TRUCKEE TAHOE AIRPORT

Airspace Design Review

DRAFT

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Introduction

The Truckee area is a vibrant region served by a varied user community and excellent airport facilities. The Truckee Tahoe Airport District (TTAD) is conducting a study to analyze and recommend how the airport can influence the use of surrounding airspace to reduce environmental impact and enhance safety. The primary goals are to reduce noise and fuel emissions, shorten track miles, and enhance the safe and efficient use of the federally controlled airspace surrounding the Truckee Tahoe Airport.

NextGen is a very large and complex set of programs that will emerge over many years and will make revolutionary changes in how airplanes fly and how airspace is managed. NextGen includes improvements to technology, infrastructure, policies, procedures, and training. As NextGen procedures are implemented, delay reductions, fuel saving, lowered user costs, reduced noise, lowered aircraft exhaust emissions, and safety enhancements are expected.

The goals of this study and its work products are to:

1. Illustrate NextGen solutions to enhance the airspace efficiency and safety to the Truckee area for the general aviation (GA) community;
2. Identify mitigation measures for constraints;
3. Create outreach materials for use locally and with FAA; and
4. Identify existing inventory of airspace and related constraints;

This project is designed to be collaborative and include stakeholders throughout the process. The project established an Airspace Design Technical Advisory Committee that will meet as a whole and with specific subject matter experts throughout the project. The Technical Advisory Committee included: airport staff, consultant team, FAA Northern California Center Approach Control Facility, SurfAir, NetJets, Truckee Tahoe Airport Advisory Committee Team (ACAT) member, and Navaid Technical Services.

Information on this project can be found at http://truckee.airportnetwork.com/as well as project updates and information on public outreach.

Chapter 1 – Inventory

Chapter 1 of the report presents background information about NextGen, Truckee Tahoe Airport (KTRK) and associated airspace. The inventory also presents information on the NextGen programs that will be the focus of this report.

1.1 NextGen Overview

1.1.1 Introduction

In its October 2014 report, *NextGen Integration Working Group Final Report*, the FAA defined four top priority capabilities of NextGen to be implemented in the next one to three years. The Report was a result of the Radio Technical Commission for Aeronautics (RTCA) industry group comprised of stakeholders including airports, airlines, and users. The RTCA NextGen Advisory Committee was tasked by the FAA to develop recommendations related to NextGen investments by the FAA. They include:

- Closely Spaced Parallel Runways/Multiple Runway Operations,
- DataComm-enabled Controller-Pilot DataLink Communications and pre-departure clearances,
- Performance Based Navigation (PBN), and
- Surface and Data Sharing.

While these four capabilities can deliver benefits to general aviation (GA), with the exception of Performance Based Navigation (PBN), they are primarily focused on improving efficiency for large commercial aircraft operating at the nation’s busiest airports. GA aircraft that fly into those airports, such as high-end business aircraft, will obtain these benefits. There are two WAAS procedures at KTRK; as part of this study additional WAAS procedures were studied and it was determined that there are no new WAAS procedures that would show benefits for airport users or community members.

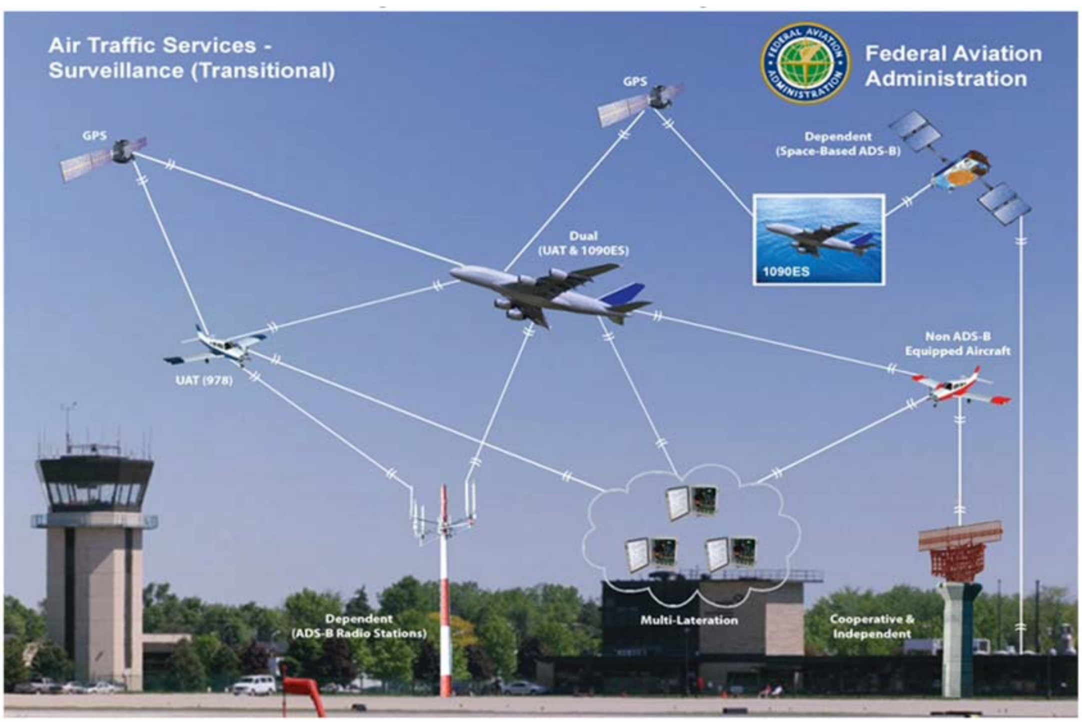
1.1.2 NextGen Programs

The following section summarizes key NextGen technologies/procedures that, when implemented, will satisfy the FAA’s NextGen priority capabilities related to GA.

1.1.2.1 Automated Dependent Surveillance Broadcast (ADS-B) Services

ADS-B, an enabling technology program, is a critical surveillance component to the implementation of NextGen. ADS-B uses GPS signals to determine aircraft location instead of radar. Aircraft operating in controlled airspace must be equipped with technology ADS-B "Out" by January 1, 2020. With ADS-B technology, the aircraft broadcasts its position information to ADS-B ground stations and other aircraft. This is called ADS-B "Out." Position information includes altitude, airspace and location. Ground stations are also broadcasting valuable information to the aircraft, such that the aircraft can receive it using ADS-B "In" technology. Aircraft equipped with ADS-B In receive traffic and weather data in the cockpit. As of January 1, 2015, approximately 8,800 GA aircraft are equipped for ADS-B Out. This is approximately 4% of the GA fleet in the United States; according to the General Aviation Manufacturers Association, in 2013 there were approximately 209,000 GA aircraft registered in the United States. **Figure 1.1**, *ADS-B Architecture*, shows how the components of ADS-B communicate with aircraft and air traffic control facilities.

Figure 1.1
ADS-B Architecture



Source: Federal Aviation Administration, January 2015

Traffic Information Service – Broadcast (TIS-B), Flight Information Service – Broadcast (FIS-B), and Automatic Dependent Surveillance Rebroadcast (ADS-R) provide aircraft equipped with ADS-B In with situational awareness of other aircraft within a 15 NM radius (+/- 3500 feet). The traffic information includes:

- Altitude
- Ground track
- Speed and distance of other aircraft
- Airport surface data
- Graphic based weather data
- Text based weather advisories
- Notices to Airmen (NOTAM)

Installing an ADS-B receiver in the cockpit provides a situational display and an audio alert to warn the pilot of approaching traffic. If aircraft are flying intercept courses, the ADS-B In avionics will sound an alert, enabling the pilots to take evasive action to avoid a collision.

ADS-B In provides additional benefits specific to GA aircraft, including receiving and displaying weather and other aeronautical information to enhance pilots' situational awareness of in-flight hazards and help prevent accidents. Three types of FAA broadcast services provide benefits to pilots of ADS-B In-equipped aircraft:

- **Traffic Information Service–Broadcast (TIS-B)**: This advisory service provides the altitude, ground track, speed, and distance of aircraft flying in radar contact with controllers and within a 15 nautical mile (NM) radius, up to 3,500 feet above or below the receiving aircraft's position. A GA aircraft equipped with ADS-B In can also receive position data directly from other aircraft broadcasting on the same ADS-B Out frequency. TIS-B also enables pilots to see Non-ADS-B equipped aircraft with transponders flying nearby.

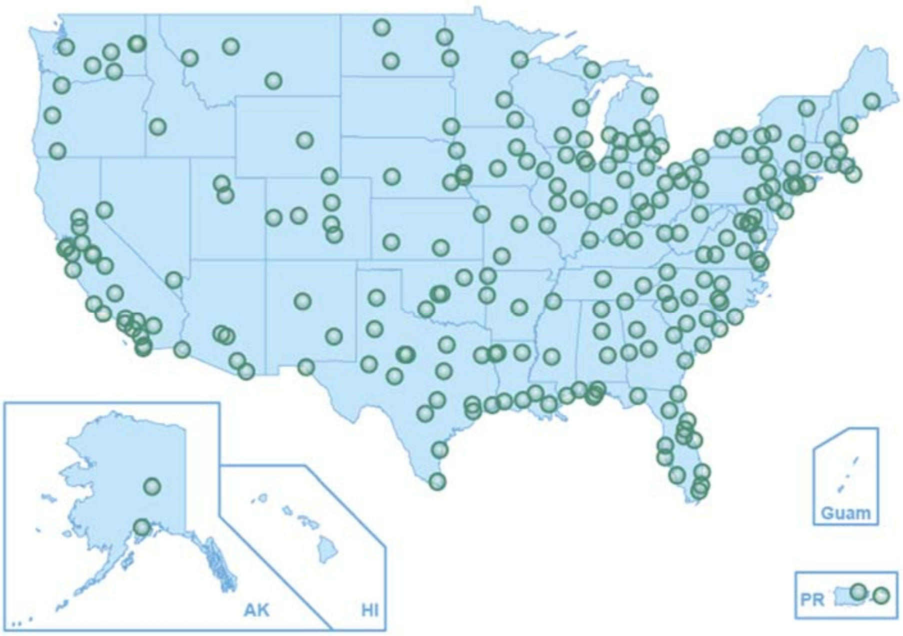
- **Automatic Dependent Surveillance–Rebroadcast (ADS-R)**: ADS-R takes position information received on the ground from equipped aircraft and rebroadcasts it to commercial aircraft. In concert with TIS-B, ADS-R provides all ADS-B In-equipped aircraft with a comprehensive view of the airspace and airport situation. ADS-R delivers traffic data within a 15 NM radius 5,000 feet above or below relative to the receiving aircraft's position.

- **Flight Information Service– Broadcast (FIS-B)**: This service broadcasts graphical and text-based weather information to the cockpit, providing a weather radar-like display similar to commercial aircraft, without the need to invest in expensive radar avionics. In addition, FIS-B broadcasts text-based advisories including Notice to Airmen messages and reports on significant weather such as thunderstorm activity. Properly equipped general aviation aircraft can receive this information at altitudes up to 24,000 feet.

The FAA has completed the baseline deployment of more than 600 ADS-B ground stations, making TIS-B, ADS-R and FIS-B services available across the United States. The FAA is working with the aviation community to set standards for how ADS-B In provides pilots with a low-cost traffic alerting capability. This work included flight testing in 2013. The traffic alert application uses ADS-B data to identify conflicting traffic nearby, alerting the pilot to look out the window and see the traffic being called out.

Hopefully, the new rules and regulations for ADS-B In will be completed prior to the mandate to equip with ADS-B Out with sufficient time for manufacturers to provide both ADS-B Out and In equipment to meet the ADS-B Out mandate. All things considered, ADS-B will be an attractive option for general aviation. **Figure 1.2**, *ADS-B Ground Stations*, shows the location of the 600 ground stations.

Figure 1.2
ADS-B Ground Stations



Source: Federal Aviation Administration, September 2014

ADS-B Out equipped aircraft will also receive traffic and weather information for display on some mobile devices. Many general aviation pilots routinely use electronic tablets (such as iPads) to view aeronautical charts, so using these devices to depict weather and traffic information is a natural fit. The FAA is also exploring the possibility of setting standards for battery-powered ADS-B Out transmitters that can be used on gliders and GA aircraft certificated without an electrical system.

In the Lake Tahoe region, there are not currently ADS-B antennas that would service KTRK or KTVL. There is not a timeline for implementation of ADS-B in this area by the ADS-B Program Office; installation of ADS-B receivers in the area is a cost issue as well as national airspace (NAS) prioritization issue. KTRK is researching a shared use agreement with the FAA to install an FAA approved ADS-B site receiver that would be a cost shared project between KTRK and the FAA. KTRK is also working with Harris Corporation to explore installing FAA approved ADS-B receiver sites.

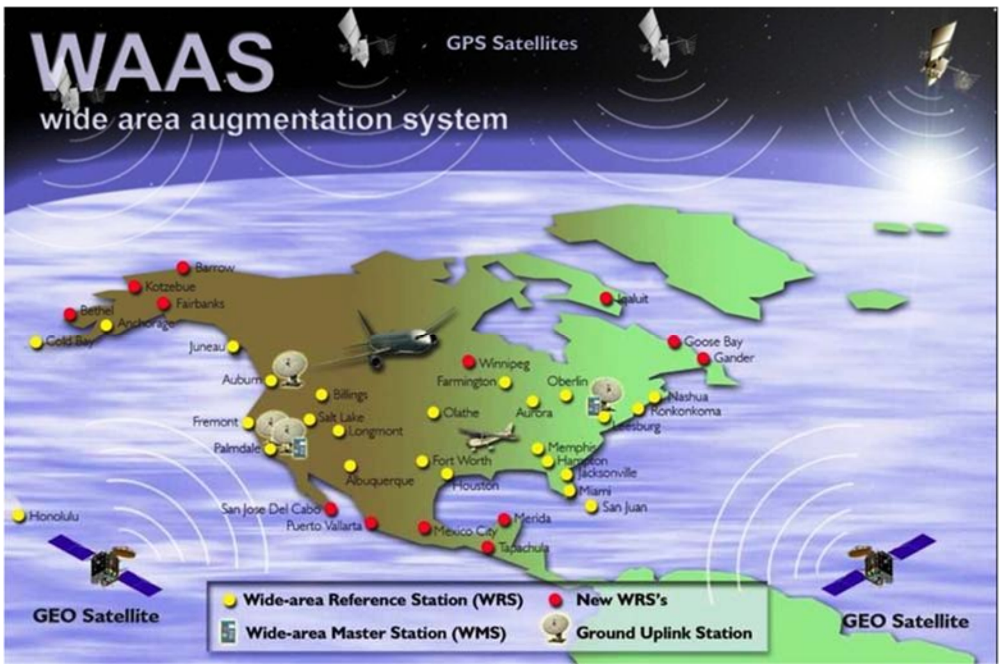
1.1.2.2 Wide Area Augmentation System (WAAS) Progress

WAAS provides GA pilots with Area Navigation (RNAV)[1] capabilities that in many cases rival or exceed what is used by commercial aircraft. WAAS enables aircraft to use vertically guided approach procedures

[1] **Area navigation** (RNAV) is a method of instrument flight rules navigation that allows an aircraft to choose any course within a network of navigation beacons, rather than navigating directly to and from the beacons.

to any qualifying airport in most of North America with minimums as low as 200 feet decision altitude (DA), without the need to install costly Instrument Landing System (ILS) equipment. These minimums can be lower than other conventional based navigation aide (NAVAID) approaches. When rising terrain is an issue near an airport, precise vertical guidance enhances safety regardless of visibility and whether the approach is being flown during the day or at night. **Figure 1.3**, *WAAS Infrastructure*, shows the current satellite and ground stations.

Figure 1.3
Wide Area Augmentation System (WAAS) Infrastructure



Source: Federal Aviation Administration, January 2016

As of December 2014, the FAA has published 3,450 WAAS-enabled approach procedures that feature Localizer Performance with Vertical Guidance (LPV)[2] minima. There are 2,326 of those LPVs at airports where no ILS is available. From a pilot's perspective, LPV approaches operate in a similar manner to traditional ILS approaches with vertical guidance similar to an ILS Cat I approach, which doesn't require advanced specialized training. This is a technology that can be used at airports without an ILS to improve access. Users say that LPV procedures are more accurate and easier to fly than ILS approaches because the flight paths are generated within the aircraft avionics, rather than from ground-based signals that are plagued by beam bends and interruptions from aircraft taxiing on the airport surface. Nationwide, more than 70,000 general aviation aircraft are equipped with the WAAS receivers needed to fly WAAS-enabled

[2] LPV procedures are the highest precision GPS aviation instrument approach procedures currently available without specialized aircrew training requirements

procedures with LPV minima or WAAS-enabled non-precision approach procedures with Localizer Performance (LP) minima. At Truckee Tahoe Airport, the RNAV GPS Z and Y arrival procedures to Runway 20 have published LP minimums (RNAV GPS Z minimums: 526’ AGL/6,420 MSL and 1 mile of visibility); the RNAV GPS arrival for Runway 11 has published LNAV minimums (RNAV GPS minimums: 2,300’ AGL/8,160 MSL and 1.25 miles of visibility).

LPV provides an access benefit especially to GA aircraft. RNAV (GPS) approaches with LPV minima to airports that have no ILS now make these destinations accessible when visibility is limited, rather than ruling them out, thus enhancing airport access for many users. An airport must have at least 3,200 feet of paved runway to qualify for an RNAV (GPS) procedure with either LP or LPV minima.

The FAA has also published 560 RNAV (GPS) non-precision procedures as of December 2014, with LP minima that employ WAAS for lateral guidance but without the added safety benefit of vertical guidance. These approaches are needed at runways where obstacles or other infrastructure limitations prevent the FAA from publishing a vertically guided approach. Non-precision LP minima are generally higher than LPV minima, with somewhat reduced airport access in poor weather.

