CDNL or L_{CDN}, and is used by the Air Force in the evaluation of sonic booms from aircraft. The A-weighted L_{DN}, used by the Federal Transit Administration, is computed as follows:

$$L_{DN} = L_{AE} + 10*\log_{10}(N_{DAY} + 10*N_{NIGHT}) - 49.4\ (dB)$$

N_{DAY} = Number of vehicle pass-bys between 7 AM and 10 PM
N_{NIGHT} = Number of vehicle pass-bys between 10 PM and 7 AM
49.4 = A normalization constant which spreads the acoustic energy associated with highway vehicle pass-bys over a 24-hour period, i.e., $10*\log_{10}$ (86,400 seconds per day) = 49.4 dB.

The **L_{DNMR}, or Onset-Adjusted Monthly DNL**, accounts for the increased annoyance of rapid onset sounds. This descriptor accounts for events that are sporadic and occur at random times and is used by the Air Force. The conventional L_{DN} metric is adjusted by adding penalties to the SEL. For events with a rate of increase in sound level below 15 dB per second no adjustment is made; from 15 - 150 dB per second, a penalty ranging from 0 to 11 dB is added; for rates above 150 dB per second an 11 dB penalty is added. The L_{DN} is then determined as usual and designated as Onset-Rate Adjusted DNL. The number of average daily events is determined by using the calendar month with the highest number of these events. The monthly average is denoted L_{DNMR} and it is always equal to or greater than the L_{DN}.

The **L_E, or SEL** (Sound Exposure Level [A or C-weighted: L_{AE} or L_{CE},]), is used to measure a single acoustic event. It is the foundation metric for many of the other descriptors. L_E is a composite descriptor that represents both the intensity of a sound and its duration, and provides a measure of the net impact of an entire acoustic event. Mathematically, the mean square sound pressure is computed over the duration of the event, then multiplied by the duration in seconds, and the resultant product is turned into a sound level. As the summation of all the sound energy in a single event, the SEL is generally 5 to 10 dB higher than the maximum.

[1]The **$L_{EQ}(t)$**, or Time-Equivalent Sound Level, descriptor accounts for noise fluctuations from moment to moment by averaging the louder and quieter moments, and giving more weight to the louder moments. It represents the equivalent continuous sound pressure level over a given period of time. L_{EQ} is SEL over some time period normalized by that time. It can be obtained using short -term measurements. L_{EQ} should not be confused with L_{50}; L_{EQ} is a measure of sound energy, not a statistical measure or statistical average.

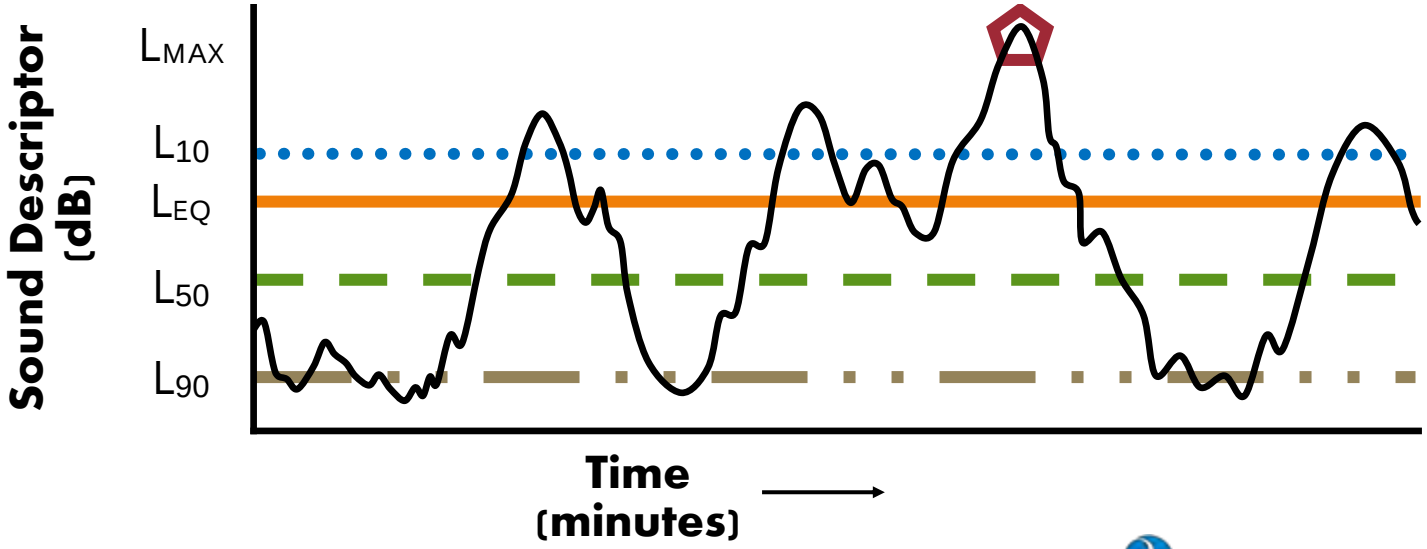
$$L_{EQ(time)} = L_{AE} - 10*\log_{10}(time_2 - time_1)\ (dB)$$

The **L_{MAX}, or Maximum Sound Level**, descriptor is the highest sound level measured during a single noise event (such as a vehicle pass by), in which the sound level changes value as time goes on. The maximum sound level is important in judging the interference caused by a noise event with common activities. L_{MAX} ignores the number and duration of these events, and cannot be totaled into a one-hour or a 24-hour cumulative measure of impact.

The **L_{PK}, or Peak Sound Level**, is a descriptor representing the true peak of the sound pressure wave. It is not the same as the L_{MAX}. The L_{PK} is the maximum value reached by the sound pressure. It is useful for capturing impulsive sounds, where the true instantaneous sound pressure is of interest. This pressure is usually presented in physical units of pounds per square foot (psf) and does not use either A or C weighting, nor is a time-constant applied. This parameter is typically used for regulating mining and blasting operations, and is also used by the Air Force.

[1]Neither the L_{EQ} nor the L_{DN} is an "average" in the normal sense of the word, where introduction of a quiet event would pull down the average. All sounds are included in the noise exposure that underlies L_{EQ} and L_{DN}. None of the noise is being ignored, even though the L_{EQ} and L_{DN} are often numerically lower than many maximum A-weighted Sound Levels. Noise exposure includes all events and all noise levels that occur during their time periods -- without exception. Every added event, even the quiet ones, will increase the noise exposure, and therefore increase L_{EQ} and L_{DN}. (Transit Noise and Vibration Impact Assessment - FTA-VA-90-1003-06, May 2006).

Visual Comparison of the Sound Levels Represented by Select Descriptors



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