# Final Environmental Assessment for Northern California Optimization of Airspace and Procedures in the Metroplex

July 2014

Prepared by:

**United States Department of Transportation**

**Federal Aviation Administration**

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Appendix B: List of Preparers
Appendix C: References
Appendix D: List of Acronyms and Glossary
Appendix E: Basic of Noise
Appendix F: Responses to Comments on the Draft EA

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# Changes to the Draft Environmental Assessment

The following changes were made to the Draft Environmental Assessment (Draft EA) subsequent to printing and the March 25, 2014 distribution of the document. The changes identified below did not necessitate revised or additional environmental analyses. Changes in text and tables are indicated with ~~strikeout~~ type where the text is removed and replaced. New text is indicated with ***bold italic*** type where text is added.

## Table of Contents

On Page vii, first listed Appendix, the following correction is made to the text:

> Appendix A: Agency ~~and Public~~ Coordination**, *Public Involvement,*** and List of Receiving Parties

On Page vii, ***Appendix F: Responses to Comments on the Draft EA*** was added to the Table of Contents.

## Chapter 1

On Page 1-1, bulleted list, the following correction is made to the text:

- **Appendix A: Agency** ~~and Public~~ **Coordination*, Public Involvement,* and List of Receiving Parties*.* Appendix A** documents agency and public coordination associated with the EA process and lists the local agencies and parties identified to receive copies of the Draft and Final EA documents.

On Page 1-2, bulleted list, the following addition is made to the text:

- ***Appendix F: Responses to Comments on the Draft EA. Appendix F presents comments from the public on the Draft EA received during the public comment period and responses to the comments prepared by the FAA.***

On Page 1-14, Section 1.4, second paragraph, the following addition is made to the text:

> **San Francisco International Airport (SFO)** is located approximately 10 nm southwest of OAK. SFO is classified as a large-hub commercial service airport under the ***National Plan of Integrated Airport Systems (***NPIAS***)***. SFO has four runways, described in **Table 1-1**. As of December 2011, SFO arrivals may be assigned one RNAV STAR or one of eight conventional STARs. Departing aircraft may be assigned one of 11 conventional SIDs.

## Chapter 2

On Page 2-6, Section 2.1.2.1, second paragraph on the page the following correction is made to the text:

The GOLDEN GATE STAR is an arrival procedure from the north that is used by traffic arriving to both SFO and SJC. **Exhibit 2-2** shows vertical profiles for aircraft arriving over the LOZIT ~~waypoint~~ ***intersection*** on the GOLDEN GATE STAR to SFO (top) and SJC (bottom) (an overhead view of aircraft operating on this procedure is provided in **Exhibit 2-3**.) SFO-bound traffic is directed to level-off at 11,000 feet above mean sea level (MSL) and SJC-bound traffic is directed to level-off at 12,000 feet MSL.

On Page 2-6, Section 2.1.2.1, second to last sentence on the page the following correction is made to the text:

> The level flight segment is noted by the collection of orange/green flight tracks ~~flight tracks~~ circled in red. This level flight segment extends for approximately 45 nautical miles (nm). Extended level-offs often result in increased controller-to-pilot communication and may require traffic alerts to pilots of the proximity of other aircraft or point-outs to other controllers responsible for neighboring airspace sectors. This adds to complexity (e.g., higher controller workload, the number of times controller-to-pilot communication occurs, and inefficient use of aircraft performance capabilities during a descent or climb.) This results in less predictable routes and reduced airspace efficiency.

On Page 2-11, Section 2.1.2.3, bulleted list, the following edit is made to the text:

- ~~Options for controllers to re-direct aircraft to avoid inclement weather or more efficiently handle sequencing are limited.~~ ***Options are limited for controllers to re-direct aircraft to avoid inclement weather or more efficiently handle sequencing.***

On Page 2-14, Section 2-5, the following correction is made to the text:

> ### 2.5 Required Federal Actions to Implement Proposed Action
>
> Implementation of the Proposed Action requires the FAA ~~Publication~~ ***publication*** of new or revised STARs and SIDs.

## Chapter 3

On Page 3-2, Section 3.1.1, third paragraph, the following edit is made to the text:

> The Study Team identified several Performance-based Navigation (PBN) solutions that ~~resulted~~ ***could result*** in increased efficiency in the Northern California Metroplex. The modifications proposed were conceptual in nature, and did not include a detailed technical assessment, which was reserved for the D&I Team to conduct.

On Page 3-11, Section 3.2.1.1, the following corrections are made to Table 3-1 to address an editing error:

**Table 3-1 No Action Alternative SIDs and STARS (3 of 3)**

| No Action Alternative Procedure | Procedure Type | Basis of Design | Enroute Transitions | Runway Transitions | Airports Served |
|---|---|---|---|---|---|
| YOSEM TWO | STAR | RNAV | 2 | 0 | SFO |
| ~~ALTAM SEVEN~~ | ~~SID~~ | ~~VOR~~ | ~~2~~ | ~~1~~ | ~~SJC~~ |
| ~~BIG SUR TWO~~ | ~~STAR~~ | ~~VOR/DME~~ | ~~1~~ | ~~0~~ | ~~SFO~~ |
| ~~BRINY ONE~~ | ~~STAR~~ | ~~VOR~~ | ~~4~~ | ~~0~~ | ~~SJC~~ |
| ~~CAPITOL THREE~~ | ~~STAR~~ | ~~VOR~~ | ~~1~~ | ~~0~~ | ~~SJC~~ |
| ~~COAST SIX~~ | ~~SID~~ | ~~VOR/DME~~ | ~~4~~ | ~~1~~ | ~~OAK~~ |
| ~~COMMO ONE~~ | ~~STAR~~ | ~~VOR/DME~~ | ~~2~~ | ~~0~~ | ~~OAK~~ |

On Page 3-13 and Page 3-15, Section 3.2.1.2, Exhibits 3-6 and 3-7 are revised to remove the centerlines from the depicted No Action Alternative flight corridors.

On Page 3-17, Section 3.2.2, second paragraph, the following correction is made to the text to address a counting error:

> There are ~~85~~ **84** procedures included in the Proposed Action. This includes ~~33~~ **32** new RNAV procedures (~~19~~ **18** new RNAV SIDs and 14 new RNAV STARs.) In addition, 28 conventional SIDs, 22 conventional STARs, and two RNAV STARs are carried forward as part of the Proposed Action. **Table 3-2** lists the names of the Proposed Action alternatives, the No Action Alternative procedure the Proposed Action alternative would replace (if applicable), the procedure type, and the basis of design (indicated by the type of navigational aid the procedures are based on (shown as VOR, RNAV, or radar vectors.) The table also shows the Study Airports served by the Proposed Action procedures and the number of runway and enroute transitions for each procedure. Finally, the table lists the intent of the procedure, including the objectives identified under the purpose and need for the Project (predictability, flexibility, and/or segregation) that each procedure design achieves. New or updated SIDs and STARs are shaded in gray.

On Page 3-20, Section 3.2.2, the following corrections are made to Table 3-2 to address an editing error:

**Table 3-2 Proposed Action SIDs and STARs (4 of 6)**

| Proposed Action Procedure | No Action Procedure | Procedure Type | Basis of Design | Airports Served | Enroute Transitions | Runway Transitions | Objectives |
|---|---|---|---|---|---|---|---|
| SAHEY ONE | PORTE FIVE | SID | RNAV | SFO | 5 | 4 | Predictability, Segregation, Flexibility |
| ~~SALAD TWO~~ | ~~SALAD TWO~~ | ~~SID~~ | ~~VOR~~ | ~~OAK~~ | ~~1~~ | ~~1~~ | ~~Flexibility~~ |
| SAN JOSE NINE | SAN JOSE NINE | SID | VOR/ DME | SJC | 2 | 1 | Flexibility |

On Page 3-23 and Page 3-25, Section 3.2.2, Exhibits 3-8 and 3-9 are revised to remove the centerlines from the depicted Proposed Action flight corridors.

## Chapter 4

On Page 4-1, Section 4.1, the following correction is made to the text to address a counting error:

> Exhibit 4-1 depicts the General Study Area developed for this EA. Table 4-1 identifies the counties that fall within or are intersected by the General Study Area boundary. In total, the General Study Area includes 11 entire counties and portions of ~~11~~ ***12*** additional counties.

On Page 4-2, Section 4-1, the following addition is made to Table 4-1:

**Table 4-1 Counties in the General Study Area**

| | | | | |
|---|---|---|---|---|
| Alameda County | Merced County[1] | Sacramento County | Santa Clara County | Sutter County |
| Colusa County | ***Monterey County[1]*** | San Benito County[1] | Santa Cruz County | Yolo County[1] |
| Contra Costa County | Napa County[1] | San Francisco County | Solano County | Yuba County[1] |
| El Dorado County[1] | Nevada County[1] | San Joaquin County[1] | Sonoma County[1] | |
| Marin County | Placer County[1] | San Mateo County | Stanislaus County[1] | |

*Notes:*
*1/ Only a portion of the county falls within the General Study Area*

Source: National Atlas of the United States of America: U.S. County Boundaries, 2005; ATAC Corporation, August 2012.
Prepared by: ATAC Corporation, April 2013.

On Page 4-10, Section 4.3.1.1, the following correction is made to the text to address a counting error:

> In total, noise exposure levels were calculated at ~~98,290~~ ***98,282*** census block centroids (centroids in the General Study Area that represent areas with population), 94,046 grid points, and ~~7,024~~ ***12,215*** unique points throughout the General Study Area.

On Page 4-15, Section 4.3.5.1, the following correction is made to the text to address an editing error:

> Exhibit 4-5 shows the location of historic and cultural resources identified in the General Study Area. A total of 767 National Register listed properties and ~~nine~~ ***eight*** tribal properties were identified. Historic properties are representative of every period in California history, include some of the nation's most important historic and cultural resources from the Spanish colonial, Mexican, and American periods. A list of the historic and cultural resources identified in the General Study Area, the county in which they are located, and DNL calculated for each resource under existing conditions is provided in the NorCal OAPM Noise Technical Report available on the project website (http://www.oapmenvironmental.com).

On Page 4-19, Exhibit 4-4 is revised to add the names and locations of eight National Parks Service properties to the map. In addition, the exhibit number is corrected from Exhibit 4-6 to Exhibit 4-4.

