DATE: January 31, 2013

TO: Kevin Bumen
Director of Aviation and Business Services
Truckee-Tahoe Airport

FROM: Pete Elmore
VP, Aviation Operations
BridgeNet International

SUBJECT: Truckee-Tahoe Wide Area Multilateration (WAM) Analysis

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The Truckee Tahoe Airport (TRK) is a community airport that provides high quality aviation facilities and services to meet local needs, and strives for low impact on their neighbors while enhancing the benefit of the community at large. TRK covers an area of approximately 990 acres at an elevation of 5,900 feet msl. It has two asphalt paved runways; runway 11/29 is 7,000 by 100 feet and runway 2/20 is 4,650 by 75 feet. The airport handles approximately 30,000 operations per year and is somewhat seasonal in its usage. In addition, the majority of the traffic volume is compressed into Fridays and Sunday/Mondays. TRK is 20NM from the nearest airport served by an air carrier (Reno, NV – KRNO). However, due to the terrain, the distance by car is 38 miles, and takes a minimum of 43 minutes.

The airport environment is dominated by the local terrain and sits is an almost complete "bowl", with only a narrow pass on either side of the airport. Peaks of local terrain exceed 10,000' msl, and both contribute to the attraction of the airport through local resorts, and limit the traffic into and out of the airport.

The airport is very active in noise abatement and management programs, and commits various resources to endeavor to achieve a balance with the local community. The WAM system was acquired in 2010 to assist the airport with data collection and communication with the community and flight crews.

The focus of this paper is the potential opportunities and impact of integrating the WAM system at TRK into the National Airspace System (NAS) for use by the Air Traffic Offices (ATO).

SAFETY

A review of the NTSB accident/incident database shows the following data:

- Between 1982 and the present, there were 81 accidents[1] or incidents involving the TRK airport.[2]
  - 11 occurred during the approach phase of flight. (13.6%)
  - 7 occurred during the cruise phase of flight. (8.6%)
  - 1 occurred during descent to the airport. (1.2%)
  - 7 occurred while maneuvering. (8.6%)
  - 22 occurred during the landing phase of flight. (27.2%)
  - 23 occurred during the take-off phase of flight. (28.4%)
  - 3 occurred during a rejected landing, or go-around phase of flight. (3.7%)

TRK airport is currently involved with the local Flight Standards District Office in an effort to improve the safety of the airport through a FAAST (FAA Safety Team) team.

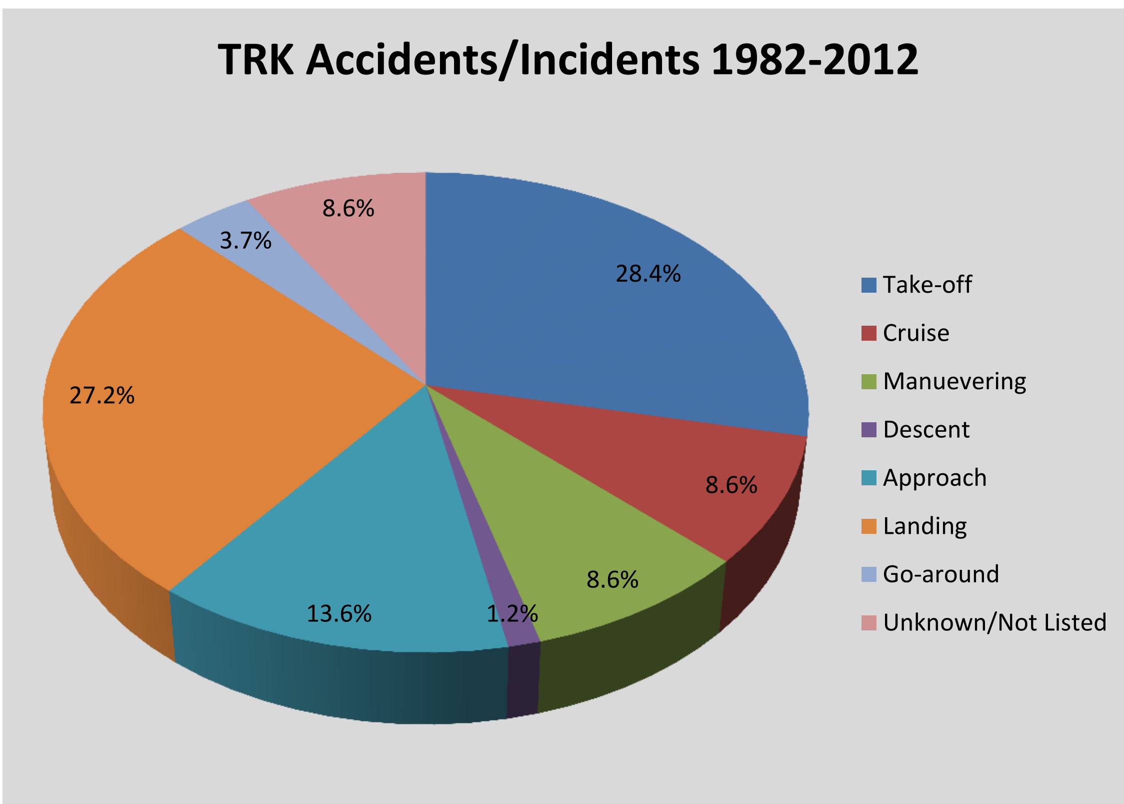

Figure 1 – NTSB Data

[1] The parameters for defining an accident or incident are set by the National Transportation Safety Board (NTSB).

[2] Accidents/Incidents were listed as TRK as either arrival or departure airport. Event may not have occurred on the airport property. See Figure 1

A review of the Aviation Safety Reporting System (ASRS) from 1988-2012 yielded 34 safety reports of all kinds for TRK. Further review indicated the following events might have been avoided with the integration of the additional surveillance capabilities of the TRK WAM;

- Four were Near Mid-Air Collision (NMAC) reports
- One report involved a Traffic Collision Avoidance System Resolution Advisory (TCAS RA)
- Two reports of unsafe proximity to terrain while searching for conflicting aircraft
- One report of an aircraft entering a cloud deck awaiting Oakland Center to attain RADAR contact (between 13,000 and 15,000 ft msl)

According to the FAA Oakland Air Route Traffic Control Center (ZOA), the primary source of surveillance in the local area is RADAR. However, due to the surrounding terrain, RADAR coverage over the airport is blocked below 11,500'msl. ATC is left with only pilot reports by VHF radio as to the initiation and termination of a flight. As a result, the FAA ATC system is unable to provide some of the basic safety services that would normally be available at an airport like TRK. ATC is unable to provide;

- Safety Alerts
- Merging Target Alerts
- Terrain or Obstruction Alerts
- Aircraft Conflict Alerts
- RADAR services for VFR aircraft in difficulty.
- Assistance to Search And Rescue (SAR) for lost aircraft.
- Sequencing to the airport

The absence of these services can be catastrophic. In 2006, a business jet landing at the RNO airport collided with a glider south of the Reno airport. Fortunately, but very uncommon for such an event, there was no loss of life. One of the factors in this accident was the inability of the Air Traffic Controller to "see" the glider on their RADAR display[3]. TRK has a significant number of glider operations, 5,496 in the last year alone, creating an increased risk for the airport area. Such risk was nearly realized in July this past year when a similar business jet reported a Near Mid-Air Collision (NMAC) with a glider over TRK.[4] Contributing factors to this event should include the lack of RADAR coverage for the ATC sector responsible for this airspace. Without landing traffic information, the crew had no choice but to overfly the airport to determine the traffic direction. This was the exact routing that put the business jet over the airport in direct conflict with the glider. Had the controller had RADAR coverage, they would have been able to provide traffic pattern information to the landing jet, or the crew could have used

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[3] According to the NTSB, the pilot was operating with his transponder in the "Off" position to conserve battery power.