The widespread and growing availability of LPV and LP procedures and the high equipage rate in the general aviation fleet is making it possible for the FAA to retire some ground-based NAVAIDs from service, including Non-Directional Beacon (NDB) and VOR equipment. Many GA aircraft owners have removed the now obsolete avionics needed to fly an NDB procedure and the FAA continues to shut down NDBs on the ground. LPV procedures can provide lower minima than are available with NDB approaches.

The FAA plans to meet any new requirements for Category 1 approach procedures with WAAS and LPV while maintaining an existing network of Instrument Landing Systems (ILS) to provide alternative approach and landing capability. The agency also intends to transition from defining airways, routes and procedures using VOR, and more to RNAV procedures using GPS and DME/DME/IRU (inertial reference unit) in the National Airspace System. An IRU is an internal navigation system used on large aircraft. The network of Distance Measuring Equipment stations provides an RNAV-backup to GPS for suitably equipped commercial aircraft. A Minimum Operational Network of VOR stations (VOR MON) will be maintained to provide a conventional navigation capability for aircraft that don’t have DME/DME/IRU avionics.

At KTRK, the proposed procedures that are in Section 3 will all be GPS required since there is not enough DME infrastructure to support DME/DME/IRU only equipped aircraft.

As the NAS is modernized, communications, navigation, surveillance, and automation systems will enable the majority of traffic outside congested areas to proceed to their destination using the most direct greatcircle routes without the need for dedicated airways. RNAV Q and T Routes[3] will be established where structure is needed for en route traffic. Routes will also be necessary to ensure the smooth flow of traffic around restricted airspace and busy terminal Metroplex areas. Overall, the expectation is that the majority of VOR airways will be removed and a smaller number of Q/T Routes will replace them.

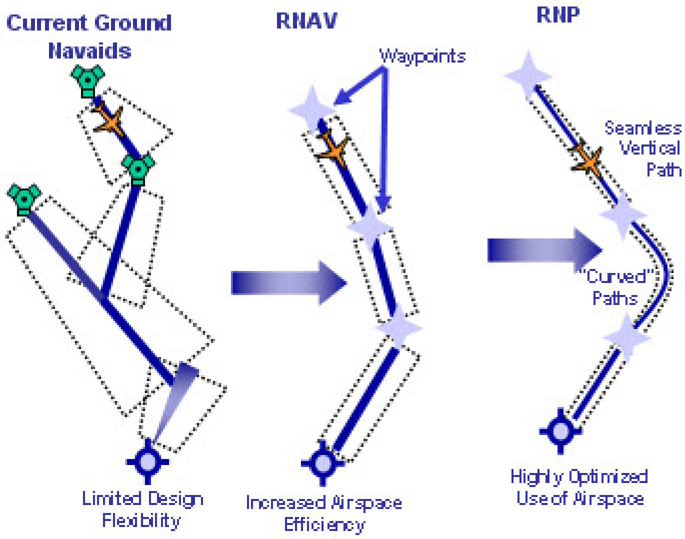
1.1.2.3 Performance Based Navigation (PBN)

One of the opportunities NextGen offers is Performance Based Navigation (PBN), which allows more efficient use of airspace through point-to-point navigation rather than restricting flight paths between ground-based radio navigation systems. PBN procedures consist of RNAV and Required Navigation Performance (RNP). The FAA's strategy for implementing PBN is to provide "RNAV Everywhere and RNP Where Beneficial." All RNAV and RNP approach procedures rely on satellite-based navigation, breaking free of the dependency on ground based navigation aids. PBN enables procedure designers to maximize the efficient use of the airspace, altering the traditional flight paths around an airport.

Figure 1.4, *PBN Navigation,* shows the change between ground-based NAVAIDS and RNAV/RNP procedures, and highlights the difference between current point-to-point navigation and new, more flexible, PBN navigation, which offers increased efficiency. This figure also illustrates the general airspace area protected from the centerline of the route; as the navigation becomes more precise, the protected airspace is reduced in parallel.

[3] Q routes, sometimes referred to as high altitude routes, are used by RNAV equipped aircraft operating between18,000' mean sea level (MSL) and 45,000' MSL whereas T Routes, sometimes referred to as low altitude routes, are used by RNAV equipped aircraft operating to 18,000' MSL.

Figure 1.4
PBN Navigation



Source: Federal Aviation Administration, October 2015

1.1.2.4 Data Communications

Over the long term, pilot/controller communications will transition from voice-to-data communications, contributing significantly to increased efficiency, throughput, and safety of the NAS. The Data Communications (Data Comm) program will gradually implement new technology to transition from the current analog voice system to an International Civil Aviation Organization (ICAO) compliant system in which digital communication becomes an alternate and eventually predominant mode of communication. Data Comm is an essential enabler to shift air traffic control from a workload-intensive tactical control to automation-assisted strategic traffic management. To achieve this goal, more efficient data communications between aircraft and air traffic management must be implemented. The Data Comm program is a key element in the implementation of NextGen.

1.2 Project Study Area

The project study area is defined as Truckee Tahoe Airport (KTRK) airspace, defined as Class G Airspace. The FAA defines Class G airspace as uncontrolled and Class E airspace as controlled; KTRK is in the process of changing to Class E airspace. While this project is focusing on KTRK, South Lake Tahoe Airport (KTVL) will also be considered in the study area due to its close proximity to KTRK, as well as the need to ensure any new procedures created for KTRK are procedurally deconflicted from existing KTVL procedures. **Figure 1.5**, *Study Area,* shows the study area boundaries and included airports.

The project study area and its associated airports define the boundary for which the navigation and aeronautical information for the operations of these airports is presented within this report. This includes NAVAIDS, obstructions, terrain, airspace, procedures, charts and low/high altitude routes.

1.3 Key Airspace Issues for the Truckee Tahoe Airport

The airspace issues within the study area were organized into five general categories: environmental impact, safety, deconfliction, radar coverage, and weather. These four categories represent:

- *Environmental Impact* - reduction of environmental impacts, including noise, and overflights.
- *Safety* –defines the ability of an aircraft to comply with existing flight procedure parameters while on approach or departure to/from the airport or flying enroute to/from the airport.
- *Deconfliction* – flight procedures that are unable to operate simultaneously at KTRK, Reno/Tahoe International Airport (KRNO), Sacramento International Airport (KSMF), and South Lake Airport (KTVL).
- *Radar Coverage* – flight procedures limited by the ability of communications in the area or the ability for air traffic control to establish radar contact.
- *Weather* – KTRK experiences mountainous weather conditions that limit the ability for aircraft to fly except under instrument flight rules.

Figure 1.5
Study Area

Source: BridgeNet International, October 2015

Chapter 2 – Inventory of Existing Information

Chapter 2 provides an inventory of navigation, flight procedures, constraints, and surveillance information for the airport. This information serves as the baseline that the proposed notional procedures will be compared against to determine how well each procedure satisfies the project goals.

2.1. Existing Activity Levels

Aircraft operations data have been evaluated; **Table 2.1,** *Aircraft Activity Levels for 2015,* shows operations by aircraft category based upon airport and instrument flight plan data. This data shows for 2015, there were a total of 27,613 annual operations (76 operations per day) that includes glider aircraft operations; glider operations occur between May and September. There are on average 62 daily operations by powered aircraft. The data shows that Visual Flight Rules (VFR) operations occur on average 72% of the time.

Table 2.1
Aircraft Activity Levels for 2015

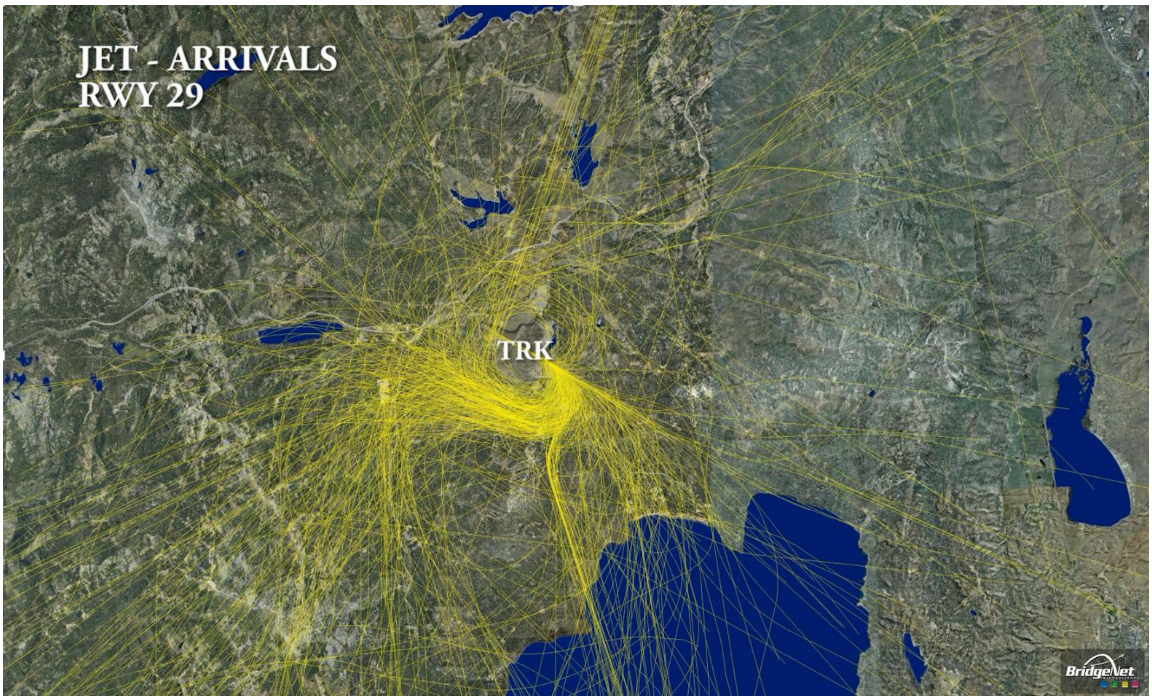
Operations by Category	2015
Piston Single Engine	10,676
Piston Twin Engine	1,524
Turbo Propeller	5,756
Small Jet	2,214
Midsize Jet	970
Medium Jet	227
Helicopter	1,097
Subtotal Powered Aircraft	22,505
Gilder Aircraft	5,108
TOTAL	27,613

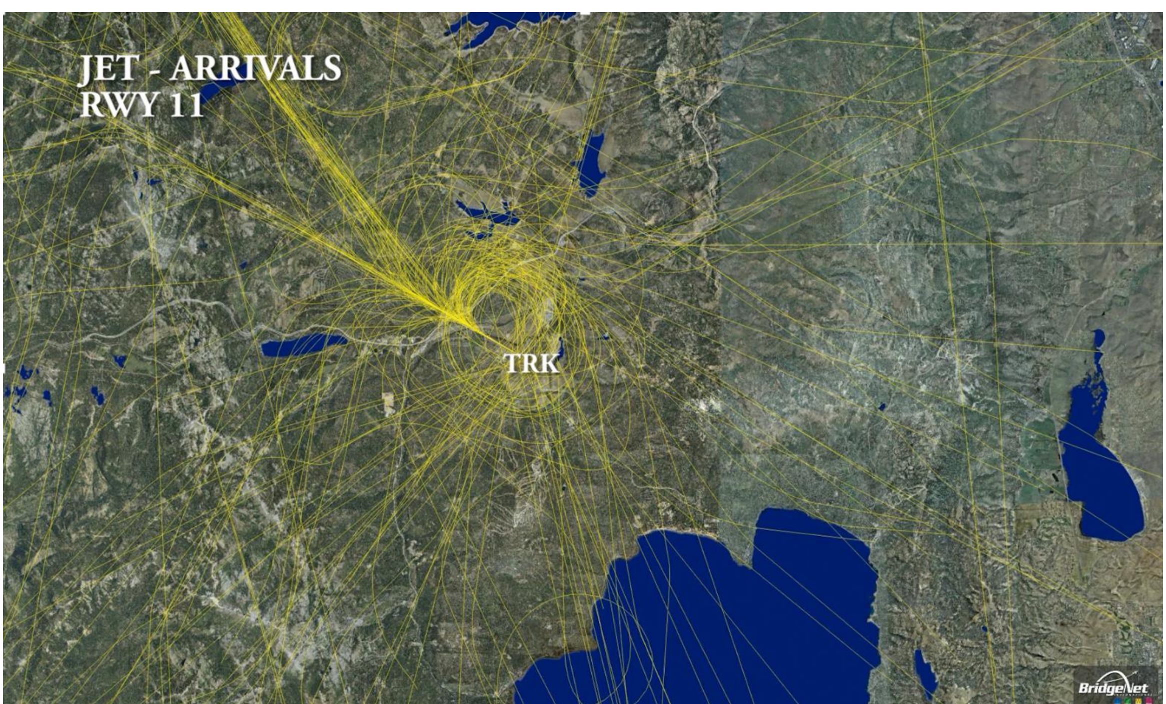
Source: Truckee Tahoe Airport Operations and Community Comment Report, Calendar 2015

2.2. Historic Radar Data

To evaluate current flight tracks and operations, historic radar data was collected. The source of this radar data is the FAA's Performance Data Analysis and Reporting System (PDARS). The data included calendar year 2014. **Figures 2.1 – 2.5** shows existing arrival and departure flight tracks.

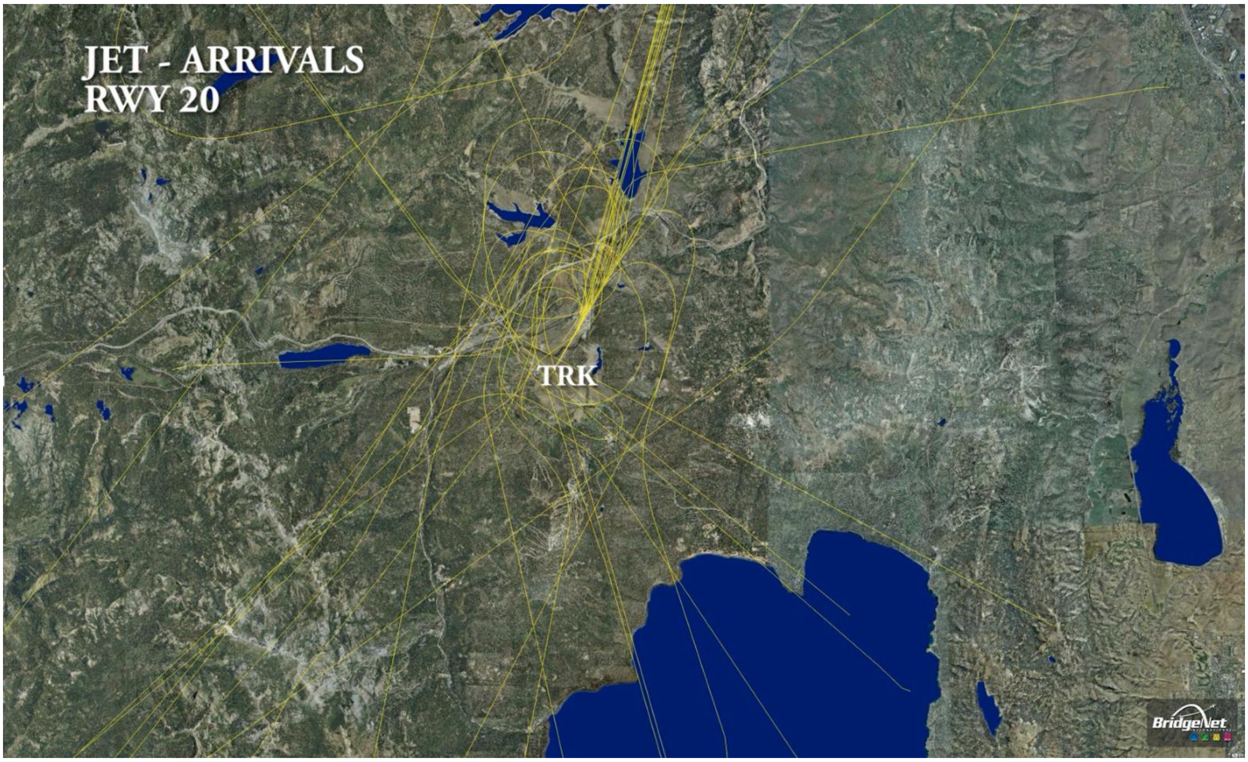
Figure 2.1
Existing Aircraft Jet Arrivals – Runway 29 & Runway 11





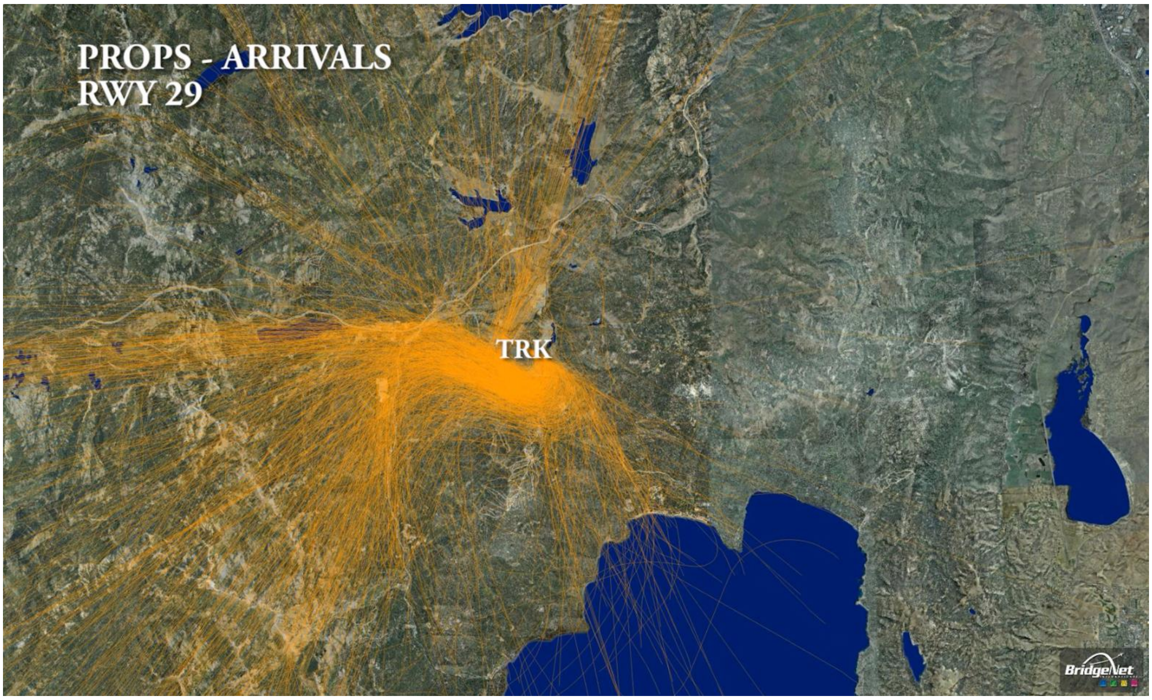
Source: BridgeNet International, October 2015