On Page 4-21, Section 4.3.5.2, the following additions are made to Table 4-3:

**Table 4-3 Federally Listed Avian Species Potentially Found in the General Study Area**

| Status | Species | Type | County of Occurrence |
|---|---|---|---|
| Candidate | Greater sage-grouse (*Centrocercus urophasianus*) | Avian | El Dorado |
| Endangered | California Clapper rail (*Rallus longirostris obsoletus*) | ***Avian*** | Alameda, Contra Costa, Marin, Monterey, Napa, Sacramento, San Francisco, San Mateo, Santa Clara, Santa Cruz, Solano, Sonoma |
| Endangered | California least tern (*Sterna antillarum browni*) | ***Avian*** | Monterey, Santa Cruz |

On Page 4-25, Section 4.3.6, the following addition is made to the text:

- A **Minority Population census tract** is defined as a tract having a minority population percentage greater than the average minority population percentage of the General Study Area. Based on the 2010 census data, the average percentage of minority population residing in the General Study Area was 41 percent. Therefore, every census tract with a percentage of minority population greater than 41 percent was identified as a census tract of environmental justice concern. ***A minority population is defined as "any readily identifiable groups of minority persons who live in geographic proximity, and if circumstances warrant, geographically dispersed/transient persons (such as migrant workers or Native Americans) who will be similarly affected by a proposed DOT program, policy or activity."[1] Minority means a person who is Black, Hispanic or Latino, Asian American, American Indian and Alaskan Native, or Native Hawaiian and Other Pacific Islander.[2]***

## Chapter 5

On Page 5-4, Section 5.1.2, the following corrections are made to the text to address a counting error:

> As discussed in Section 4.3.1.1, the NIRS model was used to compute DNL values for 2014 and 2019 Proposed Action and No Action Alternative conditions at three sets of data points throughout the General Study Area:
>
> 1. ~~53,141~~ ***98,282*** 2010 Census block centroids;

[1] **Order DOT 5610.2, *Environmental Justice,* May 2, 2012.**

[2] **Id.**

On Page 5-6, Section 5.2, the following additions are made to the text:

### 5.2.1 Summary of Impacts

Under both the Proposed Action and No Action Alternative, there would be no changes in aircraft noise exposure that would exceed the FAA's significance threshold for noise impacts on people. ***Likewise, there are no conflicts with Federal, regional, State, local land use plans, policies and controls.*** Therefore, neither the Proposed Action nor the No Action Alternative would result in compatible land use impacts.

### 5.2.2 Methodology

***FAA Order 1050.1E requires that EA documents discuss possible conflicts between the proposed action and the objectives of Federal, regional, State, local and Tribal land use plans, policies and controls for the area concerned.*** Potential impacts to compatible land use were focused on changes in aircraft noise exposure resulting from implementation of the Proposed Action. FAA Order 1050.1E states, "The compatibility of existing and planned land uses in the vicinity of an airport is usually associated with the extent of the airport's noise impact. If the noise analysis concludes that there is no significant impact, a similar conclusion usually may be drawn with respect to compatible land use."[3] ***Air traffic actions like the NorCal OAPM Project do not result in direct impacts to land such as ground disturbance.*** Accordingly, the compatible land use analysis relies on changes in aircraft noise exposure between the Proposed Action and the No Action Alternative (discussed in Section 5.1) as the basis for determining compatible land use impacts within the General Study Area.

### 5.2.3 Potential Impacts – 2014 and 2019

As stated in Section 5.1, the Proposed Action, when compared with the No Action Alternative, would not result in changes in aircraft noise exposure in 2014 or 2019 that would exceed FAA's significance threshold. ***Likewise, there are no conflicts with Federal, regional, State, local land use plans, policies and controls.*** Therefore, the Proposed Action would not result in significant compatible land use impacts.

On Page 5-14, Section 5.7.3, the following correction is made to the text to address an editing error:

**Table 5-5** presents the results of the fuel burn analysis for the Proposed Action and No Action Alternative. In comparison to the No Action Alternative, the Proposed Action would result in approximately ten MT more fuel burned in 2014 (0.40 percent increase) and approximately ten MT more fuel burned in 2019 (~~0.63~~ ***0.36*** percent increase). Given these relatively small increases, the FAA expects that when compared with the No Action Alternative, the Proposed Action would not adversely affect local fuel supplies. Therefore, no significant impacts to energy supply would be anticipated.

[3] U.S. Department of Transportation, Federal Aviation Administration, Order 1050.1E, Appendix A, Sec. 4.1.a.

On Page 5-18, Table 5-7, the following corrections are made to the table:

**Table 5-7 Past, Present, and Reasonably Foreseeable Future Actions**

| Airport Runway Related Projects | | |
|---|---|---|
| **Project** | **Description** | **Cumulative Effects Analysis** |
| SFO - San Francisco International Airport Runway Safety Area Program | This project consists of improvements to the runway safety areas (RSAs) at SFO. Project components include displacing the landing thresholds for Runways 28L and 28R by approximately 300 feet to the west to provide 600 feet of RSA; relocating the west end of the Runway 10R-28L pavement by approximately 781 feet west; shifting Runway 1R-19L approximately 200 feet to the south and reducing the north end of the runway by a similar distance; shifting Runway 1L-19R approximately 450 feet to the south and reducing the north end of the runway by a similar distance; constructing EMAS beds beyond the Runway 01L/19R and 01R/19L thresholds; constructing taxiway improvements; relocating NAVAIDs and lighting systems; implementing declared distances, and various other airfield improvements. Project construction is scheduled to commence in Summer 2014. | This project received a Finding of No Significant Impact (FONSI) Record of Decision (ROD) in December 9, 2011. The environmental analysis prepared for this project found no significant impacts to the environmental resources evaluated. No significant cumulative impacts are anticipated with the Proposed Action**.** |
| OAK - Oakland International Airport Runway Safety Area Improvement Project | This project involves shifting Runway 15/33 by 75 feet to the southeast; relocating the Runway ~~11~~ ***12*** approach threshold 520 feet to the northwest; displacing the Runway ~~29~~ ***30*** landing threshold 115 feet to the northwest; constructing an EMAS bed beyond the approach end of Runway ~~9R~~ ***10R****;* constructing taxiway improvements; relocating NAVAIDs and lighting systems; implementing declared distances, and various other airfield improvements. Project construction is scheduled to commence in late 2013.[1] | This project received a Finding of No Significant Impact (FONSI) Record of Decision (ROD) on August 17, 2012. The environmental analysis prepared for this project found no significant impacts to the environmental resources evaluated. No significant cumulative impacts are anticipated with the Proposed Action**.** |

***Notes: /1 OAK runway designations changed due to magnetic variation (MAGVAR) in October 2013.***

Source: City of San Francisco, Planning Department, *Mitigated Negative Declaration for the SFO Runway Safety Area Program*, November 2011 (http://sfmea.sfplanning.org/2010.0755E_FMND.pdf; accessed October 2013); U.S. Department of Transportation, Federal Aviation Administration *Finding of No Significant Impact/Record of Decision for the SFO Runway Safety Area Program*, December 2011 (https://archive.org/details/finalenvironment11ursc; accessed November 2013); U.S. Department of Transportation, Federal Aviation Administration, *Finding of No Significant Impact/Record of Decision for the Oakland International Airport Runway Safety Area Improvement Project*, August 2012 (http://www.portofoakland.com/environment/publications.aspx; accessed October 2013).

Prepared by: ATAC Corporation, December 2013.

## Appendix A

To document activity that occurred after the release of the Draft EA for public review, the following sections are added to Appendix A:

A.3.3 Section 106 Consultation Letters, April 8, 2014 ..... A-115
A.3.4 Section 106 Concurrence Letters ..... A-125
A.4 Draft EA Document Release and Public Workshop Notification ..... A-129
A.4.1 Notification Announcements, March/April 2014 ..... A-131
A.4.2 Project Website Announcement ..... A-153
A.4.3 Legal Notice Publication, March 25, 2014 ..... A-157
A.5 Draft EA Circulation and Public Inspection Locations ..... A-165
A.6 Public Information Workshops ..... A-171

## Appendix B

Tables B-1 and B-2 have been updated to include additional document preparers and reviewers for the Draft and Final EA.

# 1 Introduction

The National Environmental Policy Act of 1969 (NEPA) [42 United States Code (U.S.C.) § 4321 *et seq.*], requires federal agencies to disclose to decision makers and the interested public a clear, accurate description of the potential environmental impacts that could arise from proposed federal actions. Through NEPA, Congress has directed federal agencies to consider environmental factors in their planning and decision-making processes and to encourage public involvement in decisions that affect the quality of the human environment. As part of the NEPA process, federal agencies are required to consider the environmental effects of a proposed action, reasonable alternatives to the Proposed Action, and a No Action Alternative (i.e., analyzing the potential environmental effects of not undertaking the proposed action). The Federal Aviation Administration (FAA) has established a process to ensure compliance with the provisions of NEPA through FAA Order 1050.1E, Change 1, *Environmental Impacts: Policies and Procedures* (FAA Order 1050.1E).

This Environmental Assessment (EA), prepared in accordance with FAA Order 1050.1E, documents the potential effects to the environment that may result from the optimization of Air Traffic Control (ATC) procedures that would standardize aircraft routing to and from airports in Northern California, including San Francisco International Airport (SFO), Metropolitan Oakland International Airport (OAK), Norman Y. Mineta San José International Airport (SJC), and Sacramento International Airport (SMF). The Proposed Action, the subject of this EA, is called the Optimization of Airspace and Procedures in the Northern California Metroplex or "NorCal OAPM" Project. The procedures designed for the NorCal OAPM Project would be used by arriving and departing aircraft operating under Instrument Flight Rules (IFR) at the study area airports ("the Study Airports"), using currently available navigational technology.

This EA includes the following chapters and appendices:

- **Chapter 1: Introduction.** Chapter 1 provides basic background information on the air traffic system, the Next Generation Air Transportation System (NextGen) program, Performance-Based Navigation (PBN), the FAA's OAPM initiative, and information on the Northern California Metroplex and the Study Airports.
- **Chapter 2: Purpose and Need.** Chapter 2 discusses the need (i.e., problem) and purpose (i.e., solution) for airspace and procedure optimization in the Northern California Metroplex area, and identifies the Proposed Action.
- **Chapter 3: Alternatives.** Chapter 3 discusses the Proposed Action and the No Action Alternative analyzed as part of the environmental review process.
- **Chapter 4: Affected Environment.** Chapter 4 discusses existing environmental conditions within the Northern California Metroplex area.
- **Chapter 5: Environmental Consequences.** Chapter 5 discusses the potential environmental impacts associated with the Proposed Action and the No Action Alternative.
- **Appendix A: Agency Coordination, Public Involvement, and List of Receiving Parties. Appendix A** documents agency and public coordination associated with the EA process and lists the local agencies and parties identified to receive copies of the Draft and Final EA documents.

- **Appendix B: List of Preparers. Appendix B** lists the names and qualifications of the principal persons contributing information to this EA.
- **Appendix C: References. Appendix C** provides references to documents used to prepare the EA document.
- **Appendix D: List of Acronyms and Glossary. Appendix D** lists acronyms and provides a glossary of terms used in the EA.
- **Appendix E: Basics of Noise. Appendix E** presents information on aircraft noise as well as the general methodology used to analyze noise associated with aviation projects.
- **Appendix F: Responses to Comments on the Draft EA. Appendix F** presents comments from the public on the Draft EA received during the public comment period and responses to the comments prepared by the FAA.