[4] The operator reported the NMAC to the airport, but did not file an NMAC report with the NTSB. See Figure 2 and 3

an RNAV Visual Flight Procedure (RVFP)[5] that could keep them out of the path of gliders at TRK.[6][7]

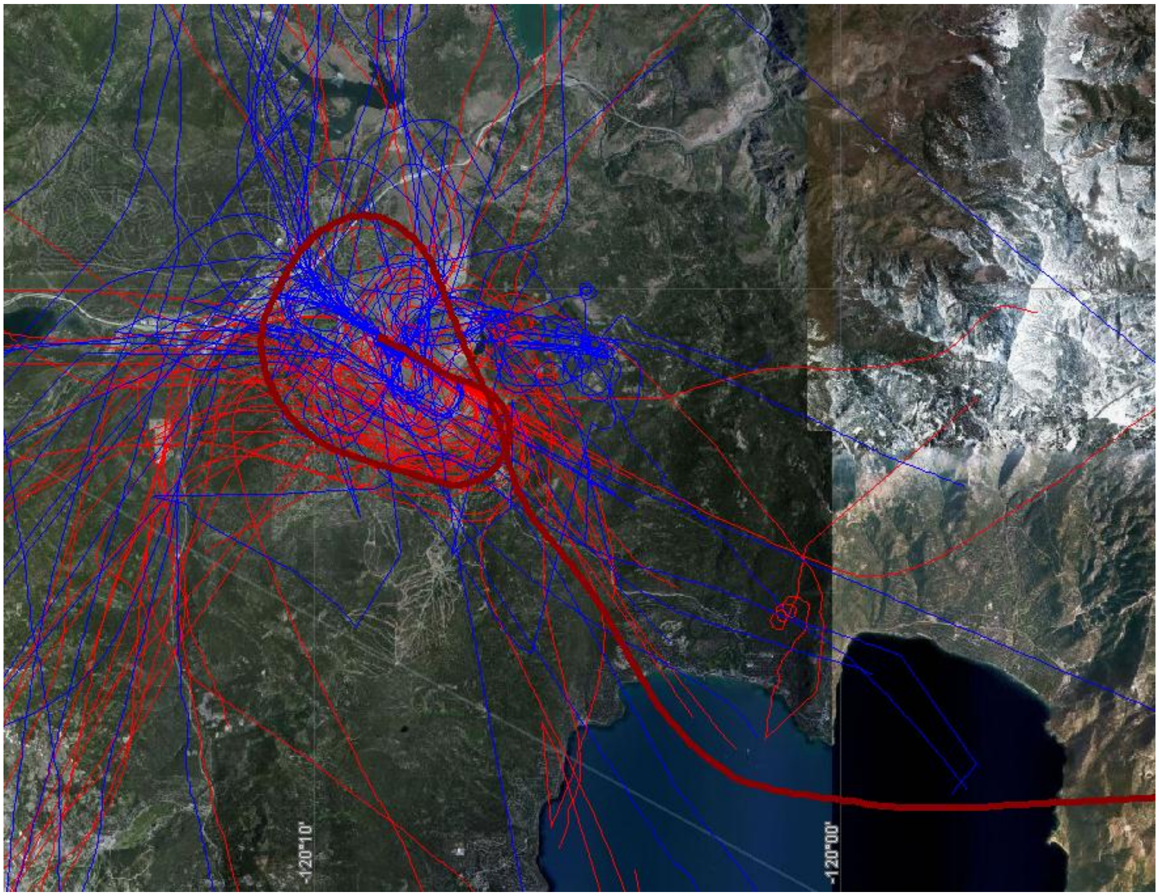


Figure 2 – WAM track of reported NMAC July 2012

[5] The jet operator had previously submitted an RVFP to the FAA for use at TRK, but was denied due to the lack of RADAR coverage as required by FAA Order 8260.55 See figure 6.
[6] For a more complete discussion of RVFPs and the impact of surveillance on their usage, see the TRK paper on the proposed RVFP.
[7] Some flights have already used the flight track of the RVFP as the crew selected routing for their visual approach, see figure 7

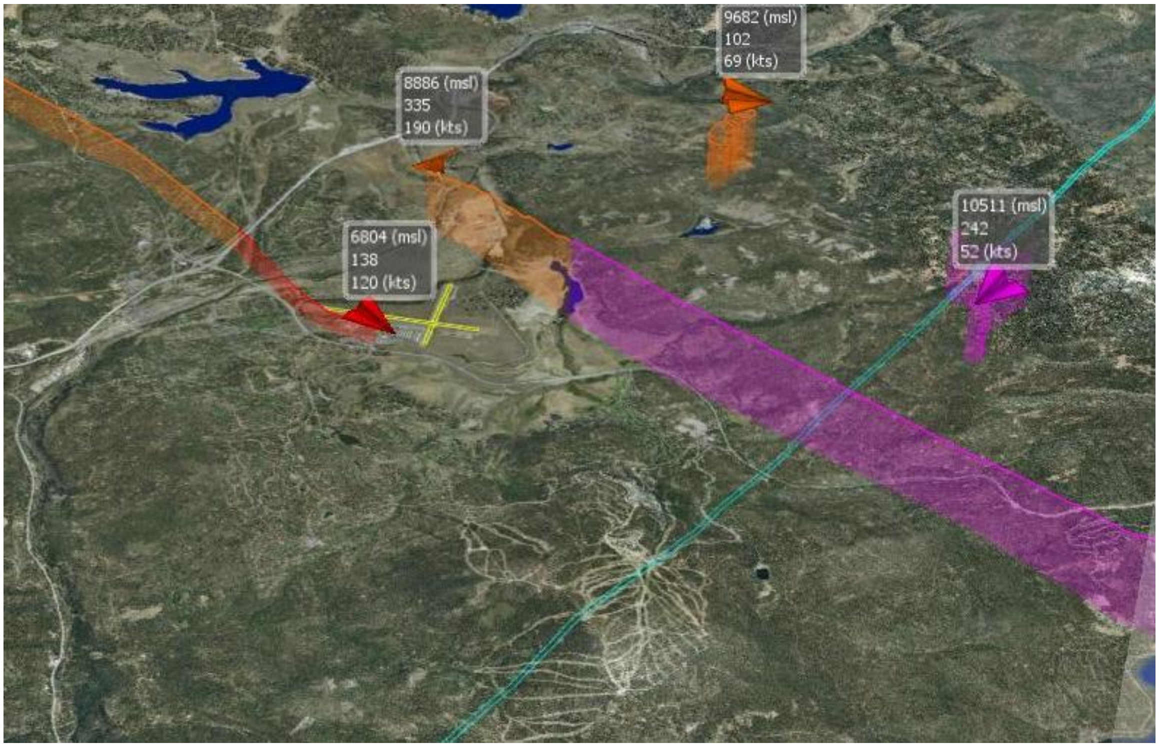


Figure 3 – WAM track of jet arrival into TRK traffic pattern in 3D.