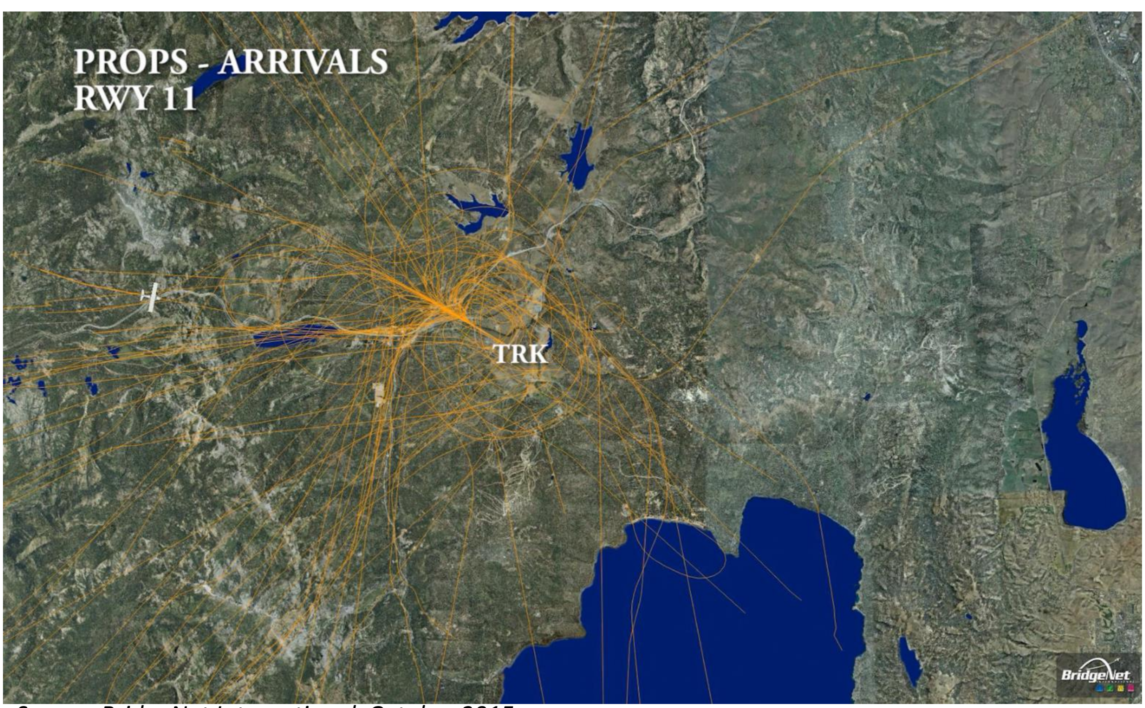
Figure 2.2
Existing Aircraft Jet Arrivals – Runway 20



Source: BridgeNet International, October 2015

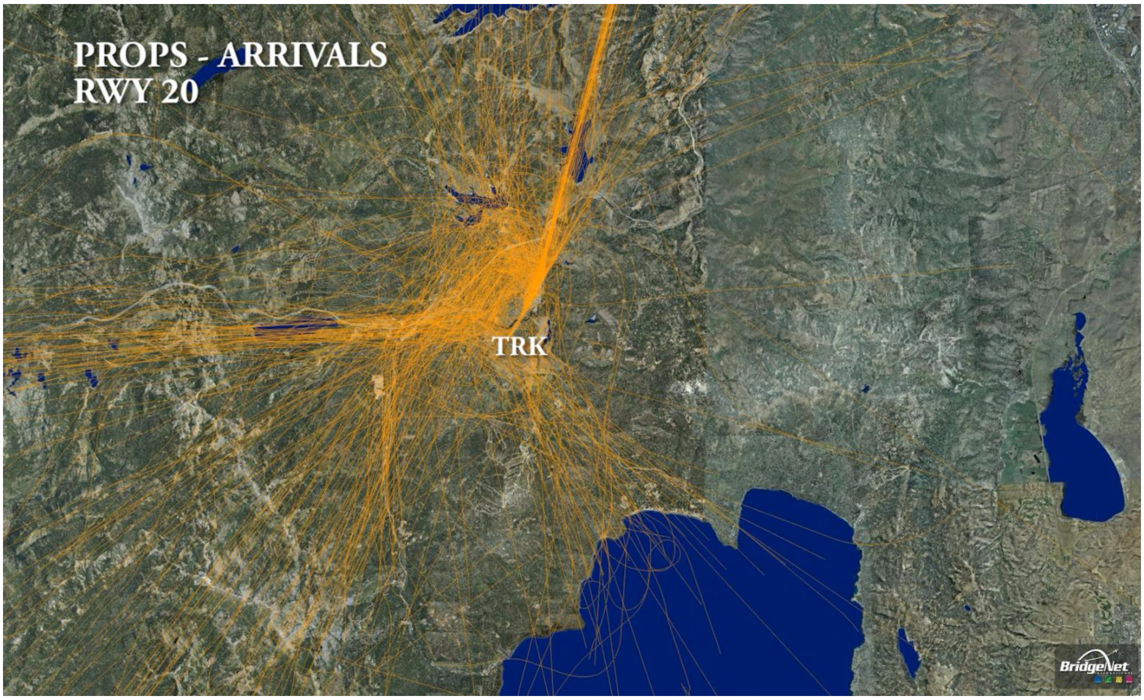
Figure 2.3
Existing Aircraft Propeller Arrivals – Runway 29 & Runway 11

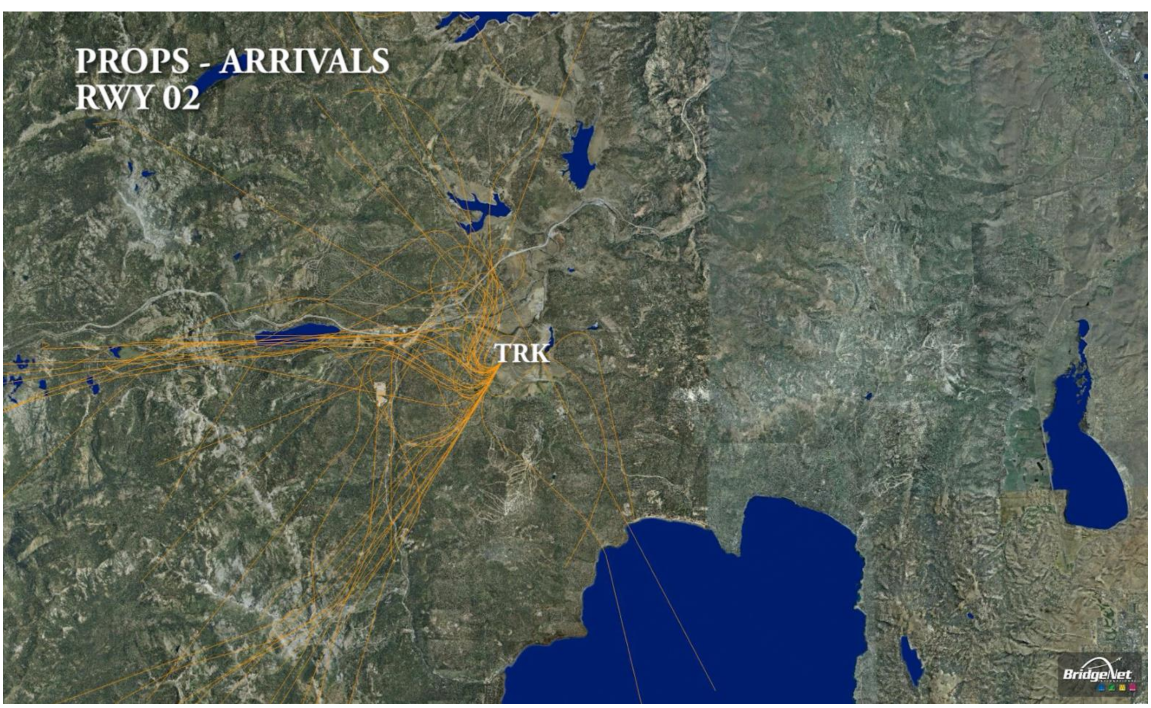




Source: BridgeNet International, October 2015

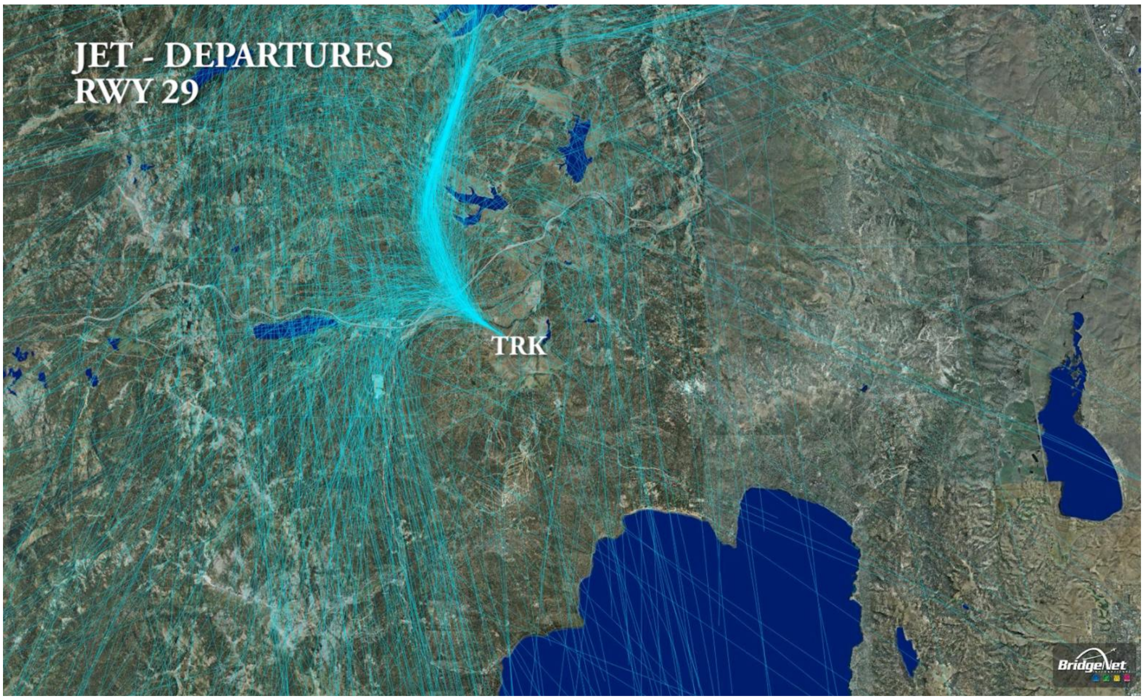
Figure 2.4
Existing Aircraft Propeller Arrivals – Runway 20 & Runway 02

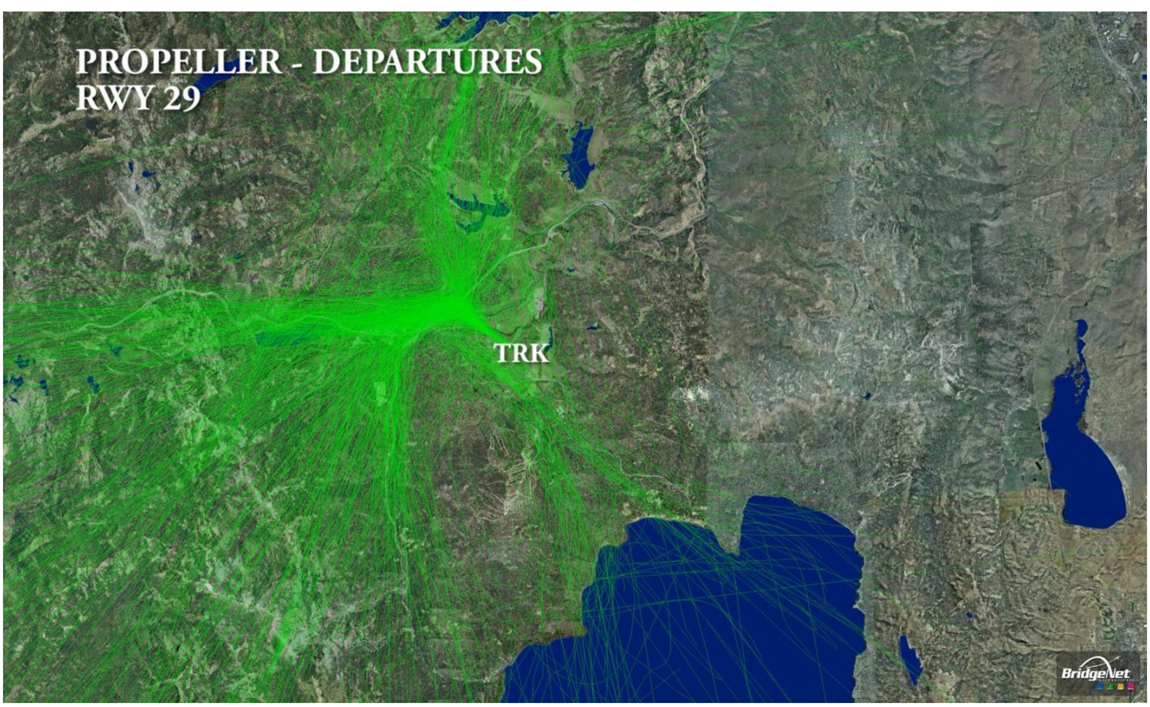




Source: BridgeNet International, October 2015

Figure 2.5
Existing Aircraft Departures – Runway 29 Jet & Runway 29 Propeller





Source: BridgeNet International, October 2015

The predominant runways in use at KTRK are Runway 20 and Runway 29 due to prevailing winds and runway length; **Table 2.2**, *Runway Use,* shows the percentage of time each runway is used. For business jets, Runway 11/29 is used for 89% of departures while Runway 11/29 is used for 91% of arrivals, with the majority of the arrivals and departures on Runway 29. Aircraft arrive and depart into the wind as much as possible.

Table 2.2
Runway Use

Runway	Aircraft Type		
	Piston	Turbo Propeller	Business Jet
Arrivals			
Runway 2	6%	2%	0%
Runway 20	26%	24%	9%
Runway 11	8%	10%	24%
Runway 29	60%	63%	67%
Departures			
Runway 2	11%	8%	1%
Runway 20	22%	13%	5%
Runway 11	5%	3%	5%
Runway 29	62%	76%	89%

Source: Truckee Tahoe Airport, March 2016

2.3 Historic Weather

As part of the background information, a detailed weather analysis was conducted to understand the surrounding weather patterns. Instrument approach procedures can be designed from either a traffic flow perspective, lowest minima[4] perspective, or a hybrid of both. Understanding the weather patterns helps provide perspective on the balance that should be obtained between these design parameters.

2.3.1 Preparation

Weather files were obtained from TTAD from a period of March 2012 through May 2015 containing a total of 14,525 individual reports. After data cleaning, 13,175 lines of data remained for analysis. Preparing the data for analysis occurred in the following steps:

- The data were analyzed for erroneous entries and other data in fields that were inconsistent with weather reports.
- Entries with blanks in “Sky Condition” field were removed.

[4] Minima refers to the minimum allowable visibility for a procedure, typically defined in miles or feet.

- "Sky Condition" contained a large amount of variance and was reduced to fields that were most restrictive. For example, a Sky Condition of SCT020 BKN 041 BKN 060 OVC 120 would be reduced to the most restrictive ceiling of BKN041. In some cases, where there was SCT 010 BKN 120, SCT 010 was kept as most limiting. The most restrictive refers to the lowest level of clouds recorded.
- The Visibility field was examined for valid data with erroneous entries removed.