## 1.1 Project Background

On January 16, 2009, the FAA asked RTCA[4] to create a joint government-industry task force to make recommendations for implementation of Next Generation Air Transportation System (NextGen) operational improvements for the nation's air transportation system. In response, RTCA assembled the NextGen Mid-Term Implementation Task Force (Task Force 5), which included more than 300 representatives from commercial airlines, general aviation, the military, aerospace manufacturers, and airport stakeholders.[5] Section 1.2.5 discusses the NextGen Program in more detail.[6]

On September 9, 2009, RTCA issued the NextGen Mid-Term Implementation Task Force Report, which provided the Task Force 5 recommendations. One of these recommendations directed the FAA to undertake planning for the implementation of Performance-Based Navigation (PBN)[7] procedures on a metroplex basis, including Area Navigation (RNAV) and Required Navigation Performance (RNP),[8] discussed further in Sections 1.2.5.1 and 1.2.5.2. Based on this recommendation, the FAA began the OAPM initiative.

The purpose of the OAPM initiative is to optimize air traffic procedures and airspace on a regional scale. This would be accomplished by developing procedures that take advantage of technological advances in navigation, such as RNAV, while ensuring that aircraft that are not equipped to use RNAV continue to have access to National Airspace System (NAS). This approach addresses congestion and other factors that reduce efficiency in busy

[4] RTCA, Inc. Executive Summary, *NextGen Mid-Term Implementation Task Force Report*, September 9, 2009.

[5] RTCA, Inc. is a private, not-for-profit corporation that develops consensus-based recommendations regarding communications, navigation, surveillance (CNS), and air traffic management (ATM) system issues. RTCA functions as a federal advisory committee and includes roughly 400 government, industry, and academic organizations from the United States and around the world. Members represent all facets of the aviation community, including government organizations, airlines, airspace users, airport associations, labor unions, and aviation service and equipment suppliers. More information is available at http://www.rtca.org.

[6] RTCA Inc., Executive Summary, *NextGen Mid-Term Implementation Task Force Report*, September 9, 2009.

[7] Additional information on Performance-Based Navigation (PBN) is provided on the FAA Fact Sheet, "NextGen Goal: Performance-Based Navigation," April 24, 2009 [http://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=8768 (accessed April 11, 2012)].

[8] A Metroplex is a geographic area covering several airports, serving major metropolitan areas and a diversity of aviation stakeholders.

metroplex areas and accounts for key operating airports and airspace in the metroplex. The NorCal OAPM Study Airports are further discussed in Section 1.4. The OAPM initiative also addresses connectivity with other metroplex areas. The overall intent is to use limited airspace as efficiently as possible for congested metroplex areas.[9]

## 1.2 Air Traffic Control and the National Airspace System

The following sections provide basic background information on air traffic control and the NAS. This information includes a description of the NAS, the role of Air Traffic Control (ATC), the methods used by air traffic controllers to manage the Air Traffic Control system, and the different phases of aircraft flight within the NAS. Following this discussion, information is provided on the FAA's NextGen program and the OAPM initiative.

### 1.2.1 National Airspace System

Under the Federal Aviation Act of 1958 (49 USC § 40101 *et seq*.), the FAA is delegated control over use of the nation's navigable airspace and regulation of domestic civil and military aircraft operations in the interest of maintaining safety and efficiency. To help fulfill this mandate, the FAA established the NAS. Within the NAS, the FAA manages aircraft takeoffs, landings, and the flow of aircraft between airports through a system of infrastructure (e.g., air traffic control facilities), people (e.g., air traffic controllers, maintenance, and support personnel), and technology (e.g., radar, communications equipment, ground-based navigational aids [NAVAIDs],[10] etc.) The NAS is governed by various FAA rules and regulations.

The NAS comprises one of the most complex aviation networks in the world. The FAA continuously reviews the design of all NAS resources to ensure they are effectively and efficiently managed. The FAA Air Traffic Organization (ATO) is the primary organization responsible for managing airspace and flight procedures used in the NAS. When changes are proposed to the NAS, the FAA works to ensure that the changes maintain or enhance system safety and improve efficiency. One way to accomplish this mission is to employ emerging technologies to increase system flexibility and predictability.[11]

### 1.2.2 Air Traffic Control within the National Airspace System

The combination of infrastructure, people, and technology used to monitor and guide (or direct) aircraft within the NAS is referred to collectively as ATC. One of ATC's responsibilities is to maintain safety and expedite the flow of traffic in the NAS through enforcement of defined minimum distances between aircraft (referred to as "separation"). This is accomplished through required communications between air traffic controllers and pilots and the use of navigational technologies such as radar.

Aircraft operate under two distinct categories of flight rules: Visual Flight Rules (VFR) and Instrument Flight Rules (IFR).[12] Under VFR, pilots are responsible to "see and avoid" other

[9] U.S. Department of Transportation, Federal Aviation Administration, *FAA Response to Recommendations of the RTCA NextGen Mid-Term Implementation Task Force*, January 2010, p. 14.

[10] NAVAIDs are facilities that transmit signals that define key points or routes.

[11] U.S. Department of Transportation, Federal Aviation Administration, Order JO 7400.2G, Change 3, *Procedures for Handling Airspace Matters*, Section 32-3-5(b) "National Airspace Redesign," April 10, 2008.

[12] 14 Code of Federal Regulations (C.F.R.), Part 91.

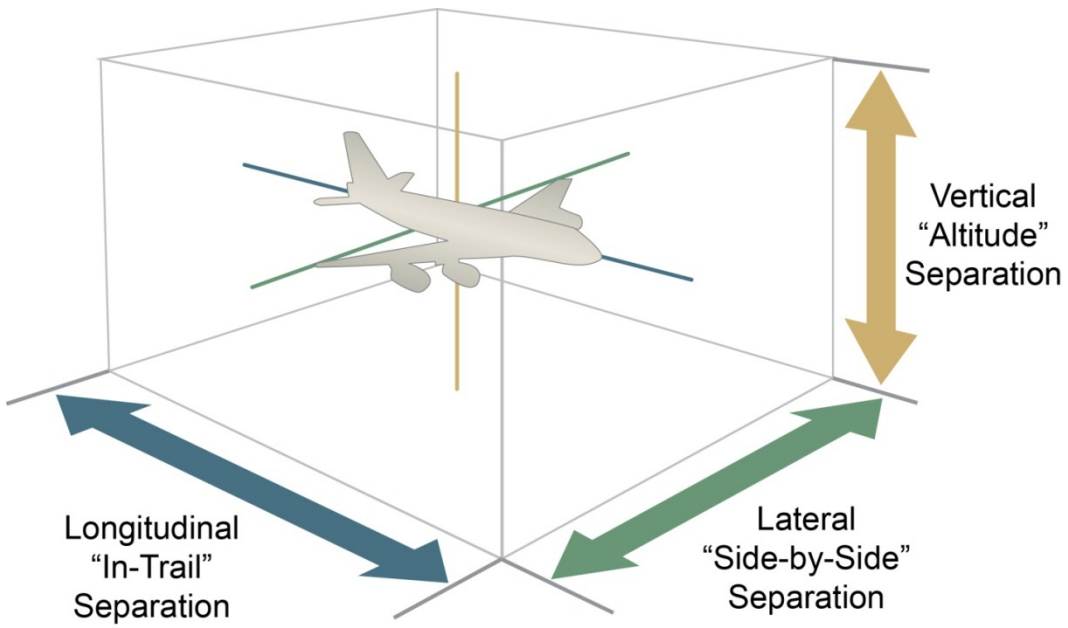
aircraft and obstacles such as terrain to maintain safe separation yet have greater flexibility to choose altitudes and routes. Under IFR, aircraft operators are required to file flight plans and use navigational instruments to operate within the NAS. The majority of commercial air traffic operates under IFR.

Depending on whether aircraft are operating under IFR or VFR, air traffic controllers apply various techniques to maintain separation between aircraft,[13] including the following:

- **Vertical or "Altitude" Separation:** separation between aircraft operating at different altitudes;
- **Longitudinal or "In-Trail" Separation:** separation between two aircraft operating along the same flight route referring to the distance between a lead and a following aircraft; and,
- **Lateral or "Side-by-Side" Separation:** separation between aircraft (left or right side) operating along two separate but nearby flight routes.