To fully understand the impact of the lack of RADAR coverage, we looked at the two published IFR approaches into TRK. The first, a VOR/DME RNAV circling approach[8] begins 15.5 NM from the approach end of runway 11 on the inbound turn of the holding pattern At this point, the aircraft should be at 11,000', and already below consistent RADAR coverage. For an aircraft at 120kts, this means that the final eight to ten minutes of the flight are without any RADAR based safety services. If the aircraft needs to execute a missed approach for any reason, the total time without RADAR services could reach close to 20 minutes for a small aircraft. The other instrument approach procedure is the GPS runway 19[9]. Descent from 11,500' begins at KEWFI intersection, some 23 NM from the approach end of runway 20. This distance equates to over 12 minutes without RADAR services to reach the airport, and over 25 minutes for a small aircraft that executes the missed approach procedure. During this time, none of the safety advisories that are mandatory for the controller to provide at an airport with RADAR coverage are available to the aircraft landing at TRK.[10]

In addition to the safety advisories that are absent without RADAR, Search And Rescue (SAR) activities are impacted. The FAA does not issue an Alert Notice (ALNOT) until an aircraft is 30 minutes overdue. Once issued, local facilities have one hour to report back on communications with the missing aircraft. It is not until this time (90 minutes

[8] See Appendix A
[9] See Appendix A
[10] FAA Handbook 7110.65 paragraphs 2-1-2, 2-1-6, 2-1-27, 2-1-29, 5-2-9, 5-5-3, 5-14-1, 5-15-6, 7-3-1, 7-6-1

after the aircraft should have been on the ground) that responsibility is transferred to the Regional Command Center (RCC) for escalated SAR efforts. Even if the aircraft is assumed to have landed off-airport, the lack of RADAR coverage means there is up to a 23 NM long track that must be searched for the downed aircraft. This distance is increased over 50% by the possibility of a missed approach. In inclement weather, this amount of area in the terrain surrounding TRK would take days to accomplish. The FAA Airman's Information Manual (AIM) states the following; "According to the National Search and Rescue Plan, 'The life expectancy of an injured survivor decreases as much as 80 percent during the first 24 hours, while the chances of survival of uninjured survivors rapidly diminishes after the first 3 days."

If the FAA were to include WAM into the NAS for ATC purposes, there is a demonstrated coverage down to the ground at the airport, and therefore coverage is available throughout all phases of the normal approach[11]. The time without RADAR coverage would go from over 25 minutes to zero. All of the ATC safety alerts would be available to the pilot either directly or passed through the TRK Unicom[12]. These alerts could possibly prevent an unsafe event from occurring, thus preventing the need for a SAR effort. And in the unfortunate even of an off airport encounter, the controller could determine where the aircraft departed RADAR coverage, leaving an area of less than one square mile to search for the aircraft. Additionally, an ALNOT and SAR can begin immediately when the controller has reason to believe the aircraft was in distress or was forced into an off airport event[13].

According to the FAA NextGen Office, the current contract for ADS-B surveillance guarantees ADS-B coverage only in those areas where current RADAR coverage exists. It is therefore worth noting that there is no contractual obligation or commitment from the FAA NextGen office to provide ADS-B surveillance within the Truckee Valley at any point in the future. Thus, even with NextGen, these issues will still exist.

Additional general information regarding overall safety can be found in the EuroControl Document "*Generic Safety Assessment for ATC Surveillance using Wide Area Multilateration*" provided by TRK.

[11] See figures 4 and 5
[12] The possible duties and responsibilities of the TRK Unicom are beyond the discussion of this paper.
[13] FAA Handbook 7110.65 section 10-3