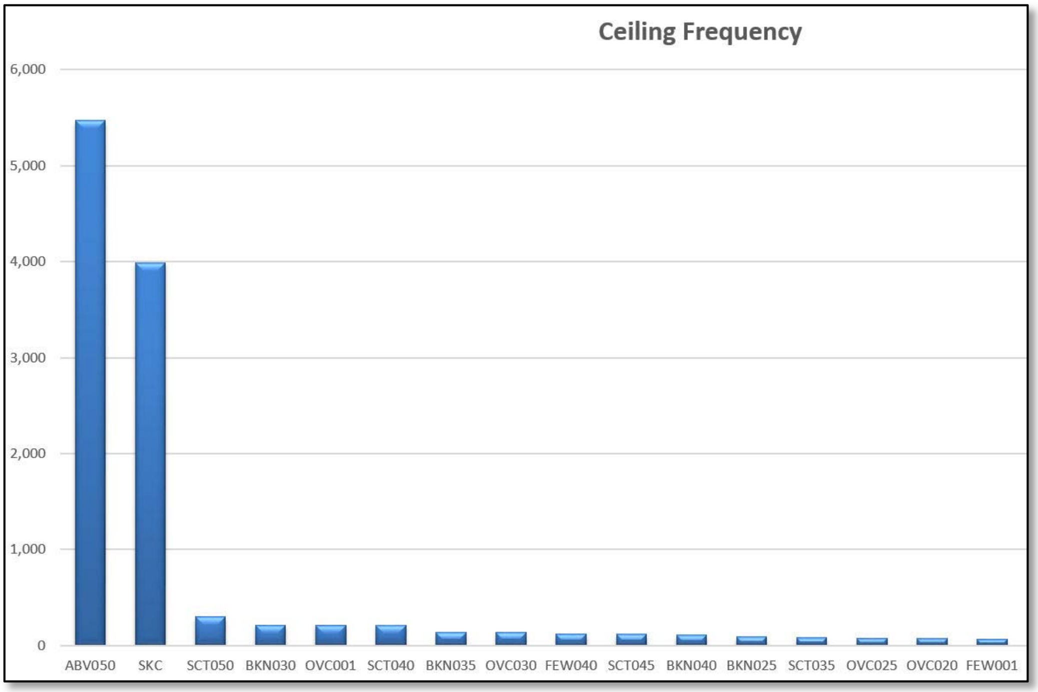
2.3.2 Analysis

For Sky Conditions (Ceilings) the data was reviewed by percentage and bar graph. When discussing aviation weather, the ceiling defined is the lowest broken or overcast layer or vertical visibility into a complete obscuration. As with many aspects of aviation, weather reporting uses many abbreviations and acronyms. In weather, typically there is a three letter abbreviation followed by three numbers, such as SCT050. This would read as 'scattered clouds at 5,000' above ground level (AGL)'; for the abbreviations, add two zeros to the numbers. The following are frequently used weather abbreviations:

ABV = Above	SKC = Sky Clear
FEW = Few clouds over 25% or less of the sky	BKN = Broken clouds over more than 50% - 90% of the sky
SCT = Scattered clouds over 30- 50% of the sky	OVC = Overcast over 100% of the sky

In **Figure 2.6,** *Historic Weather 2012 - 2015*, it is clear that KTRK's weather has ceilings above 5,000' AGL a significant portion of the time. There are 9,465 records of the total 13,175 indicating that, 71.8% of the time, KTRK has either clear skies or ceilings above 5,000' AGL.

Figure 2.6
Historic Weather, 2012 – 2015

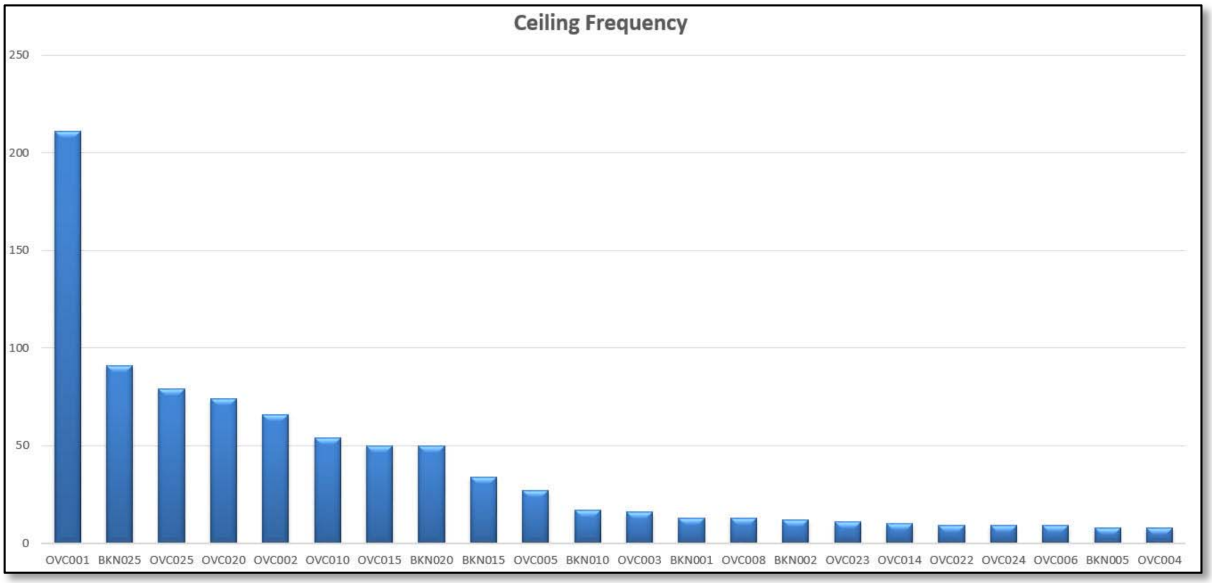


Source: ABCx2, October 2015

KTRK's current approach procedures to Runways 11 and 20 contain the highest procedure minimums associated with circling approaches: 2,579' AGL and three miles' visibility. The highest procedure minimums are the most restrictive, meaning aircraft must make a decision to execute the approach or fly a missed approach at a higher altitude than approaches with lower minimums. When all 13,125 entries are examined, there are 1,031 total instances of a Sky Condition of a ceiling of 2,600' AGL or below. Of these, the most frequent is OVC001 (Overcast ceiling at 100' AGL) and BKN025 (Broken clouds at 2,500' AGL) accounting for 302 instances as shown in **Figure 2.7**, *Sky Conditions with Ceiling Below 2,600' AGL*.

Figure 2.7

Sky Conditions with Ceiling Below 2,600' AGL



Source: ABCx2, October 2015

2.3.2 Visibility

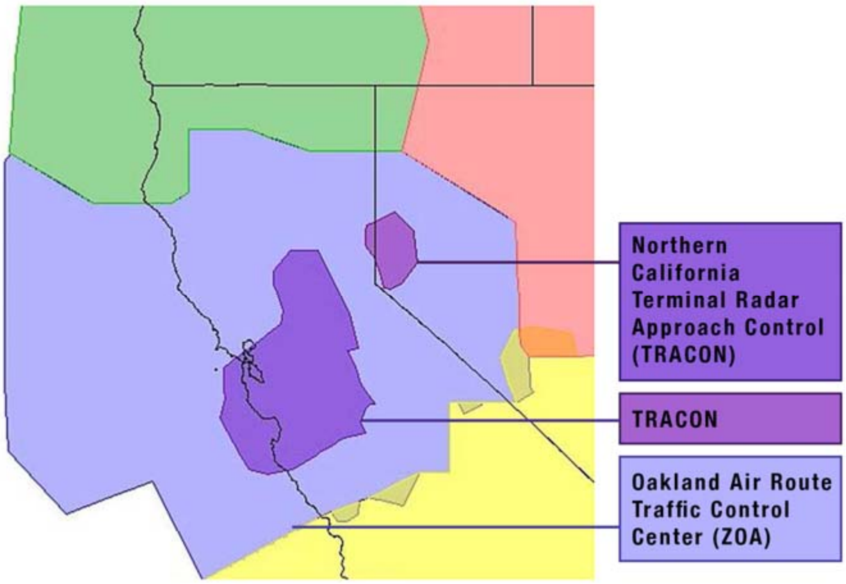
A review of 12,789 records with respect to Visibility, reveal that there were 11,528 individual reports of 10 miles or greater. Of the 12,789 reports, only 219 (<2%) were below VFR minimums.

The weather at KTRK is predominately clear. When the sky conditions are less than clear, the next highest occurrence is OVC001 (Overcast ceiling 100' AGL) in snowy conditions or morning ground fog. Morning ground fog occurs when the dew point and relative temperature are the same, producing moisture. Once the sun rises, the air and ground temperatures warm up which dissipates the fog. Ground fog typically dissipates by mid-morning. When reviewed against the highest lines of approach minima currently existing at KTRK, the ceilings were lower than circling minimums 8% of the time over a three-year period. Therefore, the approaches at KTRK may be considered to be most beneficial by providing access to the runways via prescribed paths rather than being designed for low weather conditions.

2.4 Define Airspace Interaction

Truckee Tahoe Airport is within the Oakland Air Route Traffic Control Center (ZOA) airspace. This airspace is adjacent to the Northern California Terminal Radar Approach Control (NorCal TRACON or NCT). **Figure 2.8**, *Airspace Map, ZOA and NorCal TRACON,* shows the ZOA and NCT boundaries. While there are no specific airspace constraints, the procedure constraints are due to the ability of ZOA to establish radar contact with aircraft when departing or arriving TRK. Aircraft on departure are normally radar identified between 10,000’ and 11,000’ mean sea level (MSL) and on arrival, radar contact is usually lost at about the same altitudes.

Figure 2.8
Airspace Map, ZOA and NorCal TRACON



Source: Federal Aviation Administration. Labels - BridgeNet International, December 2015

2.5 Inventory Existing Airspace Facilities

This section describes airspace, air traffic control facilities, navigation aids and surveillance in the study area.

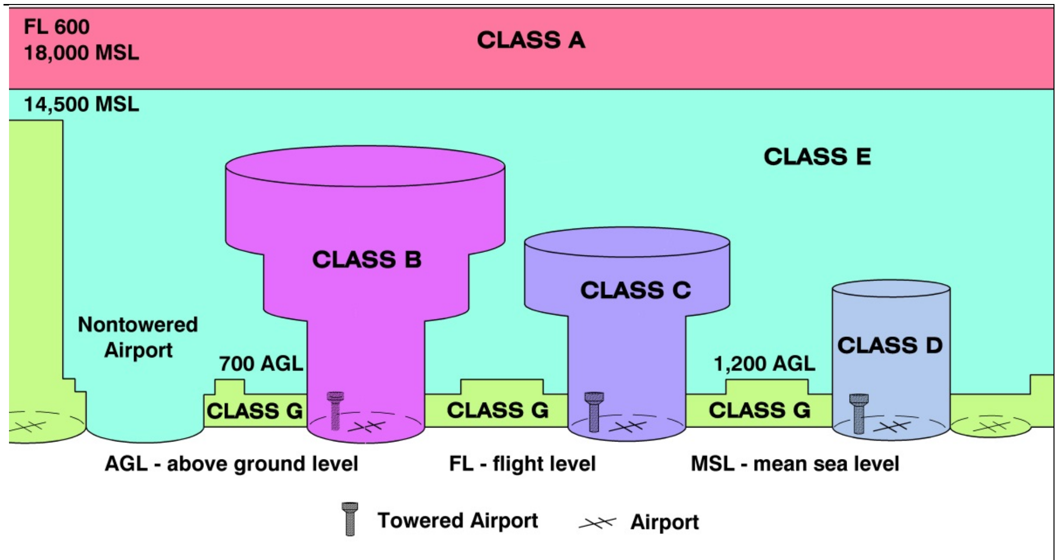
The airspace over the study area and all of the US is under the jurisdiction of the FAA. This authority was granted by Congress via the Federal Aviation Act of 1958. The FAA established the National Airspace System (NAS) to protect persons and property on the ground and to establish a safe and efficient airspace environment for civil, commercial, and military aviation. The NAS is defined as the common network of US airspace, including air navigation facilities; airports and landing areas; aeronautical charts; associated rules, regulations, and procedures; technical information; personnel; and material. This section also discusses system components shared jointly between civilian users and the military.

Federal Aviation Regulations (FAR) define six categories of airspace, each with distinct operating requirements, which conform in both name and description with airspace designations used internationally. The categories are Class A, B, C, D, E, and G, and each has decreasingly restrictive requirements regarding ATC communications, aircraft entry, aircraft separation, and VFR operations. The general shape and requirements of each airspace class are shown in **Figure 2.9**, *Airspace Classifications*. KTRK operates in Class G airspace, which is uncontrolled airspace. When aircraft operate in Class G airspace, they must adhere to visual flight rule (VFR) minimums, which requires aircraft to have 1 statute mile of visibility and remain clear of clouds during daytime hours. At night, aircraft must have three statute miles (SM) of visibility and have clearance from clouds: 2,000 feet horizontally, 1,000 feet above and 500 feet below the aircraft.

Concurrent to the writing of this report, the TTAD has provided comments to the FAA concerning a Notice of Proposed Rule Making (NPRM) asking that the airspace surrounding KTRK be reclassified to Class E Surface area. This would require pilots to fly VFR with three miles of visibility, and fly at an altitude at least 500 feet below, 1,000 feet above, and 2,000 feet laterally from clouds. This would enhance safety around the airport and retain IFR departures conducting RNAV Off-The-Ground procedures within controlled airspace. Additionally, if/when a seasonal tower is implemented at KTRK, Class E Surface Area would already exist for the times/dates when the tower is closed.

Figure 2.9

Airspace Classifications



AGL = above ground level FL = flight level MSL = mean sea level

Airspace Class	Communication with ATC	Entry Requirements	Separation Services	Special VFR in Surface Area
A	Required for all operations	ATC clearance	All	N/A (No surface area)
B	Required for all operations	ATC clearance	All	Yes
C	Required for all operations	Two-way communications required prior to entry	VFR/IFR	Yes
D	Required for operations	Two-way communications required prior to entry	Runway operations	Yes
E	Required for IFR operations	Required for IFR operations	Required for IFR operations only	Yes
G	Not required	None	None	N/A (No surface area)

Source: Mead & Hunt, December 2014

2.6 Existing Procedures

There are four published flight procedures at KTRK, three RNAV GPS procedures and one Standard Instrument Departure (SID). The existing procedures cover each runway end and are usable in all weather conditions. Existing procedure flight tracks are shown in **Figures 2. 1 – 2.5**.

2.7. Preliminary Identified Airspace Constraints

This section describes a preliminary set of airspace constraints that have been identified by the project team. The constraints were derived by examining existing conditions information and discussing issues with FAA technical staff and the airport.

Terrain – Terrain is probably the most challenging airspace constraint in the vicinity of KTRK. Due to the proximity of rising terrain to the airport, instrument flight procedures must be developed that require steeper than normal climb and descent gradients. The terrain in the area of the airport is sometimes referred to as precipitous terrain, which indicates there can be abrupt changes in terrain. This is a limiting factor when it comes to the types of aircraft that are capable of flying such procedures. Performance Based Navigation (PBN) procedures open up more possibilities than conventional procedures allowed at an airport such as KTRK; however, existing PBN criteria can still be a limiting factor when attempting to design procedures to increase access to airports in mountainous and precipitous terrain.

Surveillance Coverage – The lack of radar coverage surrounding KTRK reduces the efficiency of operations in to and out of the airport. Alternate means of surveillance have been promoted by airport staff but have not been approved for integration into the National Airspace System (NAS) as an approved source of surveillance data. ADS-B may provide some coverage in the future. However, requests for additional ADS-B antennas in the vicinity of KTRK and KTVL airports have yet to be approved.

Communications – Recent modifications to the location of radio antennae have proven to increase the reliability of aircraft being able to contact ZOA on the ground at KTRK. In the event a pilot cannot reach ZOA by radio, cell phone communication is most often used as an alternative means of communication prior to departure. Once aircraft reach 10,000 feet MSL they are normally in communication with ZOA.

Environmental Issues – Adhering to historic noise sensitive areas is also a limiting factor to the use of the limited airspace available. Procedures must be designed that meet terrain and obstructions criteria as well as PBN criteria, yet protect the surrounding communities from adverse impacts. Developing environmentally friendly PBN procedures is a high priority for the TTAD.

Chapter 3 – Evaluate Airspace Actions

The next step in the study process was to identify NextGen techniques and procedures that could address specific operating needs of the general aviation fleet mix at KTRK. Chapter 3 of the report presents these potential airspace concepts. These actions were identified based upon the airspace inventory, evaluation of operating constraints, and the available NextGen programs, detailed in Chapter 2.

3.1 Potential Actions

A number of concepts were identified as potential procedural improvements for which NextGen programs and technologies could be applied to KTRK to achieve the goals of this study for Standard Instrument Departures (SIDs), arrival procedures, and Standard Terminal Arrival Routes (STARs). Each of the concepts were evaluated against the following requirements; if the concept didn't fully meet all criteria, it was not carried forward. The concepts must:

- Must provide environmental benefits – reduced emissions, noise, or track miles.
- Serve all runways to enhance runway utilization and reduce environmental impact.
- Meet current FAA procedure design criteria.
- Meet current FAA terrain and obstruction requirements.
- Meet current PBN design criteria.
- Provide independent operations from current procedures at:
    - South Lake Tahoe Airport (KTVL)
    - Reno/Tahoe International Airport (KRNO)
    - Sacramento International Airport (KSMF)
- Be available to the majority of aircraft that use KTRK.

The concepts in this chapter were evaluated from an airspace standpoint with regard to existing limitations and FAA orders; should these concepts carry forward they will require an FAA approved obstruction evaluation to be completed.

3.1.1 Standard Instrument Departure – HARDY & BULOK

Issue to be addressed

There are currently two Instrument Departures available at KTRK:

- The TRUCK FOUR is a Graphical Obstacle Departure Procedure that serves aircraft departing Runway 2 or Runway 29. It is not usable for Runway 11 or Runway 20 due to obstacles.
- The TAHOE ONE RNAV was published on February 4, 2016. It is an RNAV SID that serves aircraft departing Runway 2 or Runway 29. It is not usable for Runway 11 or Runway 20 due to obstacles.

The challenge will be to provide SIDs that can be used for each runway end and meet FAA Performance Based Navigation (PBN) criteria, the additional local criteria provided by the TTAD, and Oakland Air Route Traffic Control Center (ZOA).

Current Conventional/RNAV Conditions

Aircraft departing using the TRUCK FOUR Obstacle Departure Procedure (ODP) depart Runway 2 or Runway 29 following the published procedures in instrument meteorological conditions (IMC) or in visual meteorological conditions (VMC) may execute a Visual Climb Over Airport (VCOA) procedure to transition to the TRUCK intersection before proceeding on course to their destination. Aircraft performing a VCOA make a climbing 365°circle over the airport to gain altitude before turning on course. An example of existing aircraft departures is shown in **Figure 2.5** for Runway 29, the dominate departure runway.