**Exhibit 1-1** depicts the three dimensions around an aircraft used to determine separation.

**Exhibit 1-1 Three Dimensions Around an Aircraft**



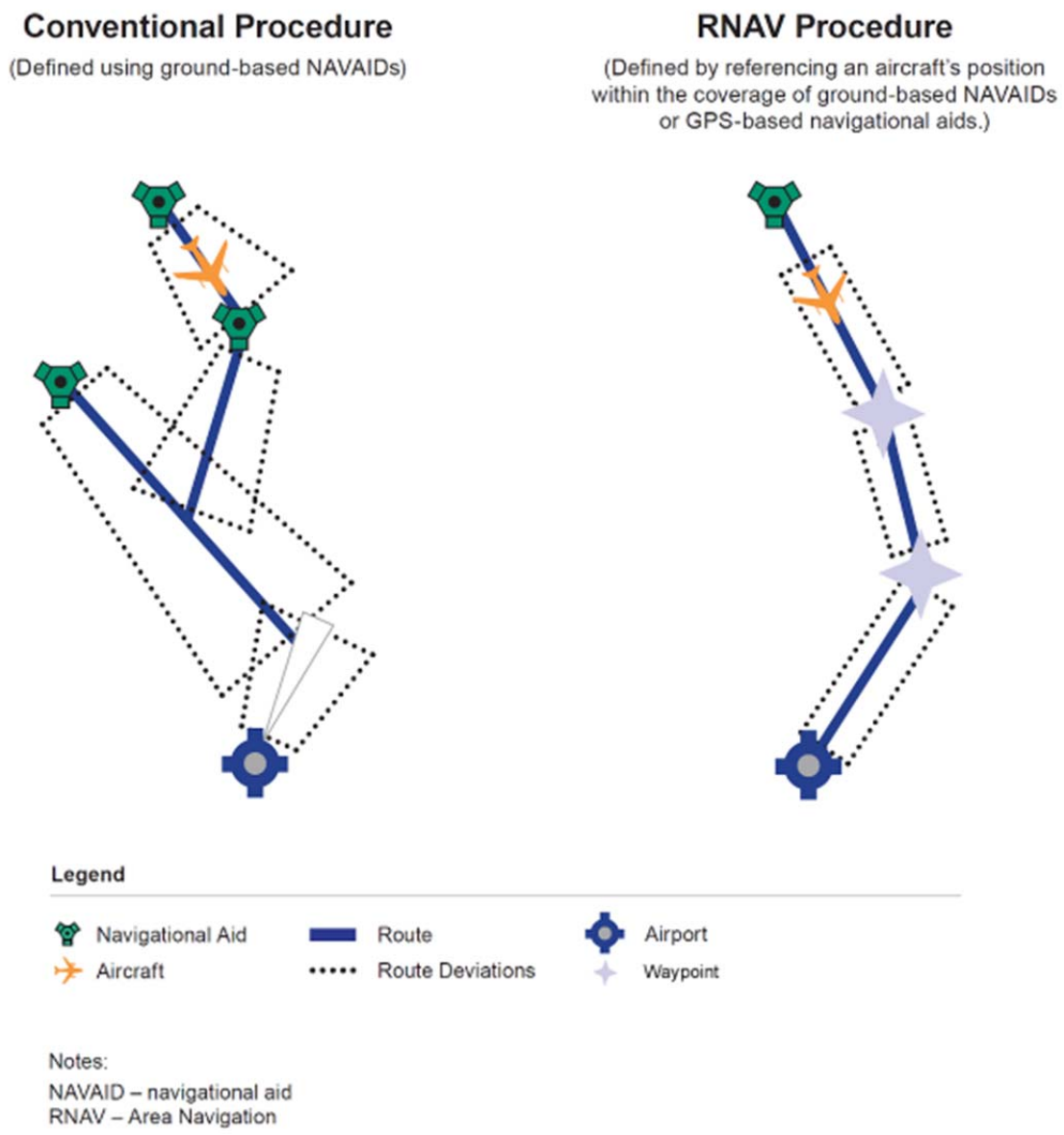

Source: ATAC Corporation, December 2012.
Prepared by: ATAC Corporation, October 2013.

Air traffic controllers use radar to monitor all aircraft and provide services that ensure separation. Published instrument procedures are tools used by ATC to provide predictable, efficient routes that move aircraft through the NAS in a safe and orderly manner. These procedures minimize the need for communication between air traffic controllers and pilots.

[13] Defined in FAA Order 7110.65U, *Air Traffic Control*.

Published instrument procedures are described as "conventional" procedures when they use ground-based NAVAIDs or are based on verbal instructions (vectors) issued by an air traffic controller. In its effort to modernize the NAS, the FAA is developing instrument procedures that use advanced technologies. A primary technology being applied in this effort is RNAV. RNAV uses Global Positioning System (GPS) technology to allow an RNAV-equipped aircraft to fly a more efficient route. This route is based on instrument guidance that references an aircraft's position relative to ground-based NAVAIDs or satellites. **Exhibit 1-2** compares a conventional procedure and an RNAV procedure.

**Exhibit 1-2 Comparison of Routes Following Conventional versus RNAV Procedures**




Source: U.S. Department of Transportation, Federal Aviation Administration, "Performance-Based Navigation (PBN)" brochure, 2009.
Prepared by: ATAC Corporation, March 2014.

ATC uses a variety of tools and coordination techniques to maintain safety within the NAS, including:

- **Vectors:** Headings issued to aircraft to provide navigational guidance and to maintain separation between aircraft and/or obstacles.
- **Speed Control:** Direction issued to aircraft to reduce or increase aircraft speed to maintain separation between aircraft.
- **Holding Pattern/Ground Hold:** Controllers assign aircraft to a holding pattern in the air or hold aircraft on the ground before departure to maintain separation between aircraft and to manage arrival/departure volume.
- **Altitude Assignment/Level-off:** Controllers assign altitudes to maintain separation between aircraft and/or to protect airspace. This may result in aircraft "leveling off" during ascent or descent.
- **Reroute:** Controllers may change an aircraft's route for a variety of reasons, such as avoidance of inclement weather, to maintain separation between aircraft, and/or to protect airspace.
- **Point-out:** Notification issued by one controller when an aircraft might pass through or affect another controller's airspace and radio communications will not be transferred.

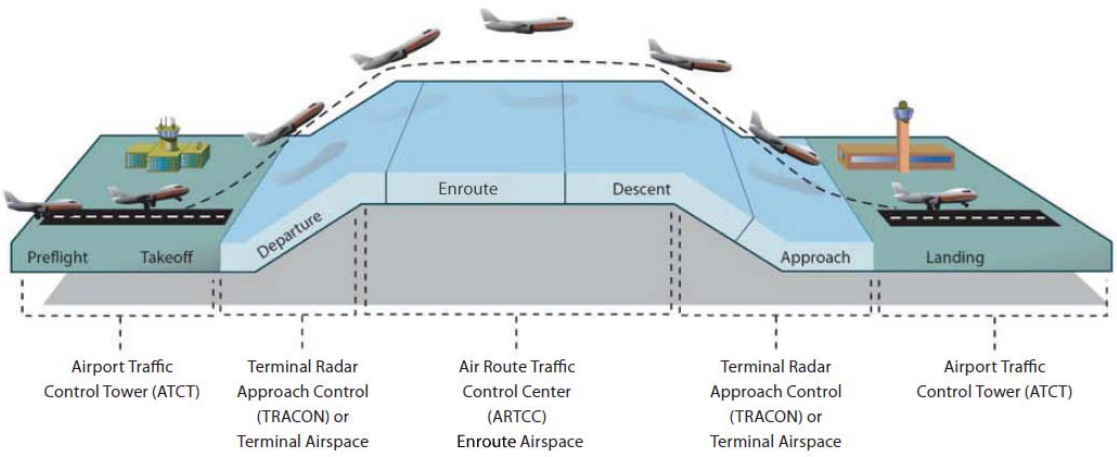
As an aircraft moves from origin to destination, ATC personnel function as a team and transfer control of the aircraft from one controller to the next, and from one ATC facility to the next.

### 1.2.3 Aircraft Flow within the National Airspace System

An aircraft traveling from airport to airport typically operates through six phases of flight (plus a "preflight" phase.) **Exhibit 1-3** depicts the typical phases of flight for a commercial aircraft. These phases include:

- **Preflight (Flight Planning):** The preflight route planning and flight checks performed in preparation for takeoff.
- **Push Back/Taxi/Takeoff:** The aircraft's transition across the airfield from push-back at the gate, taxiing to an assigned runway, and takeoff from the runway.
- **Departure:** The aircraft's in-flight transition from takeoff to the enroute phase of flight, during which it climbs to the assigned cruising altitude.
- **Enroute:** Generally, the level segment of flight (i.e., cruising altitude) between the departure and destination airports.
- **Descent:** The aircraft's in-flight transition from an assigned cruising altitude to the point at which the pilot initiates the approach to a runway at the destination airport.
- **Approach:** The segment of flight during which an aircraft follows a standard procedure that guides the aircraft to the landing runway.
- **Landing:** Touch-down of the aircraft at the destination airport and taxiing from the runway to the gate or parking position.

**Exhibit 1-3 Typical Phases of a Commercial Aircraft Flight**



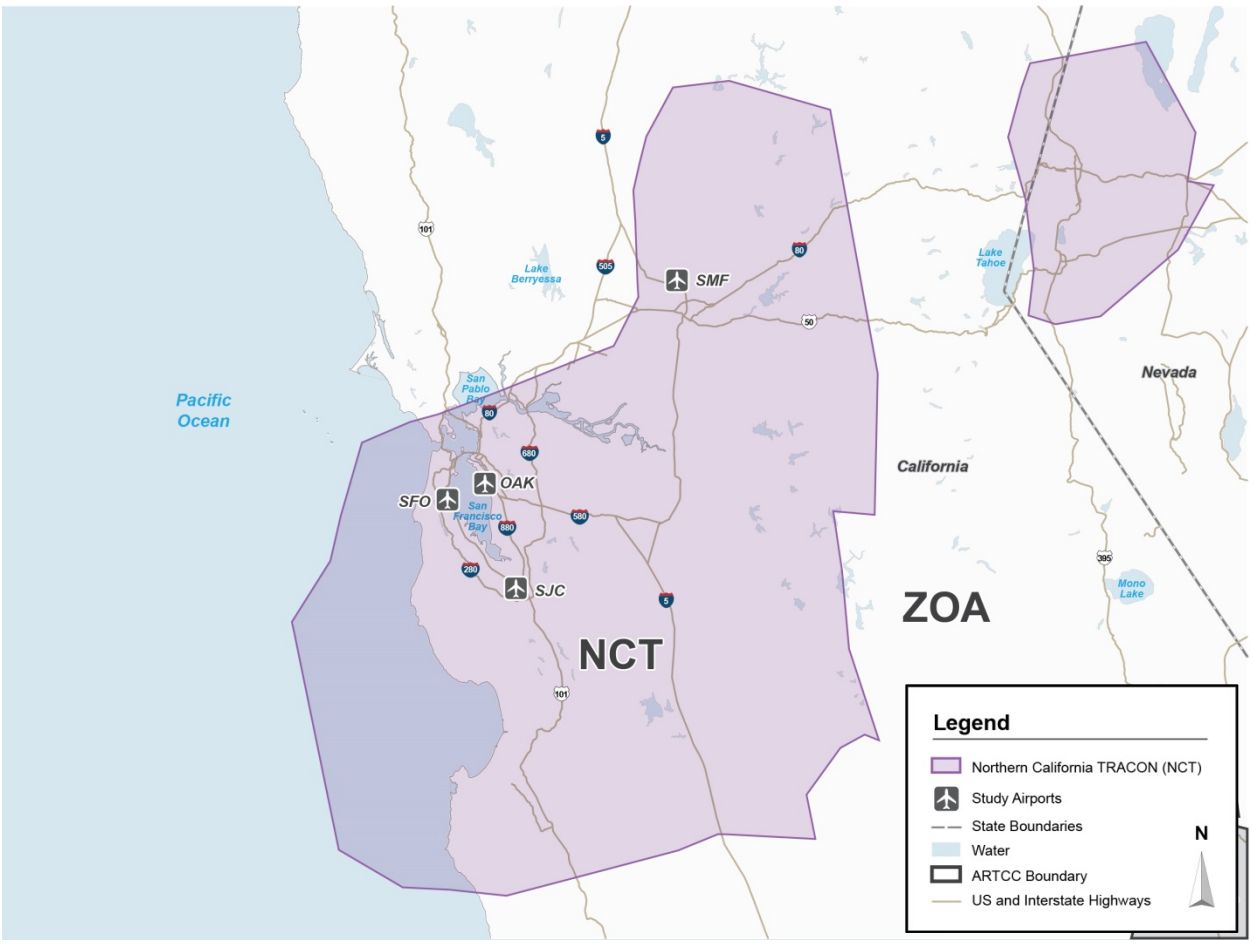

Source: U.S. Department of Transportation, Federal Aviation Administration, Houston Area Air Traffic System (HAATS), Airspace Redesign, Final Environmental Assessment, Figure 1.1.1-1, March 2008.
Prepared by: ATAC Corporation, March 2014.