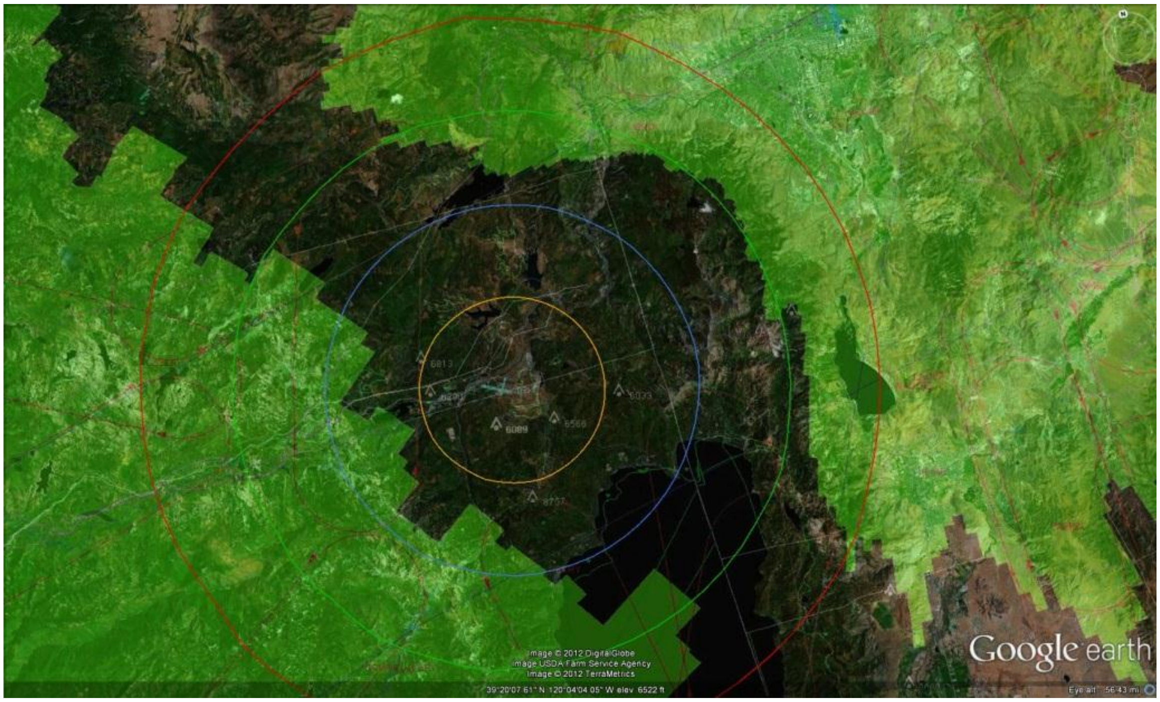


Figure 4 - Current RADAR coverage

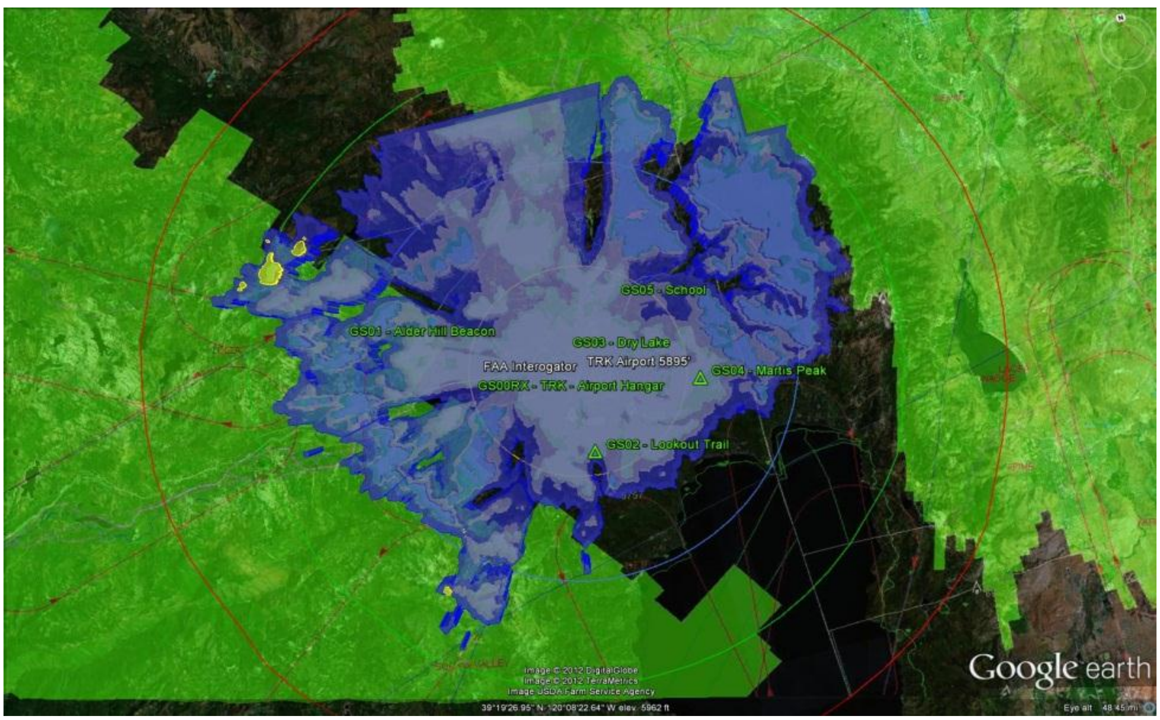


Figure 5 - RADAR coverage with TRK WAM Gap Filler

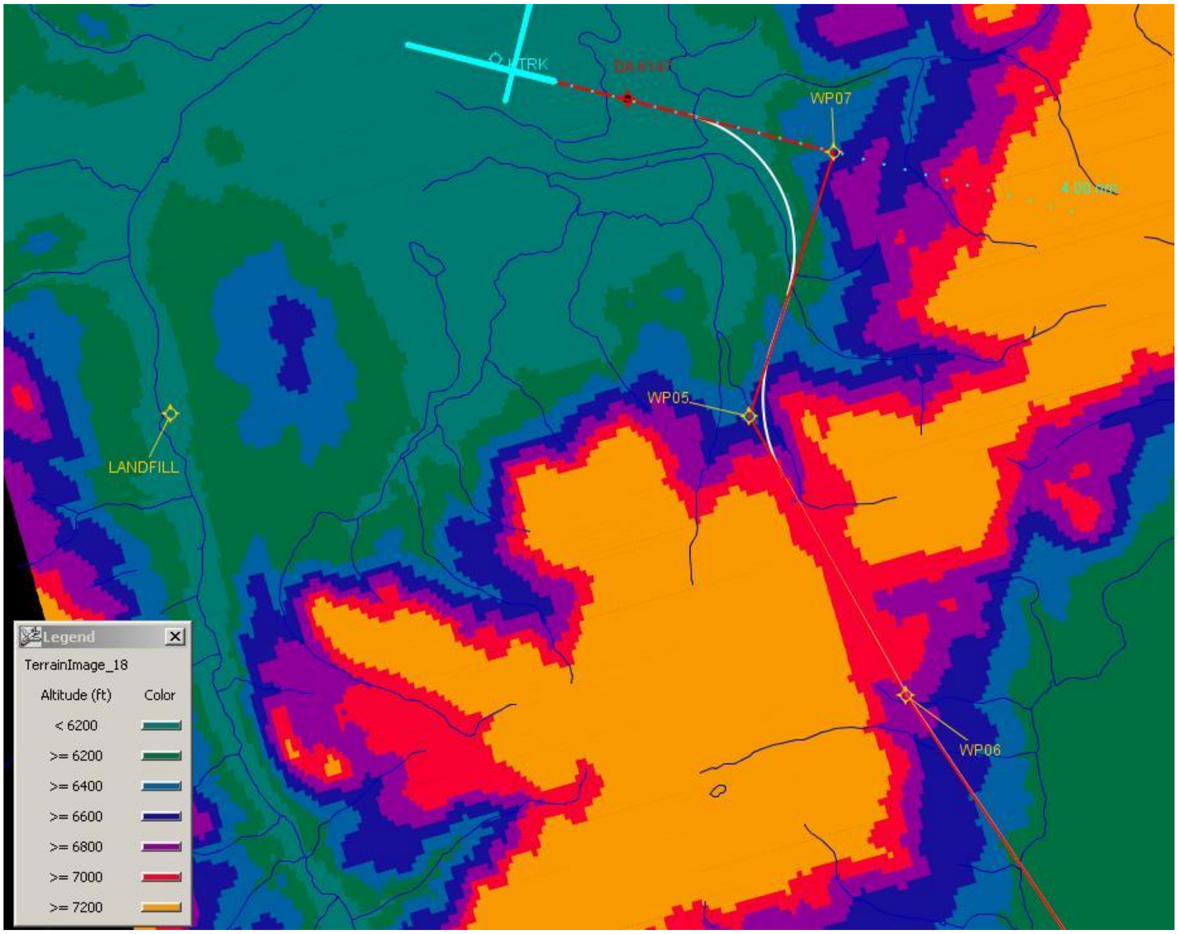


Figure 6 Jet aircraft track following the proposed RNAV Visual Flight Procedure

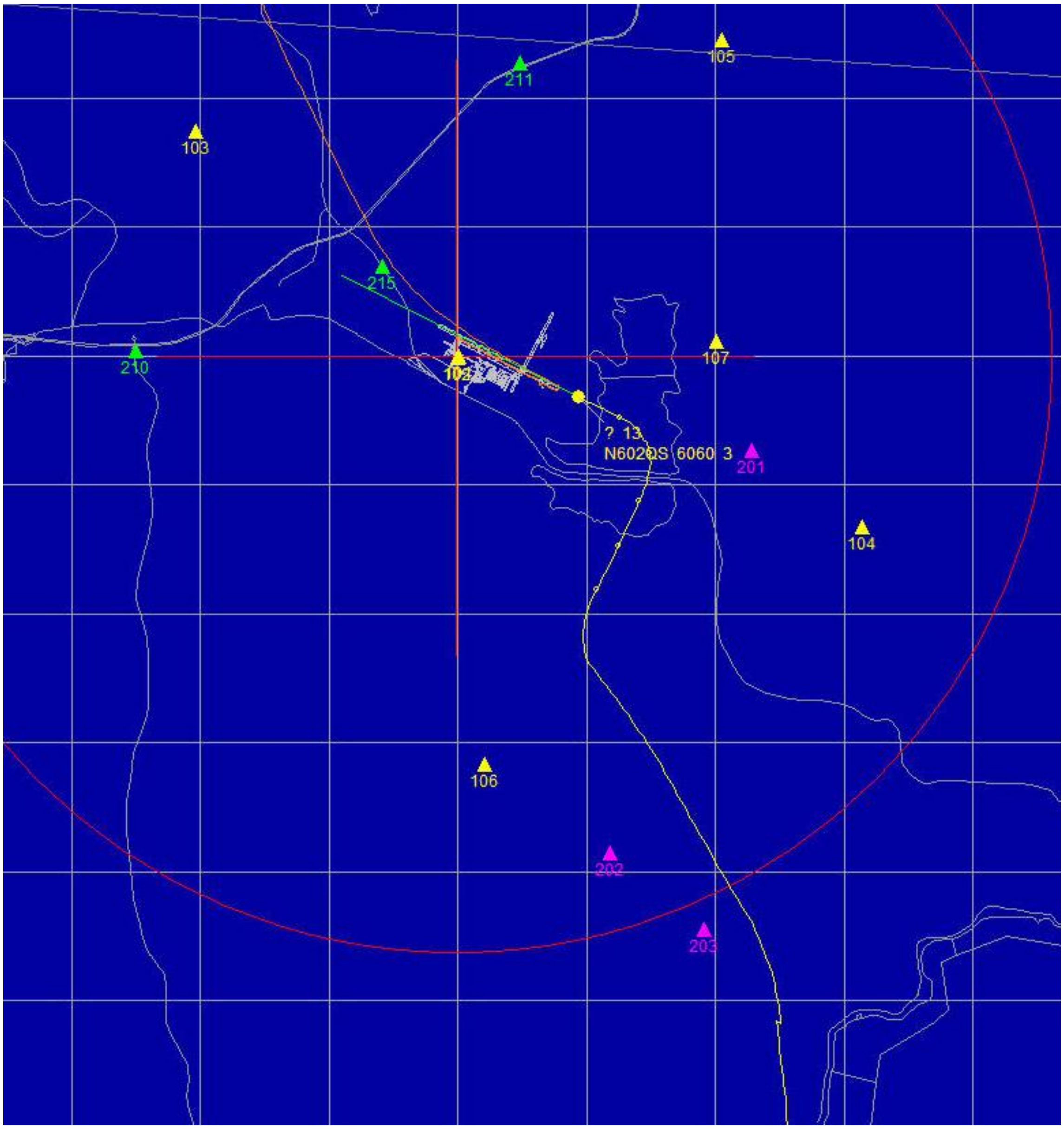


Figure 7 Actual WAM track of jet arrival using RVFP waypoints

Capacity and Efficiency

For aircraft executing an instrument approach, the procedures and lack of RADAR coverage creates a capacity and efficiency limitation. ATC must always provide positive separation for IFR aircraft on an approach, including a possible missed approach. As the Instrument Approach Procedures (IAP) at TRK do not provide positive non-radar separation between the approach and missed approach, ATC is limited to clearing one aircraft for an approach or departure at any given time. Following aircraft are issued delay vectors and holding to allow sufficient spacing and time for the preceding aircraft to execute the approach. As the FAA does not compile delay statistics for delays less than