The TAHOE ONE RNAV is a new SID that has not been fully evaluated in this study due to limited operations at the time of the publication of this report.

Preliminary NextGen Concept

A key requirement for the notional concepts was the ability to design SIDs that served all runways. In other words, if a pilot requested a certain SID, the pilot would have the option to depart any runway on that SID and join the National Airspace System (NAS). Although this is a desirable characteristic from an Air Traffic Control perspective, it was impractical due to other considerations such as noise/environmental concerns and the surrounding terrain. With that requirement and the limitations in mind, the consultant team designed two notional SIDs that appear to meet all of the goals set forth above while limiting the number of SIDs to just two, yet serving all runways. A third SID was designed, however since it didn't meet all the project criteria, it was not carried forward. These notional designs will reduce controller workload, provide environmentally friendly (noise reduction) departure procedures, provide terrain and obstruction clearance, provide the option of independent operations from the South Lake Tahoe Airport, and allow departures from all runways.

Aircraft procedure design must include using FAA criteria that determines how an aircraft performs in all circumstances, including mechanical failure and the performance of the slowest aircraft. When designing procedures, they must provide a procedure that includes "one engine out" criteria, which means if a multi-engine aircraft departs and loses an engine, they can still safely clear a 50' obstacle.

The following outlines the two SID concepts that will serve each runway end.

3.1.1.1 HARDY Notional Concept – Runway 20 & Runway 29

Summary: Aircraft departing Runway 29 would climb on the runway heading until approximately one-mile north of the airport over Highway 80. At this point aircraft would then turn to the west and fly to a waypoint just to the west end of Donner Lake, staying south of the Tahoe Donner residential area.

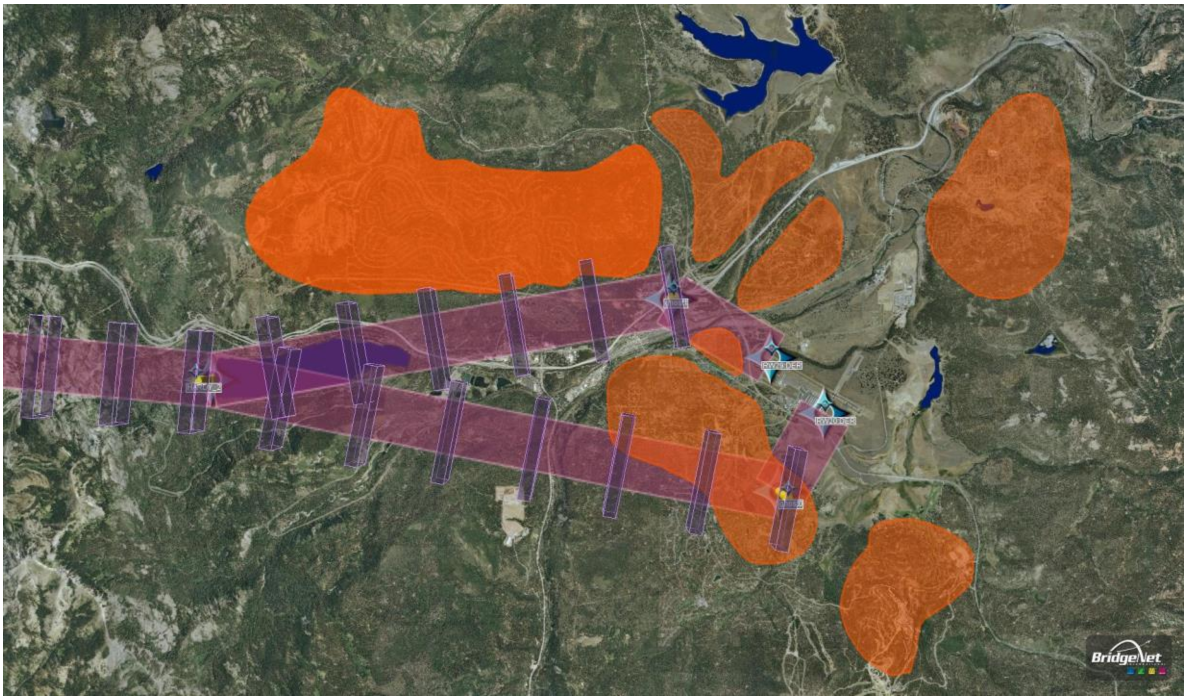
Aircraft departing Runway 20 would climb on the runway heading for approximately one mile and at this point aircraft would turn to the north west to intercept a waypoint just to the west end of Donner Lake.

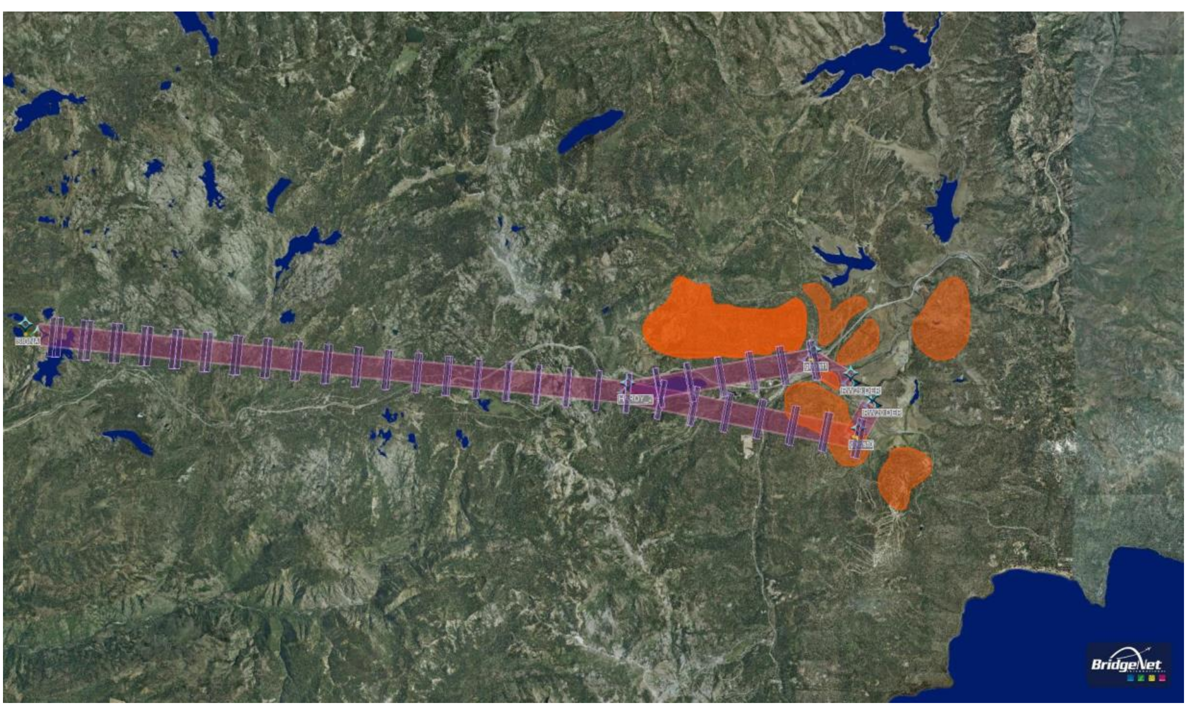
Detail: Aircraft departing Runway 20 or 29 will climb runway heading, 195.98° or 285.99°, respectively, on a "Heading to Intercept (VI) leg" to intercept a "Course to Fix (CF) leg" to the HARDY waypoint, approximately seven miles from the airport.[5] The notional HARDY SID is designed to have aircraft climb at 500 feet per nautical mile departing Runway 29 and 550 feet per nautical mile departing Runway 20 to cross the HARDY waypoint at or above 10,000' MSL and then continue climb to 11,000' MSL. Typically, procedures are named after the common waypoint in the procedure. From HARDY, aircraft continue along an en route transition to the SIGNA intersection. With further TERPS evaluation, climb gradients may be able to be reduced closer to 500 ft./NM – which can be implemented without requiring further approval from Flight Standards. The higher climb gradient for aircraft departing Runway 20 was used for terrain and obstruction clearance. **Figure 3.1**, *Runway 20 & Runway 29 HARDY RNAV SID,* shows the preliminary concept.

The HARDY SID is separated from the KTVL procedures by altitude constraints built into the procedure that ensures vertical separation is maintained until lateral separation is achieved. Aircraft are procedurally separated vertically by 1,000 feet or laterally by 8 miles. For this procedure, the airspace 4 nautical miles (NM) on either side of the HARDY procedure centerline will be protected because the aircraft are operating in a non-radar environment.

[5] Heading to Intercept and Course to Fix legs are design components of PBN procedures. A heading to intercept leg requires a pilot to fly a specified heading after takeoff until intercepting the next leg of the procedure. A Course to Fix leg requires a pilot to navigate via a specific course over the ground to the next fix on a PBN procedure. After arriving at the fix, the procedure will normally continue from fix to fix along a specified route to join and en route segment of the NAS.

Figure 3.1
Runway 20 & 29 Proposed Notional HARDY SID





Source: BridgeNet International, October 2015

3.1.1.2 BULOK Notional Concept – Runway 02 & Runway 11

Summary: Aircraft departing Runway 02 will climb on the runway heading northeast bound until approximately a mile from the airport, just south of Glenshire Road over the aggregate plant, at which point it will turn towards the northwest to intercept a waypoint.

Aircraft departing Runway 11 will climb on the runway heading until approximately a mile from the airport, at which point it will turn towards the northeast to intercept a waypoint approximately 4 miles from the initial turn near Martis Peak Rd south of the Glenshire development.

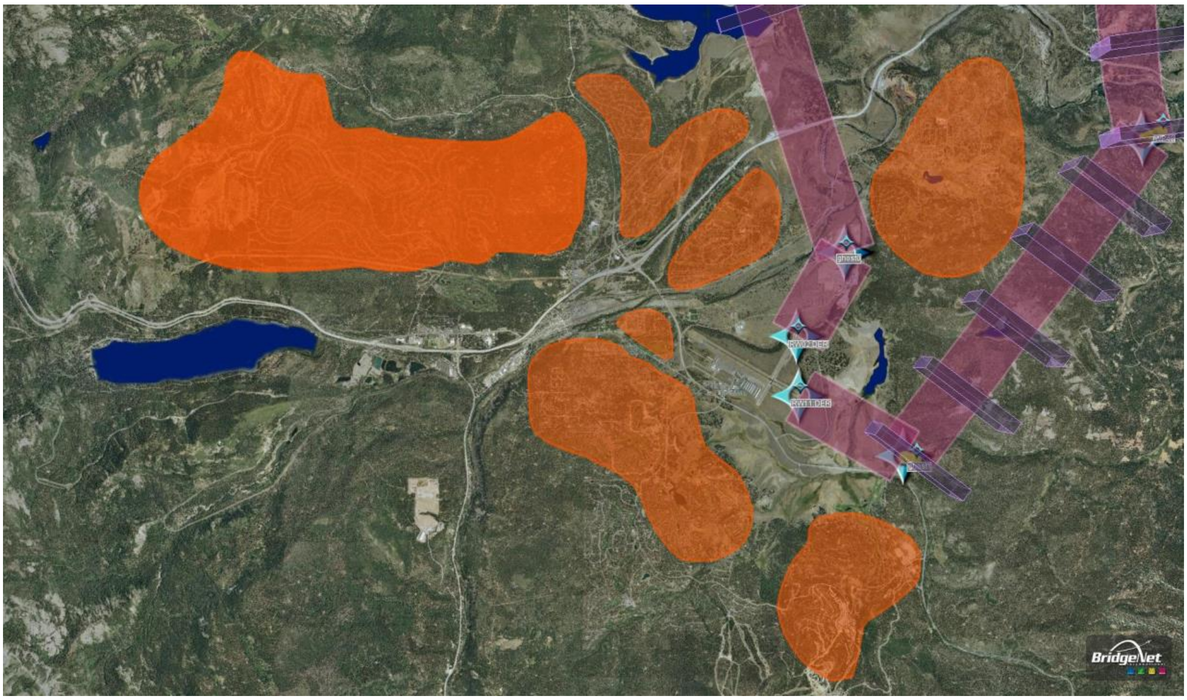
Detail: Aircraft departing Runways 02 or 11 will climb runway heading, 015.99° or 106°, respectively, on a "Heading to Intercept (VI) leg" to intercept a "Course to Fix (CF) leg" and "Track to Fix (TF) leg" to the BULOK waypoint, approximately 15.5 NM northwest of the airport. For Runway 02 departures the departure track is 16.41 NM and for Runway 11 departures the departure track is 22.76 NM from the airport to the BULOK waypoint. The notional SID is designed for aircraft to climb at 500' per nautical mile departing Runway 02 and 633 ft./NM departing Runway 11 until reaching 11,000' MSL. From BULOK, aircraft may continue along an en route transitions to the SIGNA intersection or be vectored or turned on course to the north or east by the controller. With further TERPS[6] evaluation, climb gradients may be able to be reduced closer to 500 ft./NM – which can be implemented without requiring further approval from Flight Standards. **Figure 3.2**, *Runway 2 & Runway 11 Notional BULOK RNAV SID*, shows the preliminary concept.

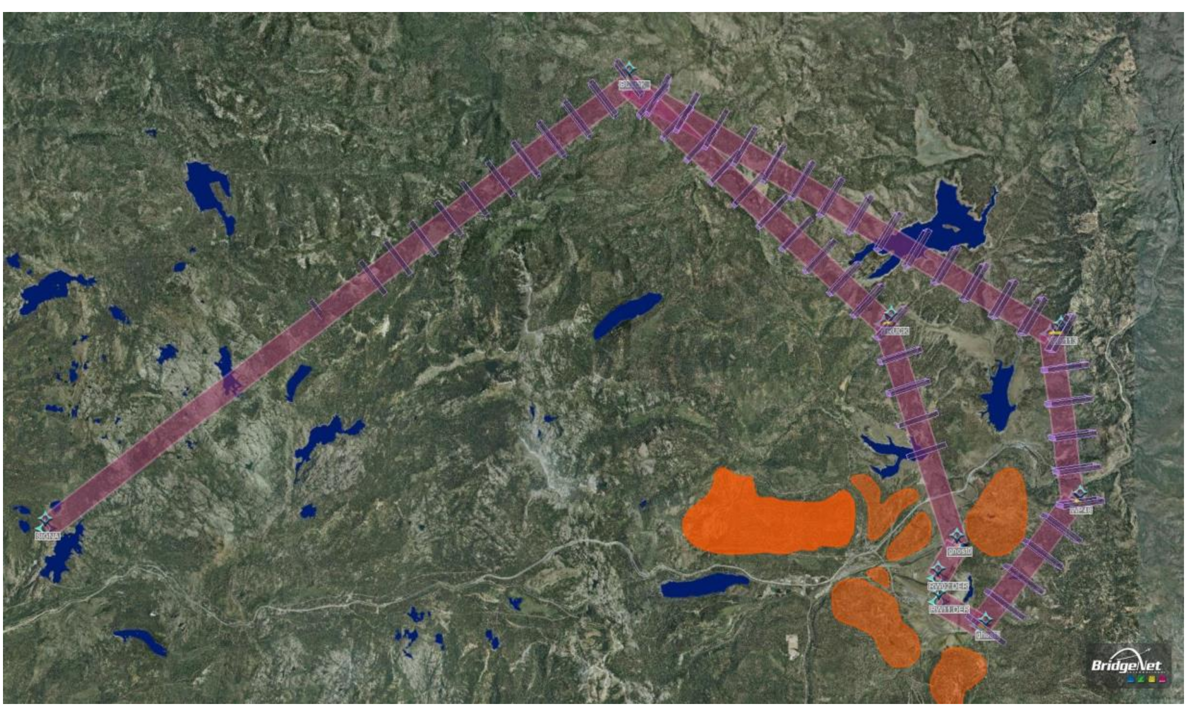
The BULOK SID is separated from the KTVL procedures by altitude constraints built into the procedure that ensures vertical separation is met until lateral separation is achieved. Aircraft are procedurally separated vertically by 1,000 feet and laterally by 8 NM. For this procedure, the airspace 4 NM on either side of the procedure centerline will be protected because the aircraft are operating in a non-radar environment.

Figure 3.3, *Non-Radar Airspace Separation,* shows the separation requirements of the proposed procedures and operations at KTVL. This graphic is a representation of the protected airspace required for the KTRK proposed SIDs and KTVL operations. As the graphic shows, there are three airspace areas, yellow (TRK), blue (TVL) and green (overlap). When aircraft depart the respective airport and are within airspace that does not overlap, they will be procedurally separated from each other laterally contained in the yellow or blue airspace. In the green area where these two airspaces overlap, when aircraft transition through this area, they will be procedurally separated vertically by 1,000 feet or laterally by 8 NM.

[6] Terminal En Route Procedures. TERPs prescribes standardized methods for use in designing instrument flight procedures.