## 1.2.4 Air Traffic Control Facilities

The NAS is organized into three-dimensional areas of navigable airspace (defined by a floor, a ceiling, and a lateral boundary), managed by different types of ATC facilities including:

- **Air Traffic Control Tower:** Controllers at an Air Traffic Control Tower (ATCT) located at an airport manage phases of flight associated with aircraft takeoff and landing. The ATCT typically controls airspace extending from the airport out to a distance of several miles.
- **Terminal Radar Approach Control:** Controllers at a Terminal Radar Approach Control (TRACON) facility manage aircraft as they transition between an airport and the enroute phase of flight. This includes the departure, climb, descent, and approach phases of flights. The TRACON airspace is broken down into sectors managed by individual TRACON controllers. As an aircraft moves between sectors, responsibility for management of that aircraft is transferred from controller to controller. Controllers maintain separation between aircraft that operate within their sectors. The terminal airspace in the Northern California Metroplex area is referred to as Northern California TRACON, or "NCT and is shown on **Exhibit 1-4**.
- **Air Route Traffic Control Centers:** Controllers at Air Route Traffic Control Centers (ARTCCs or "Centers") manage the flow of traffic during the enroute phase of flight. Similar to TRACON airspace, the Center airspace is broken down into sectors managed in a similar manner by individual controllers. As shown on **Exhibit 1-4**, the Northern California Metroplex is comprised of airspace delegated to the Oakland ARTCC (ZOA) and NCT.

**Exhibit 1-4 Airspace in the Northern California Metroplex Area**




***Notes:***
*SFO – San Francisco International Airport*
*SJC – Norman Y. Mineta San José International Airport*
*NCT –NorCal TRACON*
*OAK – Oakland Metropolitan International Airport*
*SMF – Sacramento International Airport*
*ZOA – Oakland ARTCC*

Sources: U.S. Department of Transportation, Federal Aviation Administration, National Flight Data Center, National Airspace System Resources, Airport, and Runway databases, accessed September 16, 2012 (airspace boundaries); National Atlas of the United States of America (U.S. County and State Boundaries, Water Bodies); Bureau of Transportation Statistics, National Transportation Atlas Database; ATAC Corporation (Study Area Boundary).
Prepared by: ATAC Corporation, October 2013.

The following sections discuss how air traffic controllers at these ATC facilities control the phases of flight for aircraft operating under IFR.

### 1.2.4.1 Departure Flow

As an aircraft operating under IFR departs a runway and follows its assigned heading, it moves from the ATCT airspace, through the terminal airspace, and into enroute airspace where it proceeds on a specific route to its destination airport.

Within the terminal airspace, TRACON controllers manage aircraft departing from the ATCT airspace to transfer control points referred to as “exit gates.” An exit gate represents an area along the boundary between terminal airspace and enroute airspace. Exit gates are generally established near commonly used routes to better facilitate transfer of aircraft

between terminal and enroute airspace. When aircraft pass through the exit gate, control is transferred from TRACON to ARTCC controllers as an aircraft joins a specific route.

***Standard Instrument Departures***

Departing aircraft operating under IFR use a procedure called a Standard Instrument Departure (SID). A SID provides pilots with defined lateral and vertical guidance to facilitate safe and predictable navigation from an airport through the terminal airspace to a specific route in the enroute airspace. A "conventional" SID follows a route defined by ground-based NAVAIDs, may be based on vectoring, or a combination of both. Because of the increased precision inherent in RNAV technology, an RNAV SID, which uses GPS-based navigation, defines a more predictable route through the airspace than does a conventional SID. Currently, all SIDs in effect at the Study Airports are conventional.

Some RNAV SIDs may be designed to include paths called "runway transitions" that serve particular runways at airports. A SID may have several runway transitions serving one or more runways at one or more airports. From the runway transition, aircraft may follow a common path before being directed along one or several diverging routes referred to as "enroute transitions." Enroute transitions may terminate at exit fixes or continue into enroute airspace where aircraft join a specific route.

#### 1.2.4.2 Arrival Flow

An aircraft will begin the descent phase of flight within the enroute airspace. During descent, the aircraft will pass into the terminal airspace through an "entry gate," bound for the destination airport. The entry gate represents a point along the boundary between terminal airspace and enroute airspace where control of the aircraft is passed from ARTCC to TRACON controllers.

***Standard Terminal Arrival Routes***

Aircraft that arrive within the terminal airspace normally follow an instrument procedure called a Standard Terminal Arrival Route (STAR). Aircraft leaving enroute airspace and entering terminal airspace may follow an enroute transition from an entry fix to the STAR's common route in the terminal airspace. From the common route segment, aircraft may follow a runway transition before making an approach to the airport. However, not all STARs include enroute or runway transitions.

#### 1.2.4.3 Required Aircraft Separation

As controllers manage the flow of aircraft into, out of, and within the NAS, they maintain the following separation distances between aircraft:

- **Altitude Separation (vertical):** When operating below 41,000 feet above mean sea level (MSL), two aircraft on separate routes must be at least 1,000 feet above/below each other until lateral separation is ensured.
- **In-Trail Separation (longitudinal):** Within a radar controlled area, the minimum distance between two aircraft on the same route (i.e., in-trail) can between three to ten miles, depending on factors such as aircraft class, weight, and type of airspace.
- **Side-by-Side Separation (lateral):** Similar to in-trail separation, the minimum side-by-side (left or right side of an aircraft) separation between aircraft must be at least three miles in the terminal airspace and five miles in the enroute airspace.

## 1.2.5 Next Generation Air Transportation System

The NextGen program is the FAA's long-term plan to modernize the NAS through evolution from a ground-based system of air traffic control to a GPS-based system of air traffic management.[14] The OAPM initiative is a key step in the overall process of transitioning to the NextGen system by 2018. Achieving the NextGen ATC system requires implementation of PBN procedures, including RNAV and RNP, which use GPS-based technology, aircraft "auto-pilot", and Flight Management System (FMS)[15] capabilities. RNAV and RNP capabilities are now readily available and PBN can serve as the primary means aircraft use to navigate along a route. As of 2011, 92 percent of U.S. scheduled air carriers were equipped for some level of RNAV.[16] The following sections describe PBN procedures in greater detail.

### 1.2.5.1 RNAV

**Exhibit 1-5** compares conventional and RNAV routes. RNAV enables aircraft traveling through terminal and enroute airspace to follow more accurate and better-defined routes in areas covered by GPS-based NAVAIDs. This results in more predictable routes and altitudes that can be pre-planned by the pilot and air traffic control. Predictable routes provide the ability to ensure vertical, longitudinal, and lateral separation between aircraft.

Routes based on ground-based NAVAIDs are often limited by issues such as line-of-sight and signal reception accuracy. NAVAIDs such as VHF Omnidirectional Range (VOR) are affected by variable terrain and other obstructions that can limit their signal accuracy. Consequently, routes dependent upon ground-based NAVAIDS require at least six nautical miles (nm) of clearance on either side of a route's main path to ensure accurate signal reception. As demonstrated by the dashed lines on **Exhibit 1-5**, this clearance requirement increases the farther an aircraft is from the VOR. In comparison, RNAV signal accuracy requires only two nm of clearance on either side of a route's main path.

RNAV routes can mirror conventional routes or by using satellite technology, provide routes within the airspace that were not previously possible with ground-based NAVAIDs.

### 1.2.5.2 RNP

RNP is an RNAV procedure that is enhanced by the use of onboard performance monitoring and alerting systems. A defining characteristic of an RNP operation is the ability for an RNP-capable aircraft navigation system to monitor the accuracy of its navigation (based on the number of GPS satellite signals available to pinpoint the aircraft location) and inform the crew if the required data becomes unavailable.

**Exhibit 1-5** compares conventional, RNAV, and RNP procedures and shows how an RNP capable aircraft navigational system provides a more accurate location (down to less than a mile from the intended path) and will follow a highly predictable path. The enhanced accuracy and predictability makes it possible to implement procedures within controlled airspace that are not always possible under the current air traffic system.

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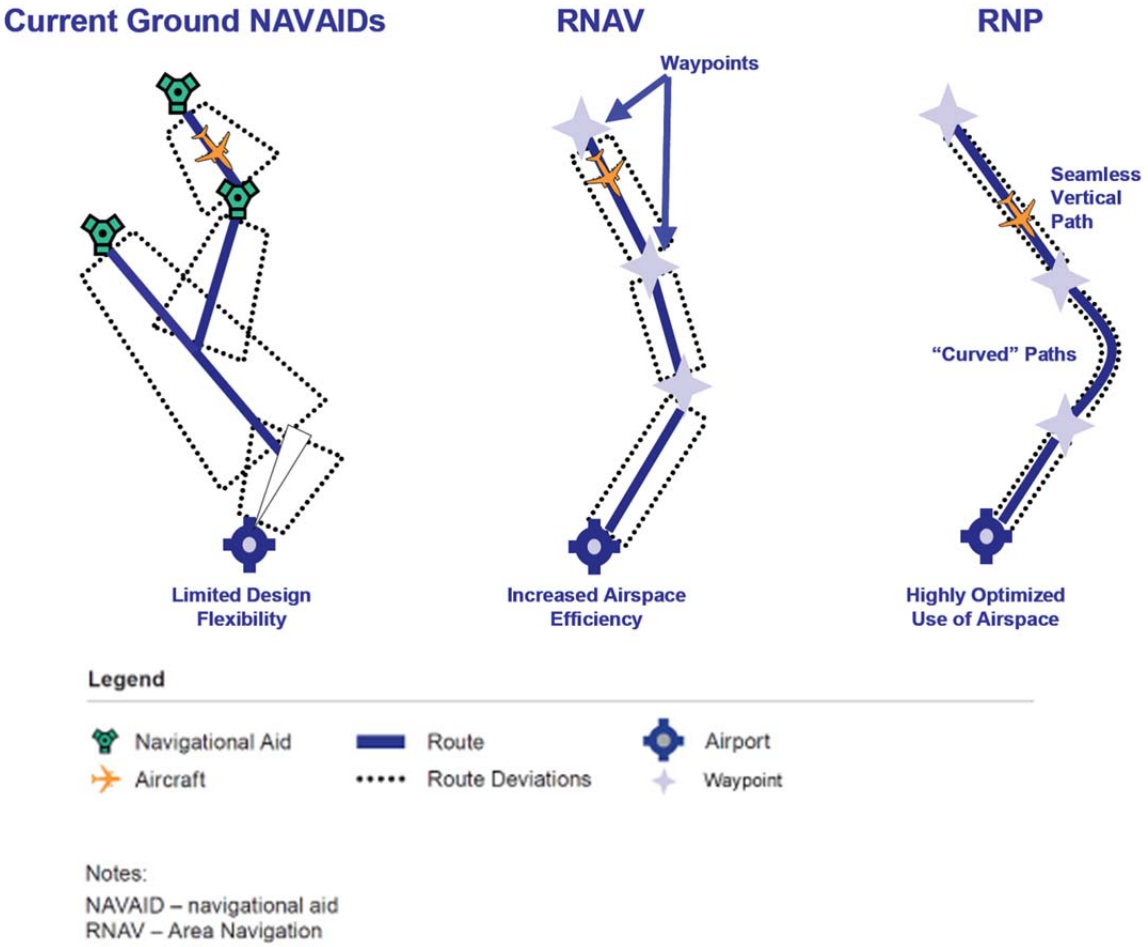
[14] U.S. Department of Transportation, Federal Aviation Administration, Fact Sheet, "NextGen Goal: Performance-Based Navigation," April 24, 2009 [http://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=8768 (accessed April 11, 2012)].