Figure 8

15 minutes in length, and since delay vectors are not counted into the 15 minutes statistics, and since TRK is not served by an air carrier, there are virtually no data points available to review. One issue is certain, if there are two aircraft that desire to execute an instrument approach into TRK, the second aircraft may not begin the approach until the preceding aircraft has either cancelled their IFR clearance, or reports back that they have landed[14]. If an aircraft desires to depart on an IFR flight plan, they may not depart until the same conditions are met by any aircraft on the instrument approach. Additionally, if multiple aircraft wish to depart on an instrument flight plan, the second aircraft may not be released for departure until the first aircraft is far enough from the airport to preclude a loss of non-radar separation, and is high enough to be within RADAR coverage. With a small aircraft as the initial departure, this delay could exceed 10 minutes for the subsequent departure. If this is during a peak period where there are both arrivals and departures, the delays could become significant enough to force an arriving aircraft to divert to an alternate airport due to insufficient fuel remaining.

The current inefficiencies are not limited to operations at TRK. Aircraft that are released on a flight plan from South Lake Tahoe airport (TVL) can have an impact on TRK arrivals. As the controller must issue an altitude that guarantees surveillance coverage and provides terrain clearance, the TVL departure must climb to 13,000’ msl. When there is a TRK arrival from anywhere south of TRK, the TRK arrival must be restricted to no lower than 14,00’ msl as they approach TRK. This places the aircraft much higher than required for a standard descent. Additional flight miles must be added to the arrival track after the TRK arrival has cleared the airspace protected for the TVL departure. As a result of the increased track miles, there is a corresponding increase in flight time, fuel burned, operational cost, CO^2 emissions, and noise exposure to the local community. With an integration of the TRK WAM system into the NAS, many of these delays could be avoided.

[14] See figure 8

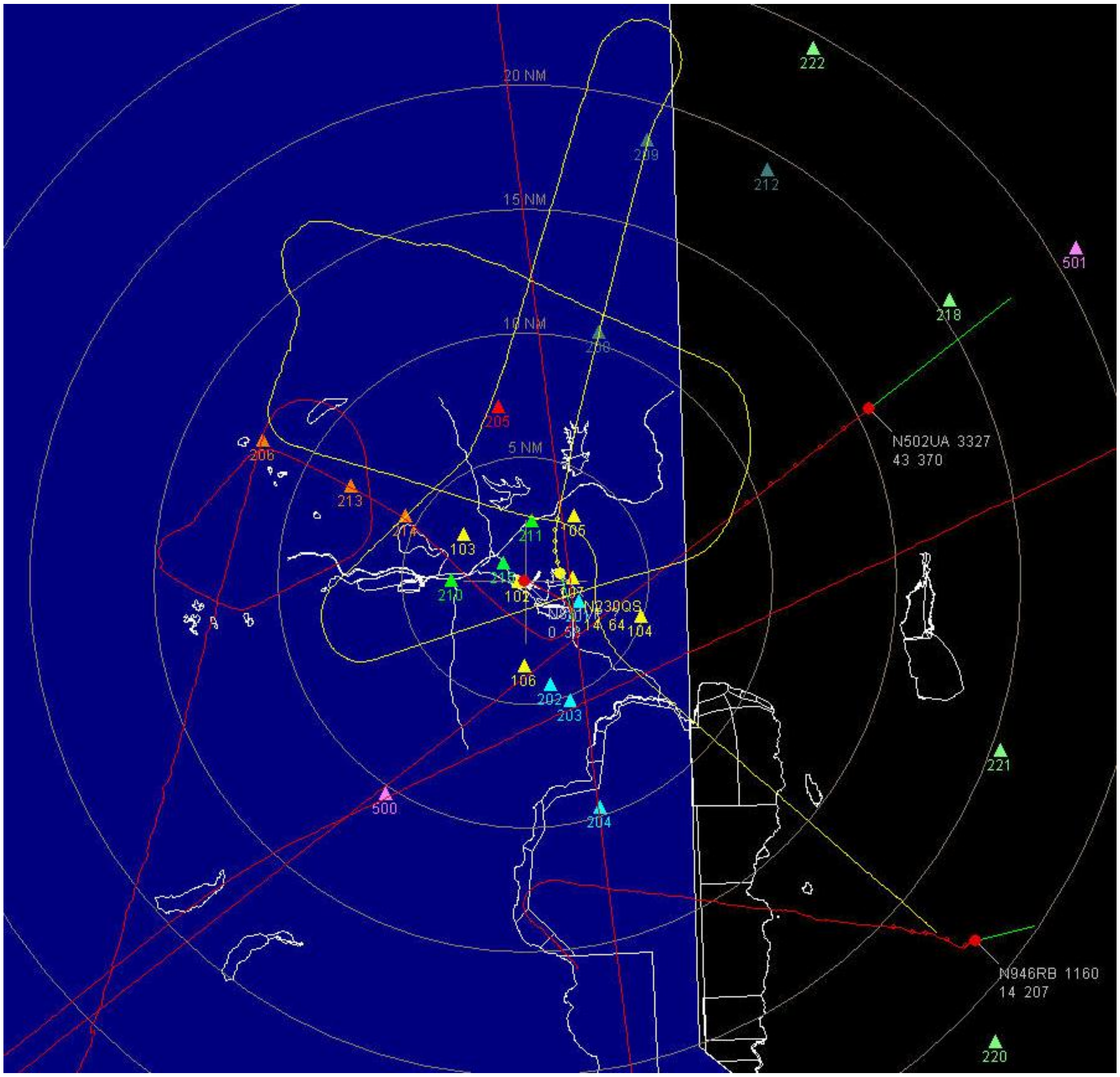


Figure 9

WAM inclusion would allow the controller to observe the aircraft land and taxi off the runway, thereby minimizing the delay impact of successive arrivals when using the GPS 19 approach. The VOR/DME RNAV approach has some course divergence between the approach path and the missed approach, allowing the controller to sequence arrivals as close as 5 NM in trail on final[15]. Likewise, departures could depart as soon as two minutes after the preceding aircraft with RADAR separation in use. During high volume periods, the efficiency of the airport is improved, as is the service to the user landing or departing TRK.

As previously mentioned, the published instrument approaches into TRK require lengthy routings as a result of the non-radar environment in which they are conducted. However,

[15] Some assumptions on landing direction are made in this example.

when operating in a RADAR environment, the controller can vector the aircraft to join the final outside the Final Approach Fix (FAF).[16] On the VOR/DME RNAV approach, this could save a procedure turn and an additional 4 NM on the approach course. With the addition of a single waypoint on the GPS runway 19 approach, the same distance on the approach course could be saved. This would equate to time savings of up to 10 flying minutes for a small aircraft. This time savings would also reduce or eliminate the need for sequencing of the subsequent aircraft, as the first aircraft could be "out of the way" when the second aircraft entered the approach environment.

Due to the differences between RADAR and non-radar obstruction criteria, the Minimum Vectoring Altitude (MVA)[17] is often lower than the Minimum Enroute Altitude (MEA). In areas where this occurs, the controller can issue vectors to altitudes lower than the pilot can fly in instrument conditions on their own. Some small aircraft need to hold to reach the MEA before proceeding on course due to the inability to make a steep climb gradient.[18] When a second aircraft is awaiting their departure release, whether the following aircraft is a jet or small piston, they must hold until the preceding aircraft is above the MEA and enroute away from the area. The ATC ability to issue vectors or on course monitoring at altitudes below the MEA would reduce the amount of time these small aircraft are flying over the airport environment. This capability would significantly improve the overall efficiency of the airport regardless of traffic volume.