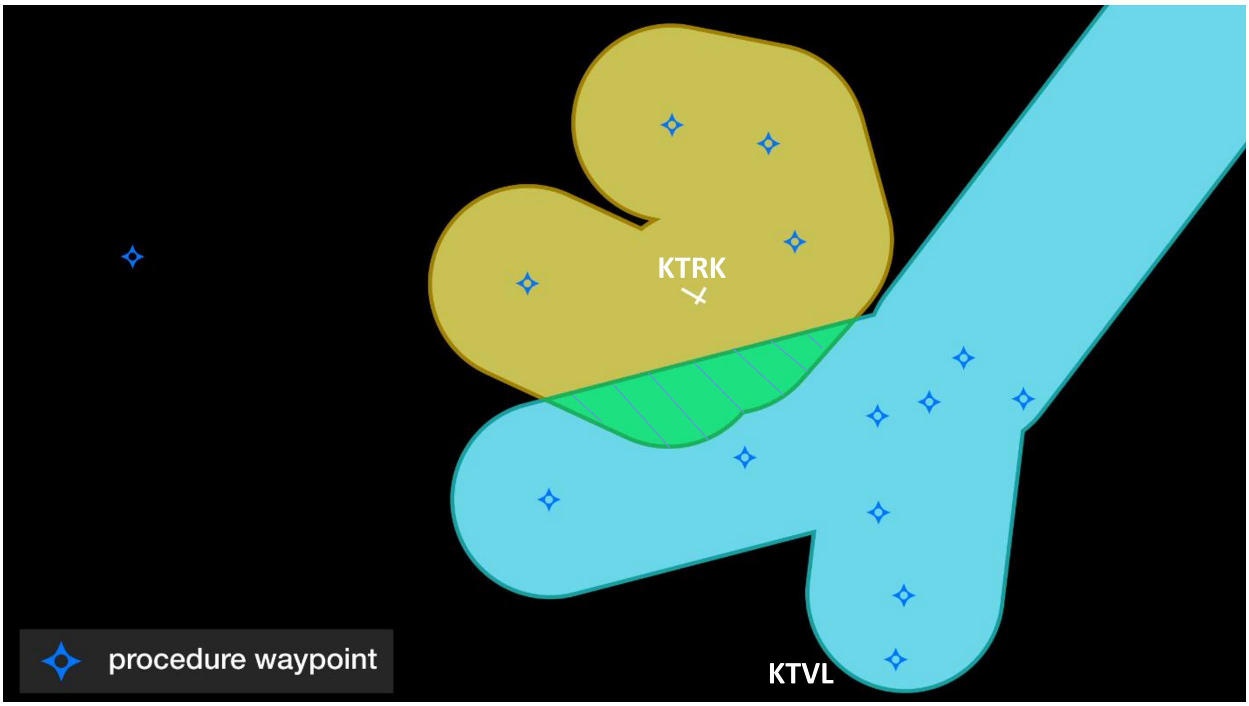
Figure 3.2
Runway 2 & 11 Proposed Notional BULOK SID





Source: BridgeNet International, October 2015

Figure 3.3
Non-Radar Protected Airspace



Source: BridgeNet International, October 2015

The following outline key elements of the proposed notional departure procedures.

Benefits

1. *Data/Comm* – Pilot/controller communications will be reduced because pilots will be flying a defined route that is predictable and repeatable.
2. *Access and Efficiency* – Airspace capacity may be increased during IMC due to pilots having the ability to file a SID from any runway. Airport efficiency may be increased by giving controllers the opportunity to stage arrivals at points closer to the airport because they know the exact route a departure will take. This reduces the amount of airspace that must be protected for a departure and may allow arrivals to be staged at points closer to the airport to commence an approach when the departure is radar identified thus reducing hold times, ground delays and the like.
3. *Safety* – SIDs protect pilots from terrain and obstructions. Flying a SID rather than flying with visual reference to terrain and obstructions in marginal conditions will increase safety when departing the airport.
4. *Environmental* – The SIDs have been notionally designed to provide environmentally friendly departure routes. If the SIDs are flown as published, even during VMC the predictable and repeatable routes will ensure the most environmentally friendly routes available, given the surrounding terrain, will be flown.

Technical Factors

Climb Gradients – Climb Gradients (CGs) evaluated in the notional SID designs range from 500-633 feet per nautical mile. Higher CGs may place a limitation of the types of aircraft that will be able to fly these procedures due to aircraft performance limitations. Turboprop and jet aircraft that are capable of climb rates of 1500-2600 feet per minute will be able to fly at least one of these notional procedures.

FAA waivers – Criteria allows for FAA approval of CGs in excess of 500 feet per nautical mile; these proposed, notional procedures will require such approval. Additional evaluation and approval may be required by the FAA to reduce the Minimum Instrument Flight Rules (IFR) Altitude (MIA) along Airways at the TRUCK and SIGNA intersections to accommodate aircraft leveling off at 11,000’ MSL instead of the presently required 11,500’ MSL. The other option may be to extend the SID En Route Transitions along the desired routes of flight if they will provide a lower MIA.

Safety Management System Requirements – Since these procedures constitute a change to the National Airspace System that will not only require TERPS evaluation but also changes to ZOA Standard Operating Procedures, a Safety Risk Management Panel (SRMP) must review all proposed changes and identify, assess and mitigate any risk associated with the implementation of these procedures.

New separate Visual Climb Over Airport (VCOA) procedure for all runways – In addition to the notional SIDs, it is recommended that new VCOA procedures be designed to take advantage of climbs in VMC for departures from all runways. Current VCOA procedures are not available for Runways 11 and 20.

VMC Noise Abatement Procedures – If new VCOA procedures are designed, consideration should be given to developing more formalized VMC departure routes for the airport.

3.2.1 Notional Approach Procedures

This section presents the parameters within which approach procedures can be designed. These procedures are a result of the consultant team drafting notional procedures that were then discussed with ZOA staff for their initial input. The notional procedures take into consideration flyability, air traffic, environmental and access concerns.

Issue to be addressed

At KTRK, there are published RNAV (GPS) arrival procedures for Runway 11 and Runway 20. These procedures, described below, aren't used on a regular basis due to their procedural conflict between KTRK arrivals and arrivals to KRNO and Sacramento International Airport (KSMF). The issue to be addressed is providing published arrival procedures that can be used by the majority of aircraft at KTRK and for each runway end.

KTRK has four runways and three total instrument approaches: Runway 11 has one procedure and Runway 20 has two procedures. All approaches are satellite based RNAV (GPS) approaches without vertical guidance containing two different types of minima: LNAV and LP. Both of these designs are outlined in FAA Order 8260.58. Within this FAA criteria document, guidelines are specific with regards to protocol for utilization of LNAV only, LNAV/VNAV, or LP/LPV based procedures, which will be discussed in this section.

Current Conventional Conditions

Aircraft arrive using LNAV and LP procedures, primarily on Runway 20 and Runway 11. KTRK has approaches with two different types of minima: LNAV and LP, described in Section 1.1.2 "NextGen Programs" and outlined in FAA Order 8260.58. This Order has specific guidelines regarding protocol for utilization/design of LNAV only, LNAV/VNAV, or LP/LPV based procedures based on local conditions, i.e. terrain, access, technology, etc. Due to surrounding terrain, some FAA required Obstacle Clearance Surfaces (OCS) are penetrated by terrain and thus preclude night landings for Runways 02, 11, and 29.

Runway 11 Existing Procedures

Runway 11 has one RNAV (GPS) approach with a single LNAV line of minima providing a minima (minimum decision height) of 8,160’ MSL. The final approach course is offset to the left by 22 degrees and is 8.6 NM in length, including each of the approach fixes starting with the Initial Approach Fix and terminating with the Final Approach Fix. Outside of the Final Approach Fix (FAF), the Initial Approach Fix/Initial Fix (IF/IAF) provides a holding pattern for aircraft arriving from the southeast to the southwest to reverse course for the approach. The glide path angle is 3.77 degrees for Category (CAT) A, B, and C approaches, which defines aircraft that have approach speeds less than 91 to no more than 141 knots. Although current criteria limit CAT C aircraft with a glide path angle of 3.6 degrees, this approach permits CAT C with a 3.77-degree glide path; a standard glide path is 3.0 degrees.

Aircraft are categorized by their approach speed for arrivals in Category A – E. At KTRK, the majority of aircraft are in Category A – C, which include single-engine propeller aircraft up through large business jets. Category A aircraft have approach speeds less than 91 knots, Category B aircraft approach at speeds between 91 – 121 knots, and Category C aircraft approach at speeds between 121 – 141 knots. The majority of business jets and high performance turbo-propellers at KTRK are in Category C.

Runway 20 Existing Procedures

Runway 20 offers two different approaches: RNAV (GPS) Y & Z. The designators of Y & Z indicate that the lines of minima are different for each approach, with Z being lower than Y; aircraft using RNAV (GPS) Z would have lower approach minimums to the runway, allowing the aircraft to descend to a lower altitude before making a decision to execute the approach or perform a missed approach. The RNAV (GPS) Z isn’t used very often because of the airspace conflict with the missed approach procedure at KRNO. Both approaches offer LNAV & LP lines of minima. The difference between the Y and Z approaches is that Z commands a climb gradient in the Missed Approach Segment (MAS) of 310’/NM to an altitude of 9,200’ MSL, whereas the Y approach only assumes a standard MAS climb of 200’/NM. The 200’ MAS is a shallower climb that can be used by all categories of aircraft that operate at KTRK.

Preliminary NextGen Concept

When aircraft are on arrival to an airport, they establish themselves on a Standard Terminal Instrument Arrival Route (STAR) when descending from level, en route flight to a terminal airport environment. When designing aircraft arrival procedures, many of the changes take place to STARs, which in the case of KTRK, are not within the descried Study Area but further out.

For arrivals, this report will present the parameters within which approach procedures must be designed. Unlike the departure procedures, the arrival procedures are more focused on modifying existing procedures rather than creating new procedures. As with the departures, these changes will be advocated with the FAA.

KTRK is surrounded by mountainous terrain, which for the purposes of designing arrival procedures is called precipitous terrain. Order 8260.58 prohibits vertically guided approaches when remote altimeters are used and when in precipitous terrain such is the case at KTRK. This is noted in the current KTRK approach designs, as each of these are laterally guided approaches only. Given this constraint, the analysis and discussion of options only focuses on LP and LNAV (lateral only) approaches since this project's focus is on technology that can currently be implemented. These procedures contain a minimum descent altitude, but do not provide a Flight Management System (FMS) coded glide path angle for the aircraft navigation system to follow, which would give vertical guidance.

The following analysis of proposed approaches used these data sets: Shuttle Radar Topography Mission (SRTM) terrain data and obstacles from the FAA Digital Obstacle File (DOF) database. Should the TTAD choose to pursue the feasibility of this analysis, the terrain and obstacle data would have to be refined and updated which may lead to different results. Therefore, the numbers proposed below are approximate and should be treated as a concept level document.

The approach procedures reviewed include:

- RNAV – use of NextGen navigation for approach to KTRK.
- Required Navigation Performance-Authorization Required (RNP-AR) – aircraft used advanced NextGen navigation using precise paths.
- Offset Approach – aircraft approach the airport at a prescribed offset degree from the runway.
- Localizer Performance (LP)
- Lateral Navigation with Barometric Vertical Navigation (LNAV/VNAV)

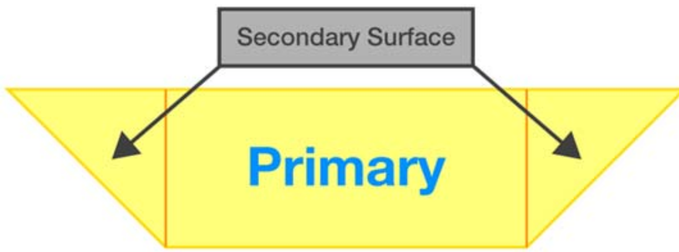
3.2.1.1 LNAV Lines of Minima

It was noted that the option for LNAV/VNAV (Lateral Navigation with Barometric-Vertical Navigation, a.k.a. FMS-generated glide path to the runway) lines of minima were not used by the FAA when constructing the existing KTRK Instrument Approach Procedures. The Order specifies the parameters under which Vertically Guided approach procedures can be used; this includes approaches with a published glide path angle: *the approach must not utilize a Remote Altimeter, nor overly precipitous terrain* (emphasis added). A review of the TERPS criteria for the KTRK approaches shows that a Precipitous Terrain evaluation was completed and found to be present for the airport. Therefore, it is not possible to publish approach procedures with vertical guidance into KTRK. Therefore, the instrument approach designs depend on the utilization of LNAV and LP only.

There are two imaginary surfaces in LNAV approaches, primary and secondary. The primary surface is a rectangular, flat surface that is 250' above the highest point in the primary area. The secondary surface is a sloping surface at the outer edge of the primary surface that starts at 250' and slopes down to 0'. When using LNAV lines of minima the final approach segment must maintain a minimum Obstacle Clearance Surface (OCS) of 250' above the highest point in the primary area, with this clearance sloping up to 0' in the secondary's, as shown in **Figure 3.4**, *Obstacle Clearance Surfaces, Side View*. **Figure 3.5**, *LNAV Final Approach Segment, Top Down View,* shows a top-down view of the primary and secondary surfaces.

Figure 3.4

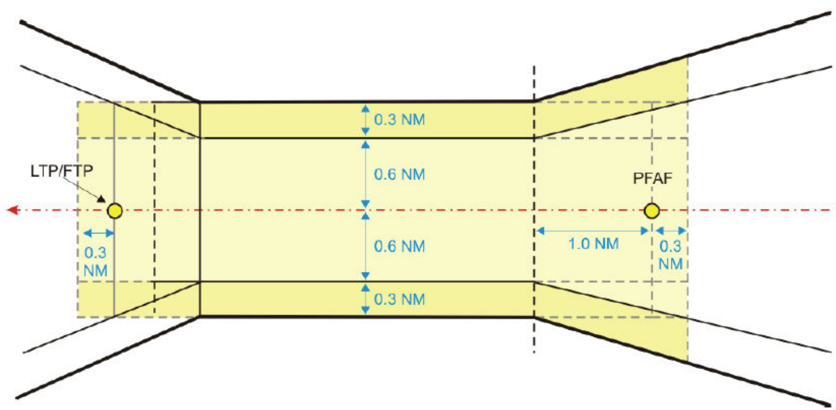
Obstacle Clearance Surfaces, Side View



Source: BridgeNet International, January 2015

Figure 3.5

LNAV Final Approach Segment, Top Down View

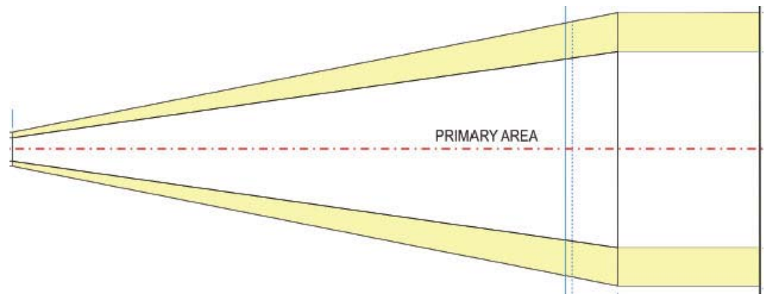


Source: FAA Order 8260.58 Volume 6

Approaches with an LP (Localizer Performance) line of minima are a type of Wide Area Augmentation System (WAAS) approach, similar to LPV (Localizer Performance with Vertical). WAAS was described in Section 1.1.2 "NextGen Programs." However, as with LNAV/VNAV type approaches discussed above, LPV approaches are not authorized in areas of precipitous terrain. Therefore, LP is used with its flat 250' obstacle clearance surface.

LP approaches provide an advantage over LNAV approaches as the final approach area is trapezoidal similar to an ILS; **Figure 3.6**, *LP Final Approach Surface,* shows this distinction. It is important to note that only aircraft equipped with a WAAS receiver are eligible to fly LP or LPV approaches. For aircraft without this capability, LNAV is available in KTRK.

Figure 3.6
LP Final Approach Surface



Source: FAA Order 8260.58 Volume 6

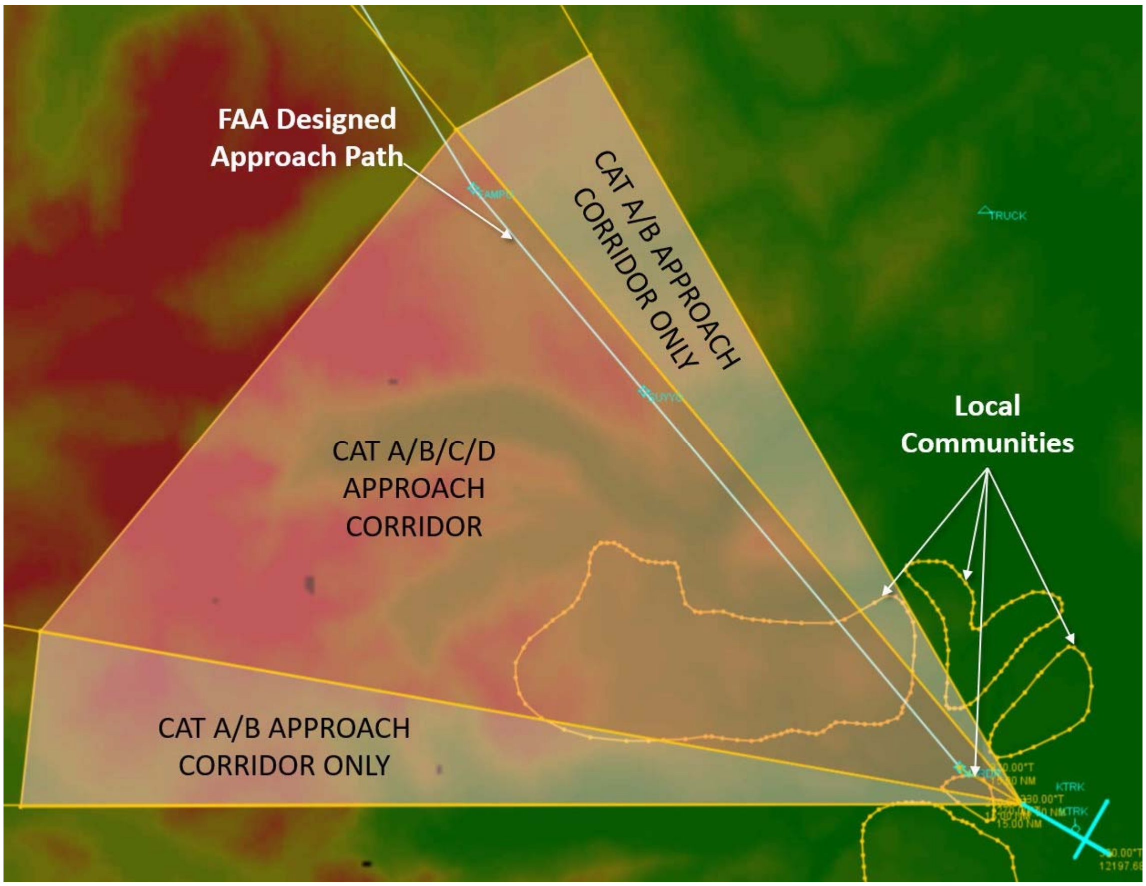
3.2.1.2 Runway 11

Alternate approach paths were analyzed for Runway 11 by importing the FAA approach, runways, and surrounding communities into the TARGETS software program that allows an overall perspective of the options available.