[15] A Flight Management System (FMS) is an onboard computer that uses inputs from various sensors (e.g., GPS and inertial navigation systems) to determine the geographic position of an aircraft and help guide it along its flight path.

[16] U.S. Department of Transportation, Federal Aviation Administration, *NextGen Implementation Plan-2011*, March 2011, p. 12.

**Exhibit 1-5 Navigational Comparison – Conventional/RNAV/RNP**

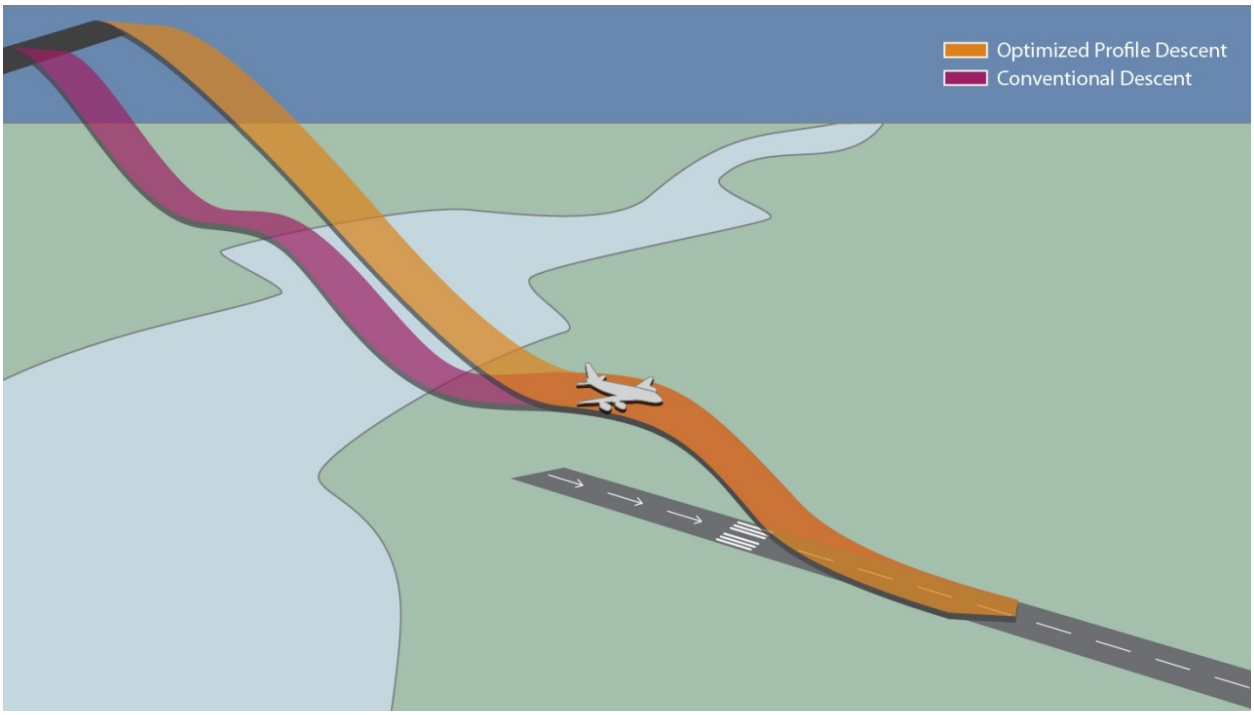



Source: U.S. Department of Transportation, Federal Aviation Administration, "Performance-Based (PBN) Brochure," October 2009.
Prepared by: ATAC Corporation, March 2013.

### 1.2.5.3 Optimized Profile Descent

An Optimized Profile Descent (OPD) is a flight procedure that allows the aircraft FMS to fly continuously from the top of descent to landing with minimal level-off segments. **Exhibit 1-6** illustrates an OPD procedure compared to a conventional descent. Aircraft that fly OPDs can maintain higher altitudes and lower thrust for longer periods. As level-off segments are eliminated, OPDs reduce the need for communications between controllers and pilots.

**Exhibit 1-6 Optimized Profile Descent Compared to a Conventional Descent**




Source: ATAC Corporation, December 2012.
Prepared by: ATAC Corporation, October 2013.

### 1.2.6 The OAPM Initiative

As part of the OAPM initiative, the FAA will design and implement RNAV procedures that take advantage of the technology that is readily available in a majority of commercial service aircraft. The OAPM initiative specifically addresses congestion, airports in close geographical proximity, and other limiting factors that reduce efficiency in busy metroplex airspace. Efficiency is improved by expanding the implementation of RNAV-based standard instrument procedures and connecting the routes defined by the standard instrument procedures to high- and low-altitude RNAV routes. Efficiency is further improved by using RNAV to maximize the use of the limited airspace in congested metroplex environments.

## 1.3 The Northern California Metroplex

The following sections describe the airspace structure and existing standard instrument procedures of the Northern California Metroplex that would be affected by the NorCal OAPM Project.

### 1.3.1 Northern California Metroplex Airspace

**Exhibit 1-4** depicts the airspace structure in the Northern California Metroplex. The Northern California Metroplex consists of airspace delegated to NCT and ZOA. ZOA abuts airspace controlled by the Los Angeles (ZLA), Salt Lake City (ZLC), and Seattle (ZSE) ARTCCs. Excluding airspace delegated to the ATCTs at controlled airports, NCT controllers currently manage airspace from the surface to 19,000 feet MSL over the Northern California Metroplex area. ZOA controllers manage the airspace above and surrounding the NCT airspace.

The lateral boundary of the NCT airspace is irregularly shaped, roughly circular over the San Francisco Bay Area with a panhandle that extends north over the Sacramento area and an island east of Lake Tahoe over the Reno area. From SFO, the primary NCT boundary extends approximately 25 nm west and north, approximately 85 nm to the southwest, approximately 92 nm to the south, 115 nm to the southeast, approximately 80 nm to the east, and approximately 120 nm to the northeast.

#### 1.3.1.1 Northern California Metroplex Special Use Airspace

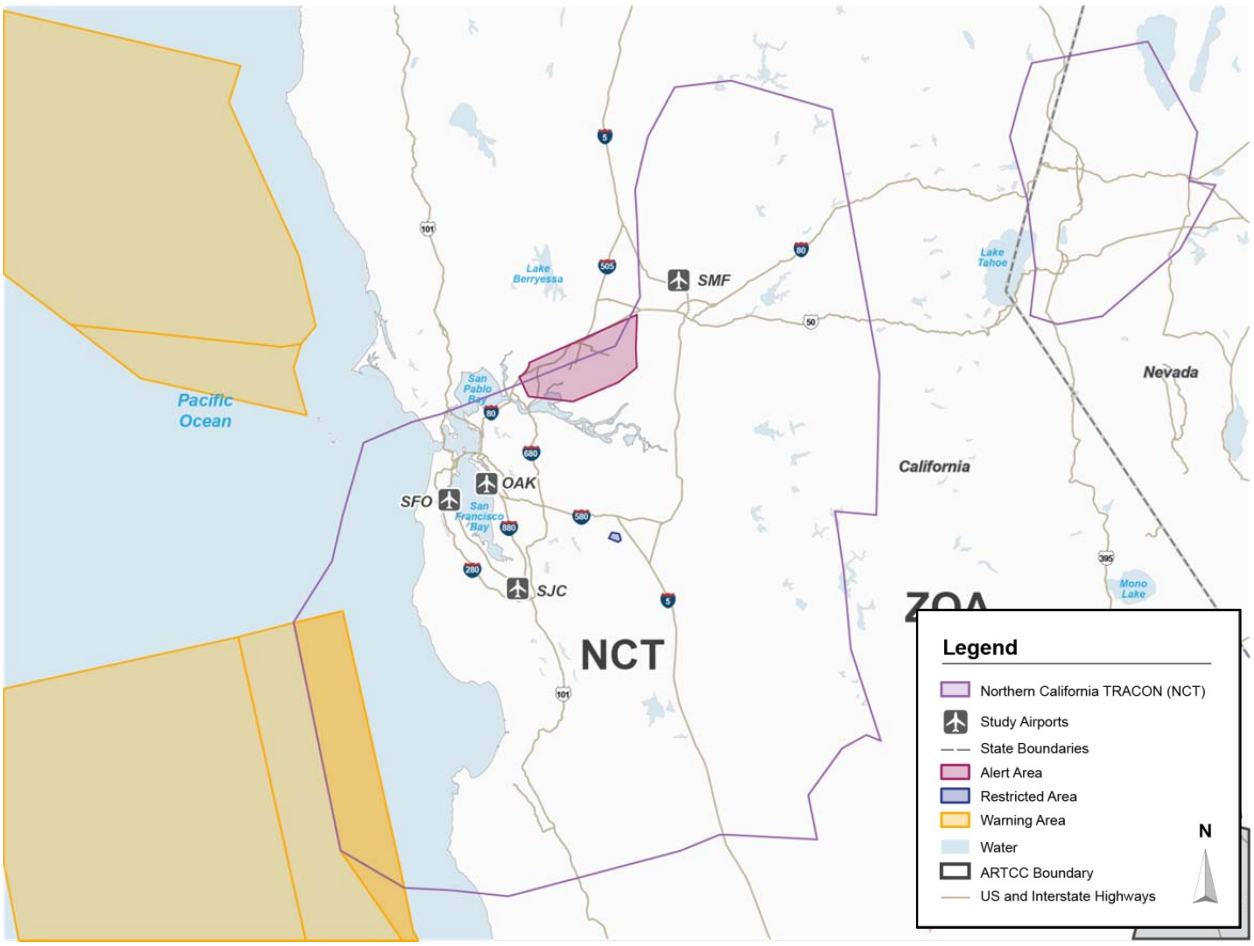
**Exhibit 1-7** depicts the boundaries of Special Use Airspace (SUA) in the Northern California Metroplex. SUA is airspace with defined boundaries in which certain activities such as military flight training and air-to-ground military exercises must be confined. These areas either restrict other aircraft from entering or limit aircraft activity allowed within the airspace. Three types of SUA are found within the Northern California Metroplex:

- **Alert Areas:** Alert areas are depicted on an aeronautical chart to inform pilots of areas that may contain a high volume of pilot training or an unusual type of aerial activity.
- **Restricted Area:** Restricted areas contain airspace identified by an area within which aircraft, while not wholly prohibited, are subject to restrictions when the area is being used. The area denotes the existence of unusual, often invisible hazards to aircraft such as artillery firing, aerial gunnery, or guided missiles. Entering a restricted area without authorization may be extremely hazardous to the aircraft and its occupants. When the area is not being used, control of the airspace is released to the FAA and ATC can use the area for normal operations.
- **Warning Area:** Warning areas are airspace of defined dimensions, extending from three nm outward from the coast of the U.S. in which activity may occur that is hazardous to non-participating aircraft. The purpose of warning areas is to warn pilots of potential danger. A warning area may be located over domestic and/or international waters.