[16] FAA Handbook 7110.65 Chapter 5

[17] MVA altitudes are generally 1,000-2,200 feet agl vertical clearance above terrain and obstacles, and 3-5NM lateral clearance from obstacles. MEA altitudes must often provide greater vertical and/or lateral clearance, as well as ensuring NAVAID reception. Some ZOA also uses Minimum IFR Altitudes (MIA) in the same manner MVAs are used. See figure 9

[18] TRUCK3 Standard Instrument Departure (SID) requires a climb gradient of 415 ft/NM to 11,500'msl or-510 ft/NM to 9,500'msl depending on the departure runway. The MEA on V200-392 is 11,500' msl.

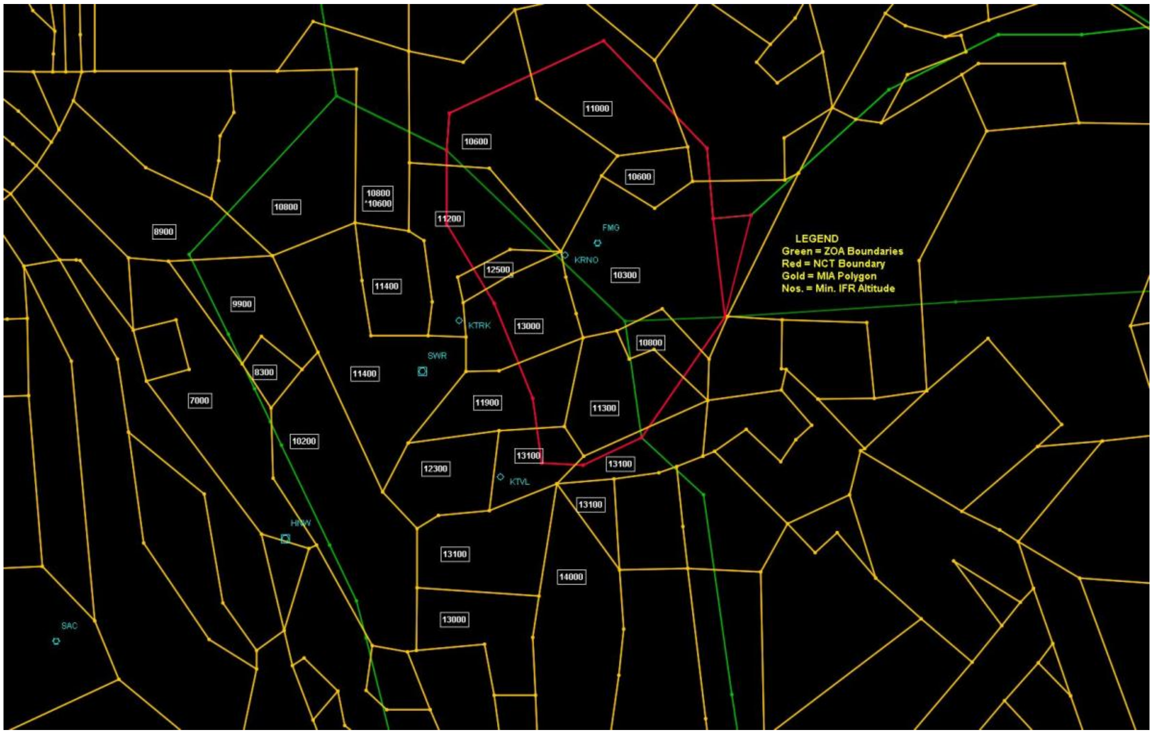


Figure 10 – ZOA Minimum IFR Altitudes over and around TRK.

Inclusion of the WAM into the NAS would not appear to cause a significant increase in traffic volume. A review by ZOA of traffic volume did not indicate a substantial volume of flights that diverted to other airports as a result of inbound delays to TRK. Contributing factors to the volume limitations are many of the same issues that make TRK such a desirable destination. Those issues include the mountainous terrain, density altitude issues, “semi-remote” location, and limited approach procedures.

Approach minimums on the TRK approaches will be unaffected by the inclusion of the data into the NAS. Approaches are designed without consideration for surveillance, based on aircraft to obstacle lateral and vertical clearances. This means there will be no impact to safety from aircraft attempting to land in weather more adverse than they do under the current circumstances. The minimum altitudes, visibility, and required minimum weather for all approaches would be unaffected by the addition of surveillance data.

It should be noted that neither FAR Part 91K nor 135 restrict the operation of flights based upon surveillance capability. Rather, there are operations that may or may not be conducted based on forecasted weather, actual weather at the time of arrival, and the availability of Instrument Approach Procedures (IAPs). As a result, the FAA does not publish the status of surveillance in the Airport/Facilities Directory (A/FD). Therefore, the inclusion of the TRK WAM into the NAS would have no direct effect on an operator’s decision on conducting flights into or out of TRK.

Environmental

Without RADAR coverage, the controller is unable to advise an arriving aircraft of the observed landing runway and potential traffic conflicts. Therefore, the pilot must proceed to the airport, overfly the airport, and determine the traffic direction. The aircraft should then proceed away from the airport, and enter the traffic pattern on a standard 45 degree entry to the downwind. While this might be mitigated by the Unicom, it is not always the case, as evidenced by the previously mentioned NMAC. This can add well over 10 minutes of flying time, even for a business jet. If the average small business jet burns 1600 lbs of jet fuel per hour during this time, the cost to the environment is 938 pounds of CO^2 per operation. Looking at the TRK website for traffic information[19], the total savings to the local environment could exceed 2,300 TONS of CO^2 in the atmosphere annually.

For small aircraft that must hold to reach the MEA, and for any aircraft that might follow them, the reduced time spent holding over the airport would result in a similar level of emission and noise reduction for the local community. Also, for any aircraft awaiting their departure release on the ground, there would be a reduction in the noise and emissions that they create.

Finance

Cost sharing or even the complete assumption of maintenance costs by the FAA, are a distinct possibility if the system were to be integrated into the NAS. Historically, the FAA does not include "Safety of Life" resources into the NAS where the maintenance is not under the control of the FAA. As a result, TRK might take the position that all WAM maintenance funding should be borne by the FAA. The financial impact to TRK would equate to the cost of maintenance of the TRK WAM system.

Should this assumption of maintenance costs become a hindrance to NAS implementation, TRK could consider a reimbursable agreement with the FAA in which TRK could subsidize some or all of the maintenance costs of the system. In either approach, the total cost to the airport could be significantly reduced or eliminated. The final savings would be completely dependent upon the agreement that could be reached with the FAA.