The existing FAA approach path shown in **Figure 3.7**, *Runway 11 Offset Approach*, transits the far eastern side of the Tahoe Donner community. Reviewing possible alternate approach paths to this runway, three corridors were drawn highlighting FAA Order 8260.58-approved offset arrival paths for Runway 11. An offset arrival path means an aircraft is not approaching the runway on a straight-in path; the aircraft is utilizing an approach that is at an angle to the runway, defined in degrees. Category A – D aircraft are permitted an offset up to 20 degrees. From 20+ to 30 degrees, only Category A and B are permitted (small aircraft, usually propeller driven). Considering the impact to local communities, the Category A/B approach corridors provide the greatest option, although this would exclude Category C and D aircraft (business jet). The central corridor allowing for Category A – D aircraft encapsulates most of the Tahoe Donner community. The Consultant team recommends retaining the current approach for Runway 11, yet designing new transitions that tie into new Standard Terminal Arrival Routes (STARs) or the enroute environment that provide an opportunity reduce the impact of overflights to communities' north of the airport.

Figure 3.7

Runway 11 Approach Offset



Source: ABCx2, January 2015

In an effort to provide a complete analysis relative to the concerns of the airport, the consultant team reviewed an RNAV Visual procedure concept. **Figure 3.8**, *Runway 11 RNAV Visual Concept*, illustrates a potential RNAV visual concept. In this figure, the pink line north of the FAA designed approach path can be designed to position a flight corridor to the Runway 11 approach end that follows a path between the Tahoe Donner and Prosser communities. The proximity of each waypoint to the next is necessary to define this flight path; however, the required proximity does not pass FAA criteria for an instrument approach, and thus cannot be used as such. It can, however, be an RNAV visual.

Figure 3.8
Runway 11 RNAV Visual Concept

Source: ABCx2, January 2015

3.2.1.3 Runway 20

Runway 20 is the other runway at KTRK with existing FAA designed approaches: RNAV (GPS) Y and RNAV (GPS) Z. Both approaches share identical approach paths, missed approach lateral paths, and contain LP and LNAV lines of minima. The difference between the approaches lies in the missed approach climb gradient requirements. The Z approach requires a climb of 310'/nm to 9,200 MSL. The approach path is offset from the runway heading by 14 degrees. With the missed approach point (WINUB) 0.8 NM from the extended centerline.

The FAA designed path lies west of the Glenshire community. Given its proximity and lines of available minima, the BridgeNet Team does not recommend any broad changes to these procedures with the exception of transitions from future STARs or enroute feeder fixes.

The documentation for the KTRK RNAV (GPS) RWY 20 procedures was dated in 2013 and subsequently updated in April 2015. The precipitating event for the 2015 updates were driven by KTRK's request to remove restrictions for night operations to Runway 20 as the offending obstacles and limitations were addressed. Runway 20 remains the only available runway during night operations.

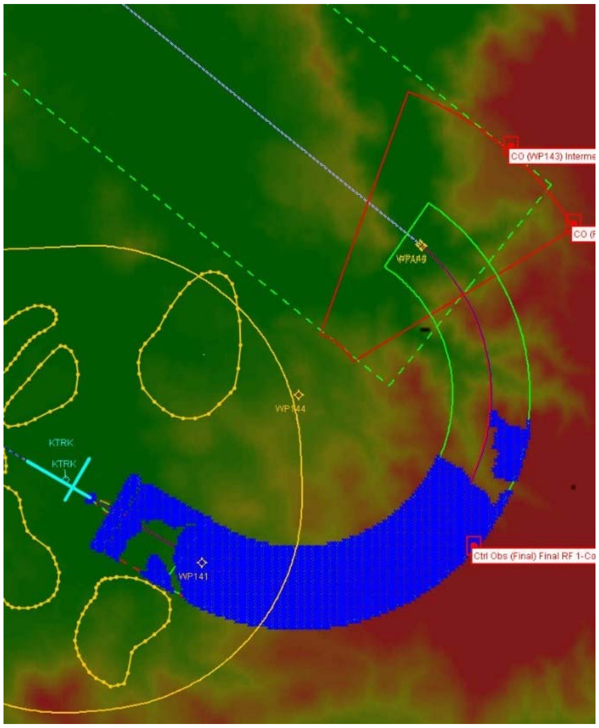
3.2.1.4 Runway 29

The proximity of Runway 29 to the local terrain poses the greatest challenges with respect to approach procedure design and correspondingly does not have any current instrument procedure designs for approaches. Approximately 3 NM from the approach end of the runway, the terrain begins a rapid climb making a straight-in approach not possible.

In an effort to explore all possible approach procedure design concepts to this runway, an RNAV (RNP) Authorization Required (AR) approach was first explored. Given the airport altitude, the descent gradient needed to remain above terrain, assumed tailwind associated with this altitude, and true airspeed for the elevation, the turn radius required for a Radius-To-Fix leg (RF) was 2.80 NM. This would necessitate a significant portion of the turn from downwind to final was over steep terrain and thus sufficient glidepath to terrain clearance would not be attainable. Attempting to minimize this terrain limitation, the final rollout point for Runway 29 was located at 2 NM from the threshold. As with previous designs, this was not sufficient to provide the necessary terrain clearance. In **Figure 3.9**, *Runway 29 Arrival RNAV RNP/AR Concept,* the blue area of the RNAV RNP AR approach indicates the areas of the arrival path that has limitations due to terrain.

Figure 3.9

Runway 29 Arrival RNAV RNP AR Concept



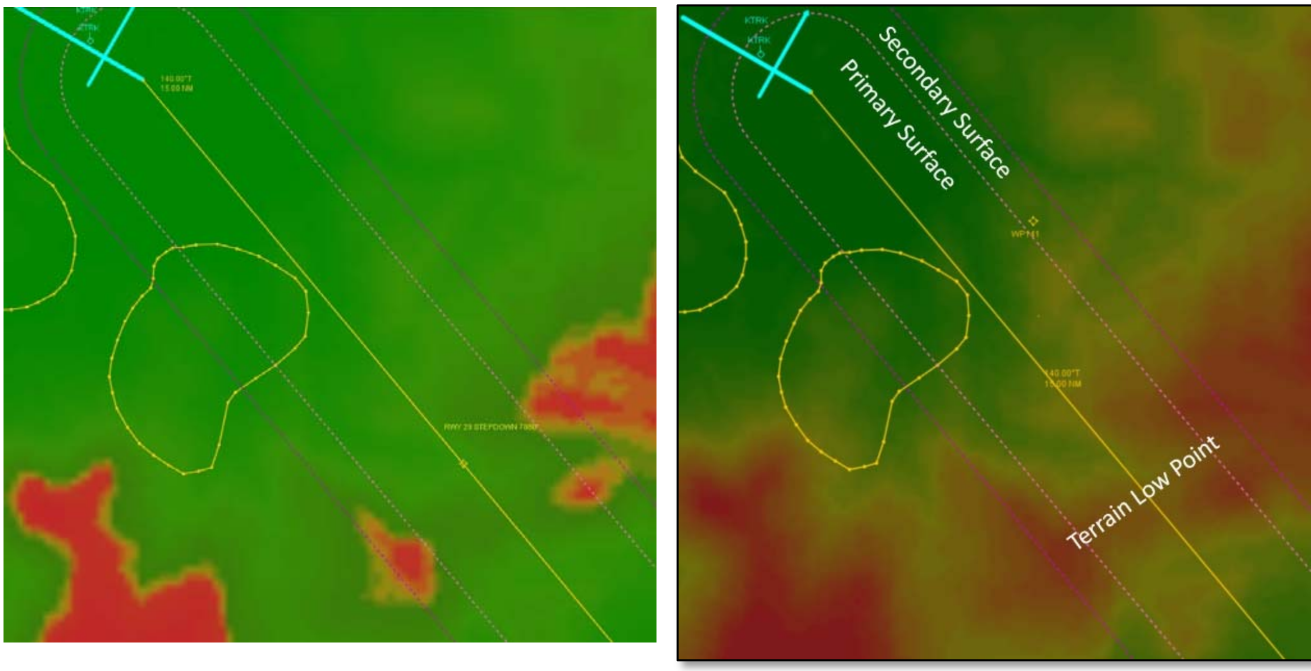
Source: ABCx2, January 2015

As with the analysis of the other runway ends, an offset approach analysis was performed. **Figure 3.10**, *Runway 29 Arrival Offset Approach*, shows this concept. A right offset of 20-degrees provided a path through a relative low point in the surrounding terrain. This course position was bounded by terrain height of 7,600+’ MSL on both sides of the secondary approach surfaces. The 20-degree offset allowed the flight path to be possible to Category A – D aircraft. With the course set, an evaluation was performed on the highest terrain point within the Primary and Secondary surfaces. The controlling elevation was identified as 7,620’ MSL (7,820’ with the AAO). A waypoint was placed on the final approach course abeam this altitude and a 250’ Required Obstacle Clearance height was attached as a stepdown fix to the runway.

The stepdown fix, with an associated altitude of 8,070’ MSL provided a 5.10-degree glideslope to the approach end of Runway 29. This glidepath disqualifies all approach categories except Category A; a standard glidepath is 3.0 degrees.

Figure 3.10

Runway 29 Arrival Offset Approach



Source: ABCx2, January 2015

3.3 Amend Current Arrival Procedures

In January 2016, meetings were held between Oakland Center (ZOA) and members of the consulting team where the above analysis was reviewed relative to the project's intended goals. ZOA indicated that amendments to the current KTRK Instrument Approach Procedures were in process. However, documentation of the changes was not currently available. This analysis focuses on the current procedures only.

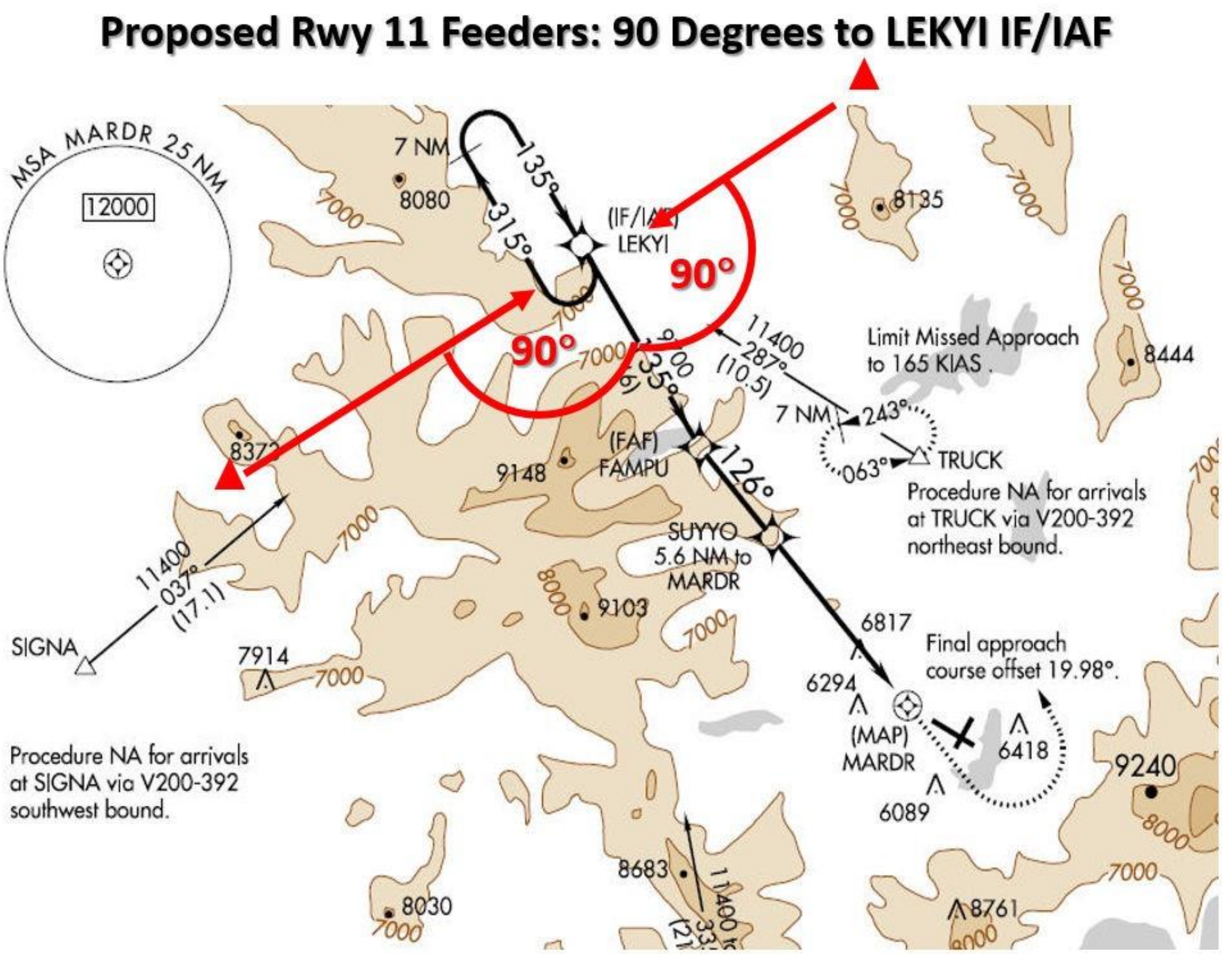
3.3.1 RNAV (GPS) RWY 11 – FEEDER FIX AMENDMENT

The current design of the RNAV (GPS) RWY 11 is a straight-in procedure with LEKYI waypoint as the initial fix/initial approach fix (IF/IAF) and a holding pattern for course reversal for arrivals from SIGNA and TRUCK waypoints. This reversal provides air traffic delays into KTRK and increases the workload for ZOA. Discussions with the ZOA controllers indicate that amending this instrument procedure to provide a "Feeder Fix" entry allowing aircraft to turn straight onto the approach path, rather than course reversals in the holding pattern, is preferred and will benefit all stakeholders.

FAA Order 8260.58 allows for Feeder Fixes to be utilized in this instance provided the inbound headings are within 90 degrees of the inbound leg course, provide for a lead turn from the feeder to the inbound course, and are shorter than 500 miles. In **Figure 3.11**, *Runway 11 Proposed Feeder Fixes,* two new Feeder Fix proposals are offered from the southwest and northeast arrivals that provide an inbound path to LEKYI at a 90-degree offset. This will provide a smooth transition to the approach course while providing ZOA a means to vector directly to the instrument approach procedure.

Figure 3.11

Runway 11 Proposed Feeder Fixes

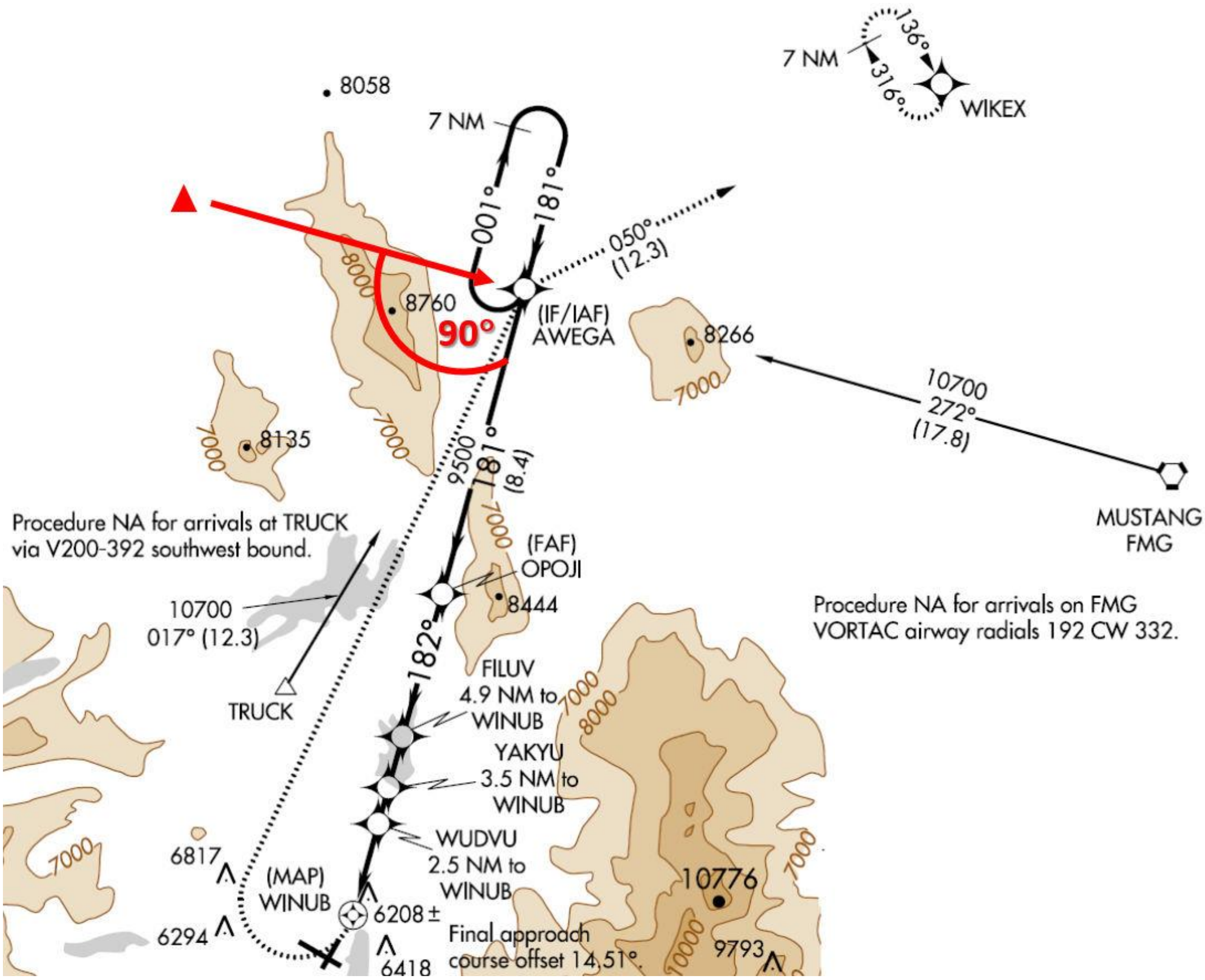


Source: ABCx2, January 2015

3.3.2 RNAV (GPS) RWY 20 FEEDER FIX AMENDMENT

The ZOA controllers made similar recommendations to the RNAV (GPS) approaches for Runway 20 – direct Feeder Fixes to the existing procedure IF/IAF. Presently, the Mustang (FMG) waypoint provides a Feeder to the IF/IAF however, its length precludes expeditious flow of traffic in a heavy flight corridor. **Figure 3.12**, *Runway 20 Proposed Feeder Fixes,* highlights the addition of a Feeder Fix from the northwest. Correspondingly, the consultant team recommends the Feeder from FMG be shortened to facilitate traffic.