### 1.3.2 Current STARs and SIDs

As of December 2011, 51 published STARs and SIDs serve the airports within the NCT terminal airspace. Of these, all but two are conventional procedures. One RNAV STAR serves SFO and one RNAV STAR serves OAK. There are no RNAV SIDs directly serving the Study Airports.

**Exhibit 1-7 Special Use Airspace**




***Notes:***

*SFO – San Francisco International Airport*
*OAK – Oakland Metropolitan International Airport*
*SJC – Norman Y. Mineta San José International Airport*
*SMF – Sacramento International Airport*
*NCT –NorCal TRACON*
*ZOA – Oakland ARTCC*

Sources: U.S. Department of Transportation, Federal Aviation Administration, National Flight Data Center (NFDC), National Airspace System Resources, Airport, and Runway databases, accessed September 16, 2012 (airspace boundaries); National Atlas of the United States of America (U.S. County and State Boundaries, Water Bodies); Bureau of Transportation Statistics,

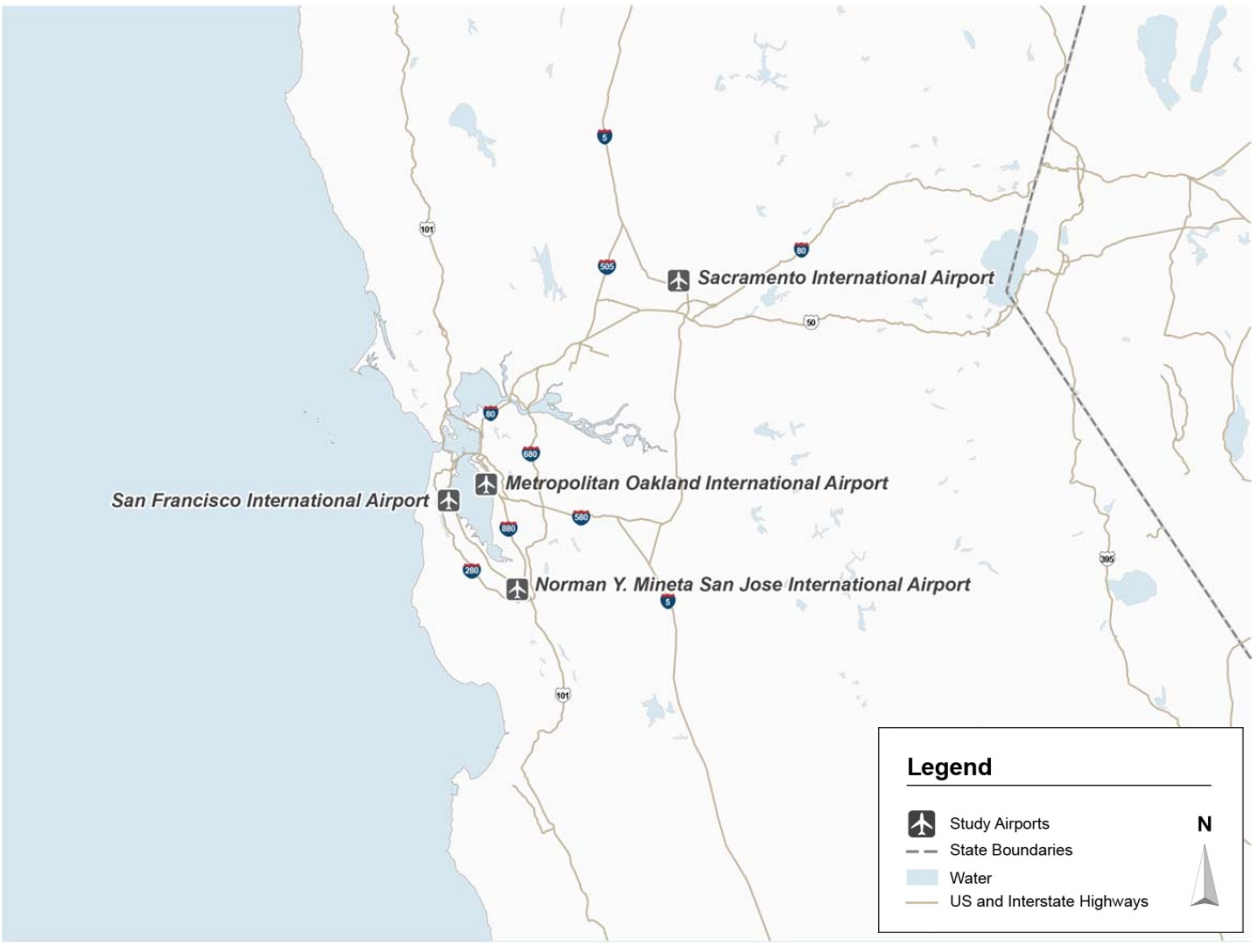
Prepared by: ATAC Corporation, August 2013.

## 1.4 Northern California Metroplex Airports

**Exhibit 1-8** shows the locations of the four NorCal OAPM Study Airports. These airports include San Francisco International Airport, Metropolitan Oakland International Airport, Norman Y. Mineta San José International Airport, and Sacramento International Airport. The following sections describe each of the Study Airports.

**San Francisco International Airport (SFO)** is located approximately 10 nm southwest of OAK. SFO is classified as a large-hub commercial service airport under the National Plan of Integrated Airport Systems (NPIAS). SFO has four runways, described in **Table 1-1**. As of December 2011, SFO arrivals may be assigned one RNAV STAR or one of eight conventional STARs. Departing aircraft may be assigned one of 11 conventional SIDs.

**Exhibit 1-8 Study Airport Locations**




Sources: U.S. Department of Transportation, Federal Aviation Administration, National Flight Data Center (NFDC), National Airport, and Runway databases; National Atlas of the United States of America (U.S. County and State Boundaries, Water Bodies); Bureau of Transportation Statistics, National Transportation Atlas Database; ATAC Corporation (Study Area Boundary).
Prepared by: ATAC Corporation, October 2013.

**Metropolitan Oakland International Airport (OAK)** is located approximately 10 nm northeast of SFO and accommodates a mix of commercial, corporate and general aviation activity. OAK is classified as a large-hub commercial service airport in the NPIAS. The airport has three runways, described in **Table 1-1**. As of December 2011, OAK IFR arrivals may be assigned one RNAV STAR or one of seven conventional STARs depending upon where they enter the terminal airspace. Departing aircraft may be assigned one of nine conventional SIDs.

**Norman Y. Mineta San José International Airport (SJC)** is located approximately 36 nm southeast of SFO. SJC is classified as a large-hub commercial service airport under the NPIAS. The airport has two runways, described in **Table 1-1**. As of December 2011, arriving IFR aircraft may be assigned to one of seven conventional STARs, depending on where they enter the terminal airspace. Departing aircraft may be assigned one of six conventional SIDs.

**Sacramento International Airport (SMF)** is located approximately 75 nm northeast of SFO. SMF is classified as a large-hub commercial service airport under the NPIAS. SMF

has two runways, described in **Table 1-1**. As of December 2011, arriving IFR aircraft may be assigned to one of three conventional STARs, depending on where they enter the terminal airspace. Departing aircraft may be assigned one of two conventional SIDs.

**Table 1-1 NorCal Metroplex EA Study Airports**

| Airport Name | Airport Code | Location | Runways[1/] |
|---|---|---|---|
| **Major Airports** | | | |
| San Francisco International Airport | SFO | San Francisco, CA | 10L, 28R,10R, 28L, 01R, 19L, 01L, 19R |
| Metropolitan Oakland International Airport | OAK | Oakland, CA | 11, 29, 09R, 27L, 09L, 27R, 15, 33 |
| Norman Y. Mineta San José International Airport | SJC | San José, CA | 12L, 30R, 12R, 30L, 11[a], 29[a] |
| Sacramento International Airport | SMF | Sacramento, CA | 16L, 34R 16R, 34L |

*Notes:*
*1/ A runway can be used in both directions, but are named in each direction separately. The runway number is based on the magnetic direction of the runway (e.g., Runway 09 points to the east direction). The two numbers on either side always differ by 180 degrees. If there is more than one runway pointing in the same direction, each runway number includes an "L," "C," or "R" at the end. This is based on which side a runway is next to another one in the same direction.*
*a/ Runway 11/29 is closed indefinitely.*

Source: U.S. Department of Transportation, Federal Aviation Administration, Digital Airport/Facility Directory, January 1, 2013 [http://aeronav.faa.gov/index.asp?xml=aeronav/applications/d_afd (accessed February 13, 2012)].
Prepared by: ATAC Corporation, October 2013.

As shown in **Table 1-2**, in 2011, approximately 73 percent of all IFR traffic within the Northern California Metroplex area operated at the major Study Airports.