Summary

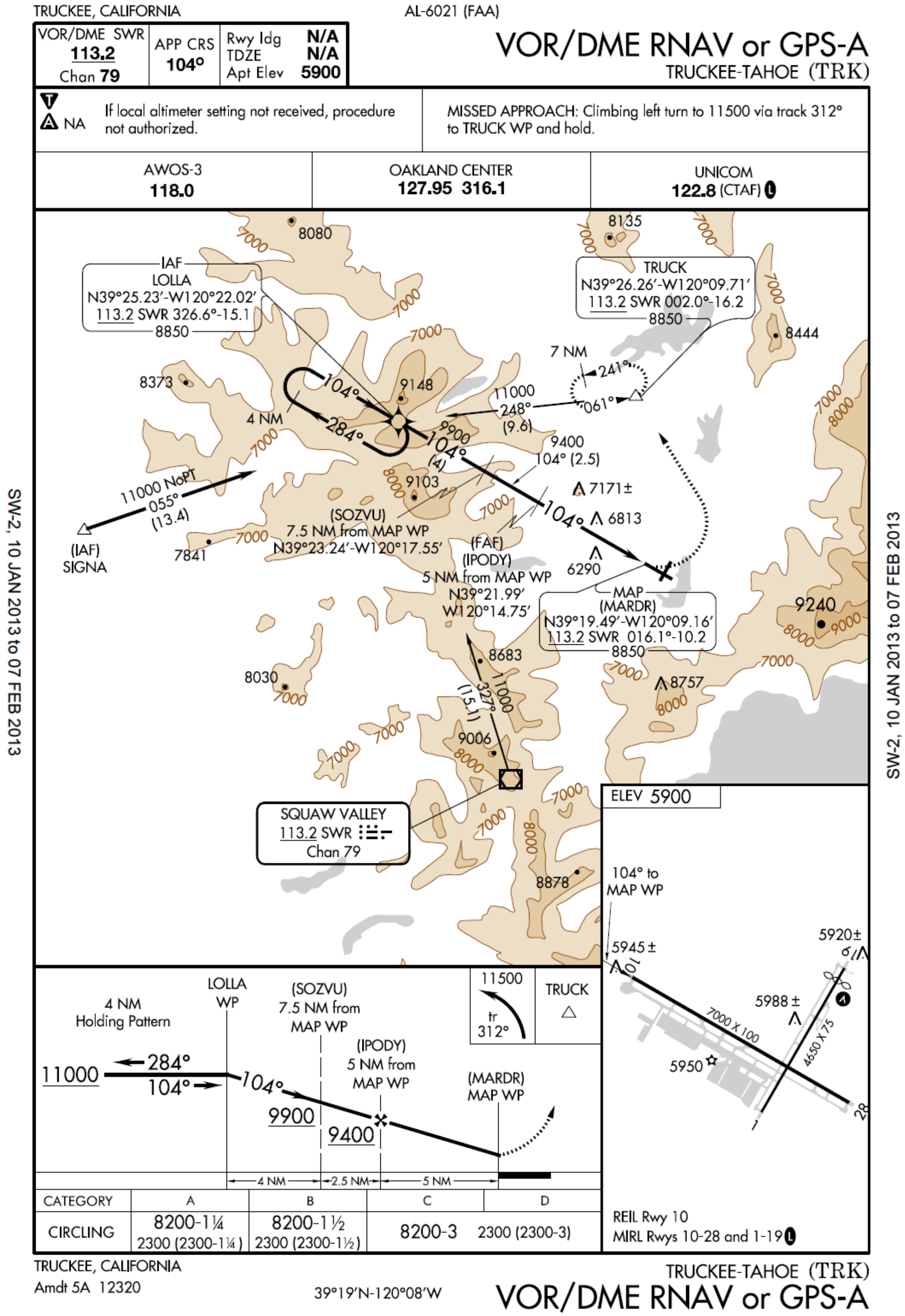
It is virtually impossible to find any drawbacks or negative ramifications to the inclusion of the TRK WAM into the NAS. Substantial improvements can be found in the areas of Safety, Capacity and Efficiency, Environmental, and Finance. The only potential drawback could be found in loss of system "control". TRK has a pro-active and flexible

[19] http://www.truckeetahoeairport.com/airport_faq.html states there are approximately 35,000 operations annually, of which 29% are jet or turbine operations.

management team in place. This agility and forward thinking attitude was the very key to bringing WAM to the airport. The Federal Government, however, cannot by its very nature be as quick to adapt, or as flexible. The transition to a NAS inclusion will eliminate much of the airport management's control of the system in the areas of expansion and technical improvement. This is not, in and of itself, a drawback. But with the change of system management, there are times where it could easily be perceived as such. Even so, there is overwhelming evidence of a positive impact to the airport users in these key areas.

BridgeNet International is more than willing to assist TRK in the inclusion of the WAM data into the NAS, through any means possible. Should you have any questions on the information contained in this paper, please feel free to contact us at your earliest opportunity.

Appendix A



TRUCKEE, CALIFORNIA
AL-6021 (FAA)
VOR/DME SWR 113.2 Chan 79
APP CRS 104°
Rwy Idg N/A
TDZE N/A
Apt Elev 5900
VOR/DME RNAV or GPS-A
TRUCKEE-TAHOE (TRK)
NA
If local altimeter setting not received, procedure not authorized.
MISSED APPROACH: Climbing left turn to 11500 via track 312° to TRUCK WP and hold.
AWOS-3 118.0
OAKLAND CENTER 127.95 316.1
UNICOM 122.8 (CTAF)
IAF LOLLA N39°25.23′-W120°22.02′ 113.2 SWR 326.6°-15.1 8850
TRUCK N39°26.26′-W120°09.71′ 113.2 SWR 002.0°-16.2 8850
8080
8135
8444
8373
9148
4 NM
104°
284°
7 NM
241°
061°
11000
248°
(9.6)
9900
104°
(4)
9400
104° (2.5)
9103
7171±
6813
6290
11000 NoPT
055°
(13.4)
(IAF) SIGNA
7841
(SOZVU) 7.5 NM from MAP WP N39°23.24′-W120°17.55′
(FAF) (IPODY) 5 NM from MAP WP N39°21.99′ W120°14.75′
MAP (MARDR) N39°19.49′-W120°09.16′ 113.2 SWR 016.1°-10.2 8850
9240
8683
8030
8757
327°
(15.1)
11000
9006
8878
SQUAW VALLEY 113.2 SWR Chan 79
ELEV 5900
104° to MAP WP
5945±
5920±
5988±
5950
7000 X 100
4650 X 75
LOLLA WP
4 NM Holding Pattern
11000
284°
104°
(SOZVU) 7.5 NM from MAP WP
(IPODY) 5 NM from MAP WP
(MARDR) MAP WP
9900
9400
11500
tr 312°
TRUCK
4 NM
2.5 NM
5 NM
CATEGORY A B C D
CIRCLING 8200-1¼ 2300 (2300-1¼) 8200-1½ 2300 (2300-1½) 8200-3 2300 (2300-3)
REIL Rwy 10
MIRL Rwys 10-28 and 1-19
SW-2, 10 JAN 2013 to 07 FEB 2013
TRUCKEE, CALIFORNIA
Amdt 5A 12320
39°19′N-120°08′W
TRUCKEE-TAHOE (TRK)
VOR/DME RNAV or GPS-A

TRUCKEE, CALIFORNIA AL-6021 (FAA)

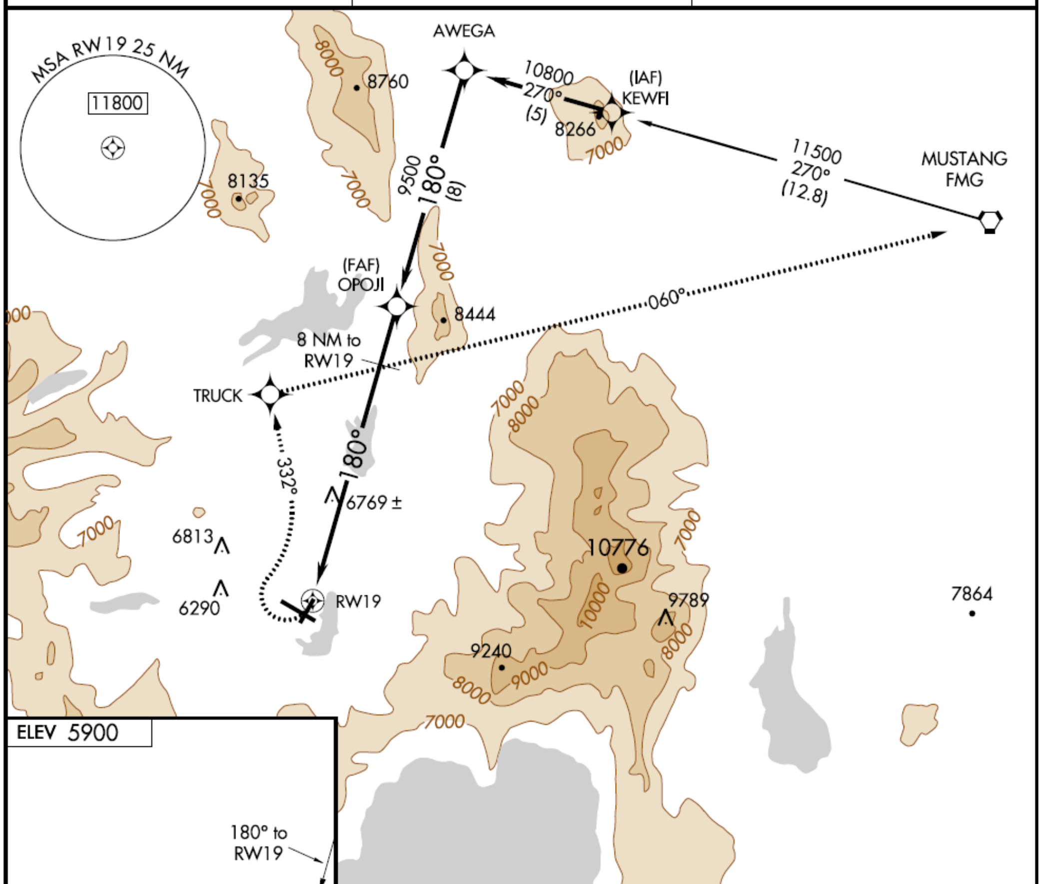
APP CRS	Rwy ldg	4535
180°	TDZE	5894
	Apt Elev	5900