Figure 3.12
Runway 20 Proposed Feeder Fixes



Source: ABCx2, January 2015

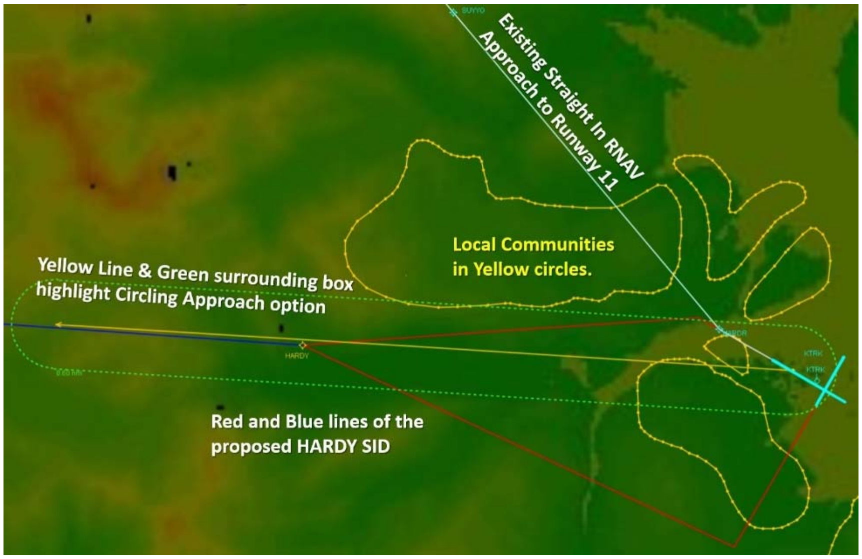
3.3.3 Circling Approach Procedure Option – Notional Design

As noted previously, the predominant weather at KTRK is Visual Flight Rules (VFR), defined as cloud ceilings above 3,000 feet and visibility above 3 miles. The circling approach lines of minima for the airport is 2,600-foot ceiling and 3 miles of visibility (Category C aircraft). Circling aircraft are able to access the airport a majority of the time because the circling minima are within VFR criteria.

Circling approach options were also explored for the airport from various geographic locations. The path overlaying the proposed HARDY SID provides the best path clear of terrain to allow an alternate route to land for aircraft arriving from the west. In **Figure 3.13**, *Notional Circle Approach Procedure,* the proposed circling approach (RNAV-A) overlays the same terrain corridor as HARDY SID, seen in yellow with a green box highlighting the path. This option would provide a shorter flight path to the airport for aircraft arriving from the south and southwest while avoiding many community areas.

While a viable approach option, this path also contains a defined risk. During VFR days with a cloud ceiling and visibility permitting the usage of this approach, many aircraft departing the airport may elect to depart VFR, without an IFR clearance, and follow the same corridor as the HARDY SID path. As a result, aircraft could be descending and climbing along the same flight corridor. It is recommended that KTRK assess the risks and benefits of this concept prior to implementation.

Figure 3.13
Notional Circle Approach Procedure



Chapter 4 Land Use

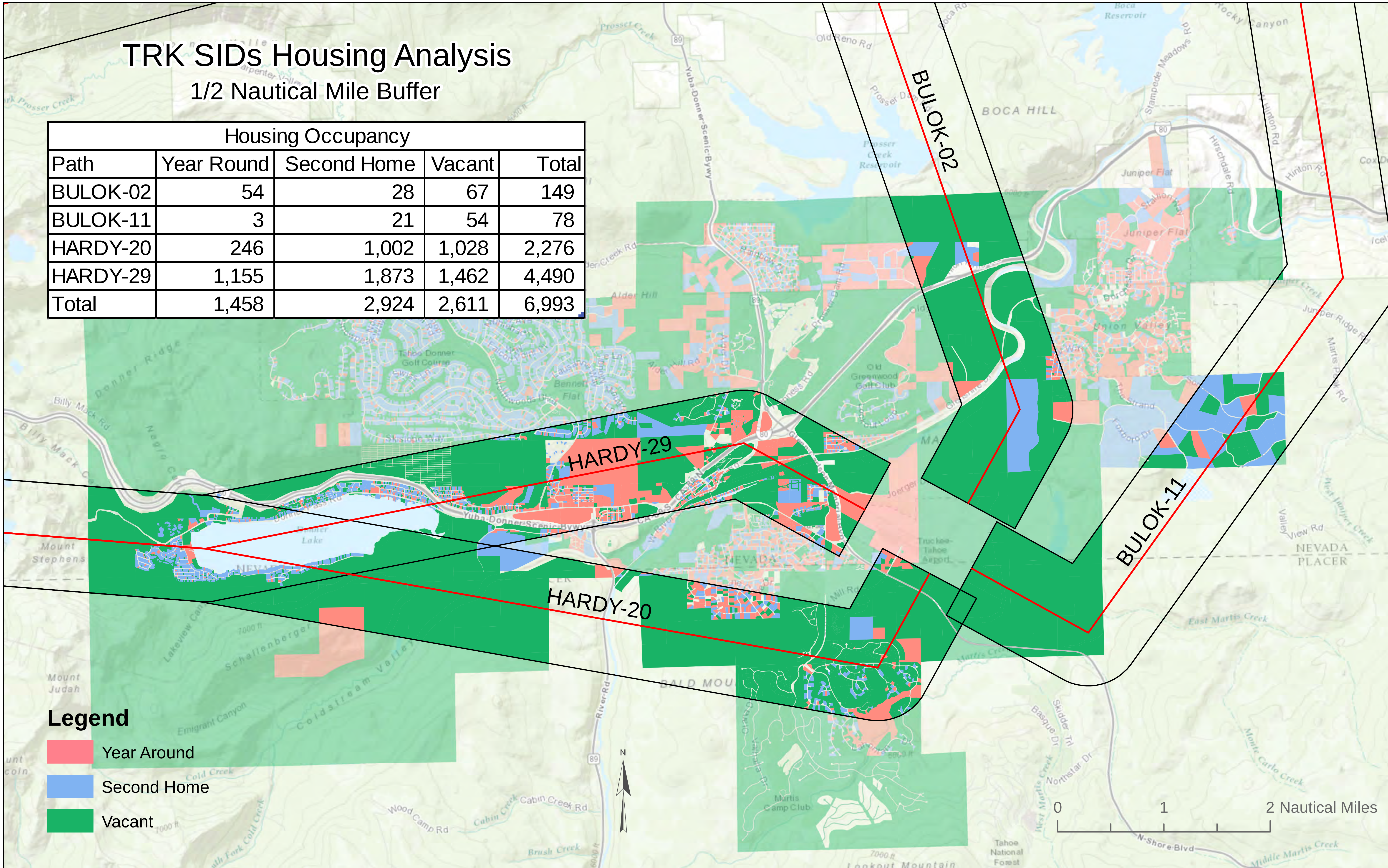
For each of the notional procedures presented in this report, a land use analysis was conducted to determine the land uses and population affected by aircraft activity. One of the goals of this project is to maintain the airport's long-standing environmental (noise) stewardship and try to decrease the population affected by aircraft operations.

Table 4.1 shows the land use, by housing type, for each of the proposed procedures.

TRK SIDs Housing Analysis

1/2 Nautical Mile Buffer

Housing Occupancy				
Path	Year Round	Second Home	Vacant	Total
BULOK-02	54	28	67	149
BULOK-11	3	21	54	78
HARDY-20	246	1,002	1,028	2,276
HARDY-29	1,155	1,873	1,462	4,490
Total	1,458	2,924	2,611	6,993



Chapter 5 Next Steps

As the project progresses, the notional designs will be refined. As they are refined, land use totals will be evaluated. The land use will evaluate primary, secondary, and vacant parcels.

As the notional designs are refined, the consultant team will prepare information for the public, including general project information and specific notional design information. TTAD will hold an open house for the project to solicit public comment and present project information to citizens.

5.1 Future Concepts

This report has focused on arrival and departure procedures that can be implemented within today's FAA design criteria. While this drove our main analysis, the consultant team was also tasked with determining a path ahead should the airport wish to try to implement a procedure outside of existing design criteria.

As of the writing of this report, FAA criteria for STARs and approaches do not support Standard Instrument Approach Procedures (SIAP) to Runway 02 or Runway 29 without using extremely high circling minima. Due to the terrain surrounding KTRK, finding arrival and departure alternatives is challenging, if not impossible, within existing FAA criteria.

One of the ways to move criteria forward is to design future concepts that can be used in VFR to add a margin of safety while proving a concept and gaining utility. In the case of KTRK, the weather supports the utilization of such procedures the vast majority of the time. Designing an RNAV Visual Flight Procedure (RVFP) may prove to be a viable alternative to conventional or RNAV SIAPs and provide an operator friendly, and environmentally friendly, approach path to an otherwise inaccessible runway environment.

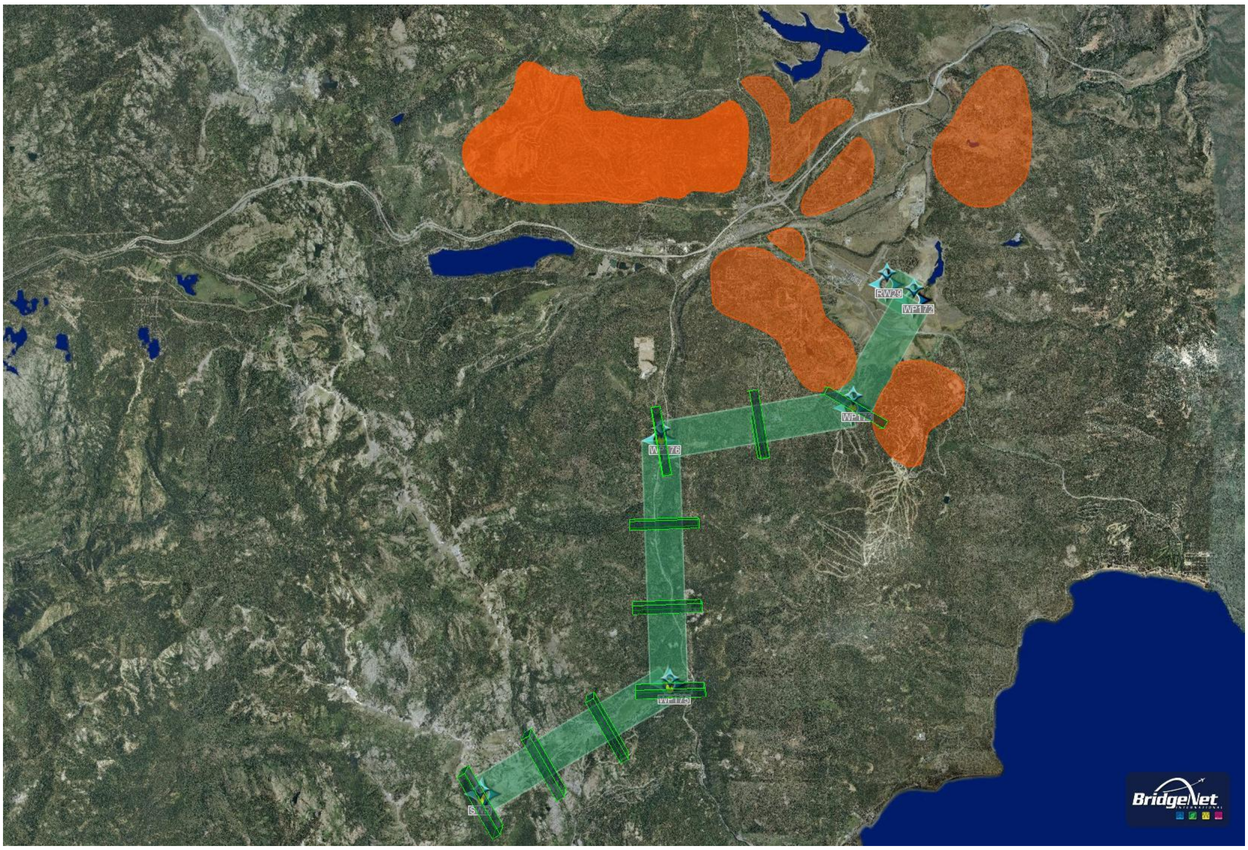
The concept would be to build an approach that pilots can fly with confidence in VFR that would provide a predictable, repeatable RNAV path to the runway within normal operating parameters of the aircraft. Additionally, this path would also be designed to provide an environmentally friendly arrival path so as to minimize any noise or visual disturbance to people on the ground.

The reason this can be done is that RVFPs are not required to comply with the stringent criteria imposed upon SIAPs. This is due to the requirement of the pilot to provide his own terrain and obstruction clearance and to be able to fly visually to the airport. The RVFP merely assists the pilot by providing an RNAV path from the en route environment to the runway. But the pilot remains responsible for the safe operation of the aircraft in VFR and must be able to keep the airport, or the traffic she is following, in sight at all times throughout the approach. This added level of safety allows RNAV paths to be constructed outside the normal criteria and can be used and modified over time to develop new and improved criteria that may eventually lead to implementation of SIAPs to Runway 2 and 29 at KTRK.

One such example is included here in **Figure 5.1**, *Runway 29 RNAV Visual Concept*. This notional STAR/RVFP would allow aircraft approaching KTRK from over Squaw Valley VOR to fly a path to the most used arrival runway on an environmentally friendly path with a pilot friendly descent gradient of approximately 395 feet per nautical mile from 11,000 feet MSL to the runway. The initial part of the procedure would be an RNAV Standard Terminal Arrival Route (STAR) that would allow for an aircraft to transition from Instrument Meteorological Conditions (IMC) to VMC, a similar term for VFR. Once in VMC, the pilot would report the airport in sight and receive clearance for the RVFP.

The path intuitively follows the lowest terrain into the airport and allows the pilot to roll out on a short final within ½ mile of the runway. This notional RVFP does not comply with standard instrument approach procedure design criteria, but would be flyable by most aircraft that fly into KTRK.

Figure 5.1
Runway 29 RNAV Visual Concept



Source: ABCx2, January 2015

To implement this procedure would require approval from FAA Flight Standards, rigorous safety analysis, and multiple flight demonstrations to prove the flyability of the procedure. This type of procedure currently falls under FAAO 8260.55 as revised and would be considered a “Special Flight Procedure” which would have to be distributed to pilots and operators in accordance to FAA regulations.

KTRK underwent a separate project to research and design a special procedure with a specific operator; that project was not carried forward. The intent of this airspace project was to research and look at the possibility of designing a special procedure available to all operators using the FAA’s guidance for creating an RNAV Visual. The original RNAV Visual concept for TRK was created for one company; it was not intended to be distributed to all users and had a different scope that wasn’t intended to look at the broader airspace. This procedure would be controlled by the Airport in that it has the ability to manage and distribute the procedure to all operators. This is considered a future concept because approval a public RNAV Visual is still conceptual with the FAA; special RNAV Visuals are not being approved by the FAA at this time. This RNAV Visual concept is ready to be carried forward for KTRK when the FAA will approve RNAV Visual special procedures. This study is reviewing the RNAV Visual from a perspective that includes a larger study area beyond the protected airspace for the specific procedure with additional goals.

Design and implementation of such a procedure could take upwards of two years to develop, test and implement. It would require a “Lead Operator” that would be willing to test the procedure in a simulator to assess the flyability of the procedure and it would require a full Safety Risk Analysis and approval from numerous divisions within the FAA prior to implementation.

However, the potential benefit of providing an environmentally friendly approach path that is predictable and repeatable along with the potential for the procedure to evolve into a SIAP that can be used in Instrument Meteorological Conditions (IMC) may be something that the Truckee-Tahoe Airport District would be willing to consider in the future.