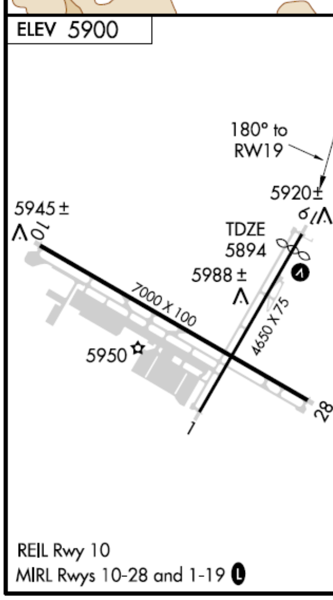
GPS RWY 19
TRUCKEE-TAHOE (TRK)

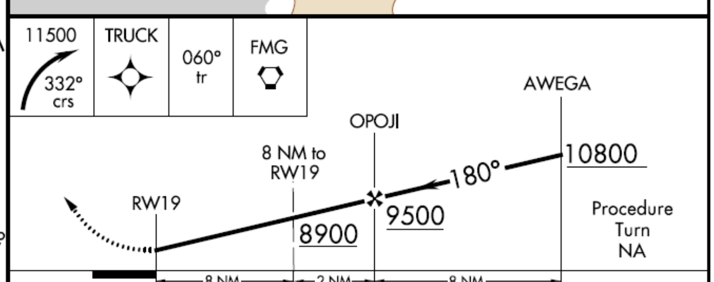
T
A NA

MISSED APPROACH: Climbing right turn to 11500 via 332° course to TRUCK WP then via 060° course to FMG VORTAC.

AWOS-3	OAKLAND CENTER	UNICOM
118.0	127.95 316.1	122.8 (CTAF) L







CATEGORY	A	B	C	D
S-19	7340-1¼ 1446 (1500-1¼)	7340-1½ 1446 (1500-1½)	7340 -3 1446 (1500-3)	
CIRCLING	7340-1¼ 1440 (1500-1¼)	7340-1½ 1440 (1500-1½)	7340-3 1440 (1500-3)	7360-3 1460 (1500-3)

SW-2, 10 JAN 2013 to 07 FEB 2013

TRUCKEE, CALIFORNIA
Orig 10322

39°19'N-120°08'W

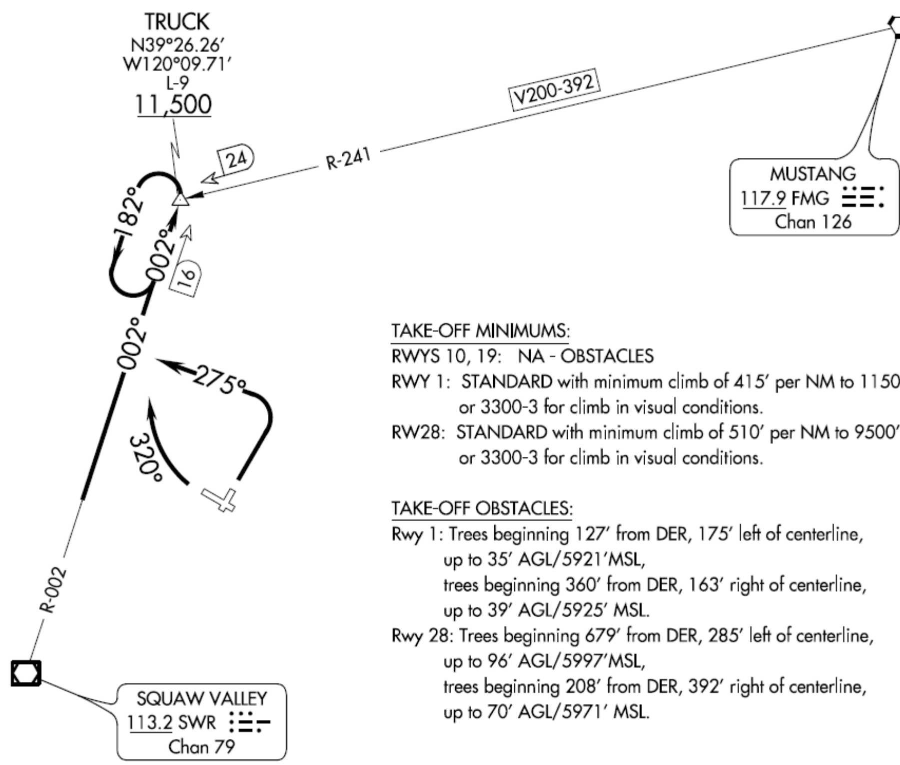
TRUCKEE-TAHOE (TRK)
GPS RWY 19

TRUCK THREE DEPARTURE (OBSTACLE)

TRUCKEE-TAHOE (TRK)
TRUCKEE, CALIFORNIA

SW-2, 10 JAN 2013 to 07 FEB 2013

OAKLAND CENTER
127.95 316.1
UNICOM 122.8 (CTAF)
AWOS-3 118.0



TAKE-OFF MINIMUMS:
RWYS 10, 19: NA - OBSTACLES
RWY 1: STANDARD with minimum climb of 415′ per NM to 11500′, or 3300-3 for climb in visual conditions.
RW28: STANDARD with minimum climb of 510′ per NM to 9500′, or 3300-3 for climb in visual conditions.

TAKE-OFF OBSTACLES:
Rwy 1: Trees beginning 127′ from DER, 175′ left of centerline, up to 35′ AGL/5921′MSL, trees beginning 360′ from DER, 163′ right of centerline, up to 39′ AGL/5925′ MSL.
Rwy 28: Trees beginning 679′ from DER, 285′ left of centerline, up to 96′ AGL/5997′MSL, trees beginning 208′ from DER, 392′ right of centerline, up to 70′ AGL/5971′ MSL.

NOTE: Chart not to scale.

DEPARTURE ROUTE DESCRIPTION

TAKE-OFF RUNWAY 1: Climbing left turn to 11,500′ via heading 275°and SWR R-002 to TRUCK INT, thence..., or, climb in visual conditions to cross Trukee-Tahoe Airport heading 290° at or above 9100′, then proceed on SWR R-002 to TRUCK INT, thence...
TAKE-OFF RUNWAY 28: Climbing right turn to 11,500′ via heading 320° and SWR R-002 to TRUCK INT, thence...,or, climb in visual conditions to cross Trukee-Tahoe Airport heading 290° at or above 9100′, then proceed on SWR R-002 to TRUCK INT, thence...

...Cross TRUCK INT at or above 11,500′. If required, continue climb-in-TRUCK INT holding pattern to cross TRUCK INT at or above 11,500′.