**Table 1-2 2011 IFR Operations at Study Airports in NCT**

| Airport | IFR Operations | Percent of Total Operations |
|---|---|---|
| San Francisco International Airport | 397,965 | 98.5% |
| Metropolitan Oakland International Airport | 149,557 | 69.3% |
| Norman Y. Mineta San José International Airport | 123,457 | 89.9% |
| Sacramento International Airport | 105,714 | 89.9% |
| **Total IFR Operations** | **776,693** | **73.05%** |
| **Total NCT IFR Operations** | **1,063,290** | **72.61%** |

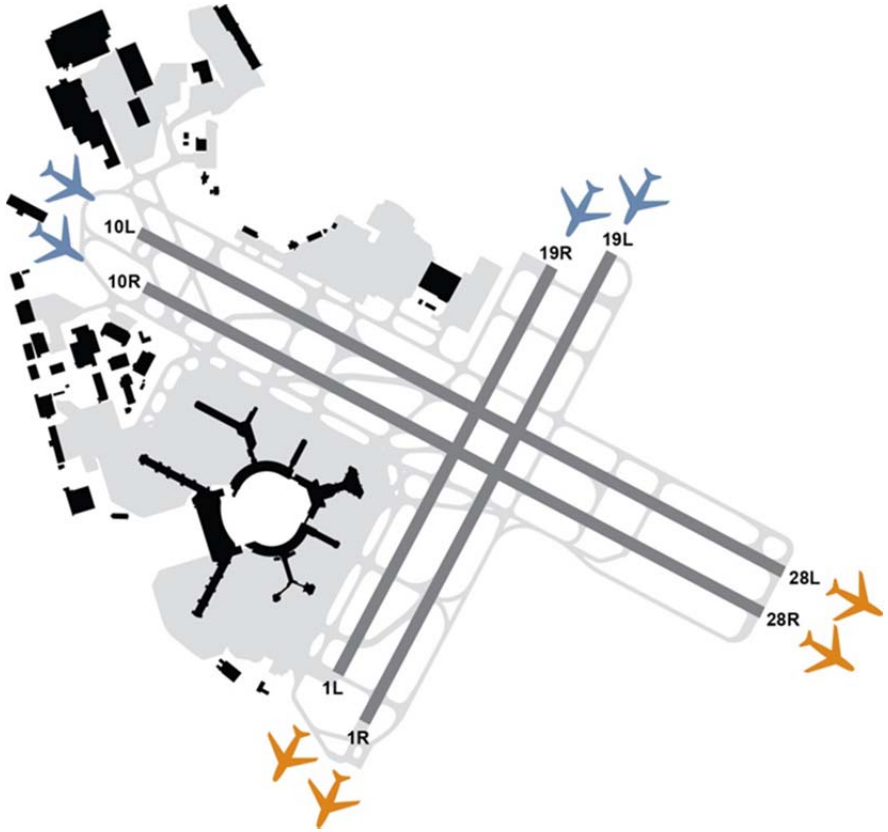
Source: U.S. Department of Transportation, Federal Aviation Administration, Operations Network, Tower Counts for SFO, OAK, SJC, SMF [https://aspm.faa.gov/opsnet/sys/Tower.asp (accessed February 13, 2013)].
Prepared by: ATAC Corporation, October 2013.

### 1.4.1 Study Airports Runway Operating Configurations

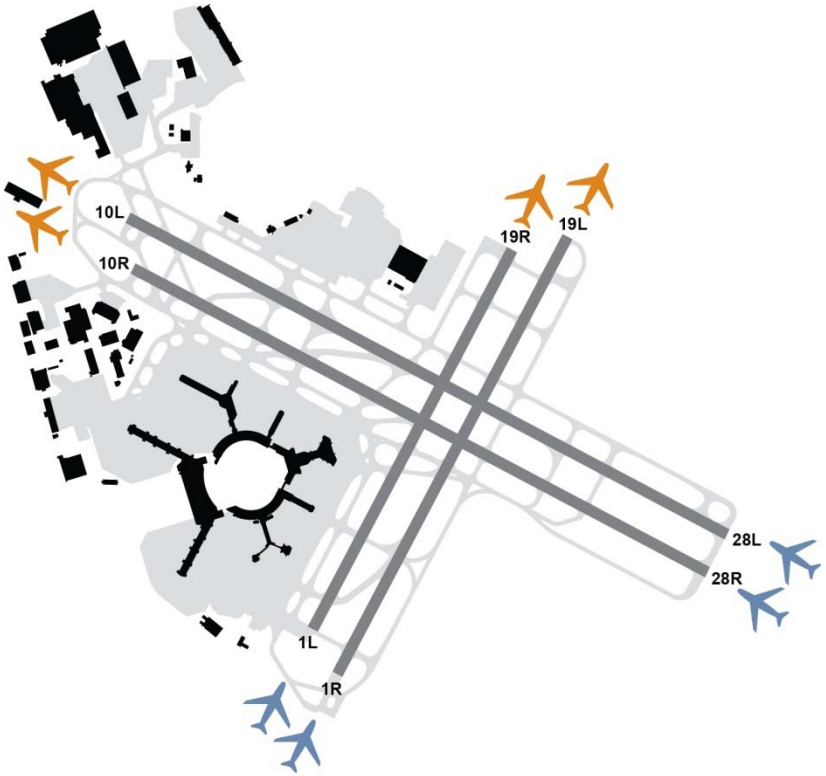
The major Study Airports often operate under several different runway operating configurations depending on conditions such as weather, prevailing wind, and air traffic conditions. As a result, it is possible for the runway ends used for arrivals and departures to change several times throughout a day. Controllers at these airports generally use two different runway operating configurations, and each runway operating configuration may designate primary and secondary arrival and departure runway ends for each configuration.

**Exhibits 1-9** through **1-12** illustrate the primary runway operating configurations at SFO, OAK, SJC, and SMF, respectively.

**Exhibit 1-9 SFO Runway Operating Configurations**




**SFO: East Flow**
**Operating Configuration – 4.3%**




**SFO: West Flow**
**Operating Configuration – 95.7%**

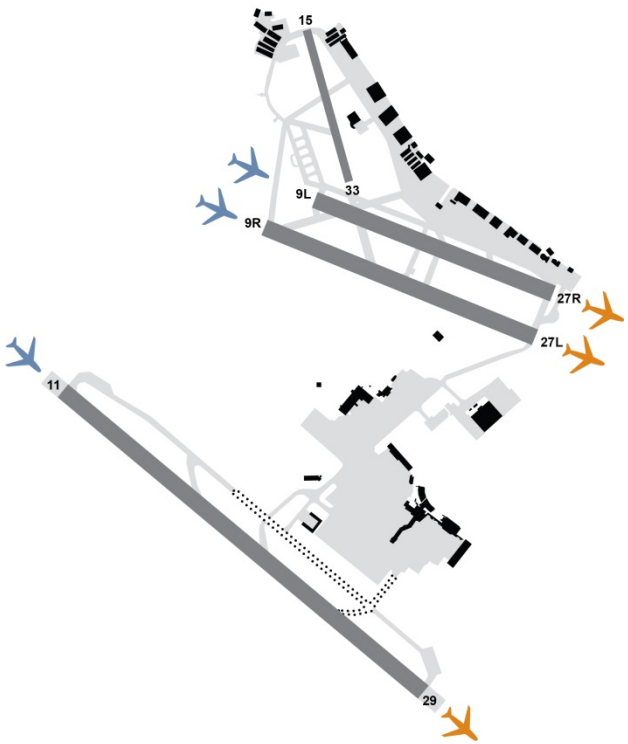
**Primary Arrival** **Primary Departure**

*Notes: Noise abatement procedures (west flow) represent 0.1% of operations.*

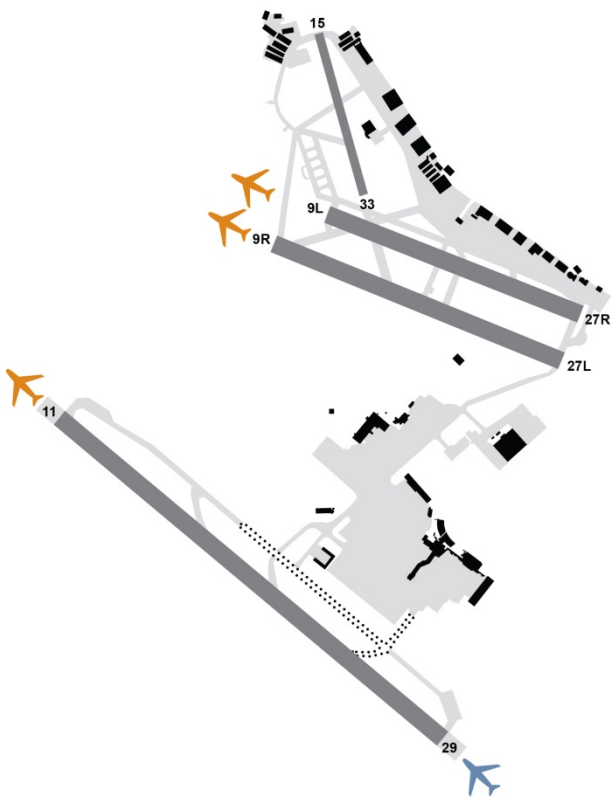
Source: U.S. Department of Transportation, Federal Aviation Administration, Airport Diagrams [http://www.faa.gov/airports/runway_safety/diagrams/ (accessed October 2013)]; FAA ASPM (retrieved February 2012); Oakland Center and Northern California TRACON Letter of Agreement, February 2008.

Prepared By: ATAC Corporation, October 2013.

**Exhibit 1-10 OAK Runway Operating Configurations**




**OAK: East Runway**
**Operating Configuration – 5.9%**



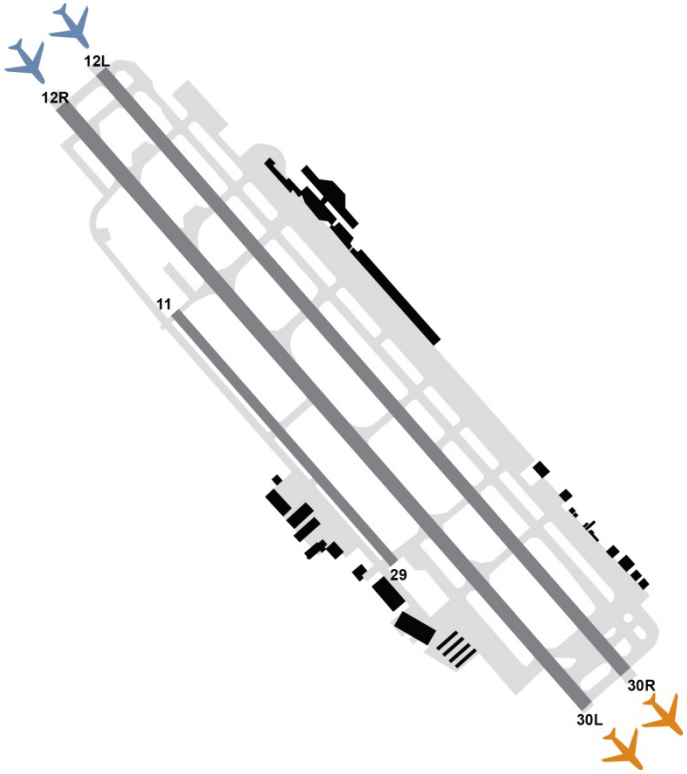

**OAK: West Runway**
**Operating Configuration – 94.1%**

**Primary Arrival** **Primary Departure**

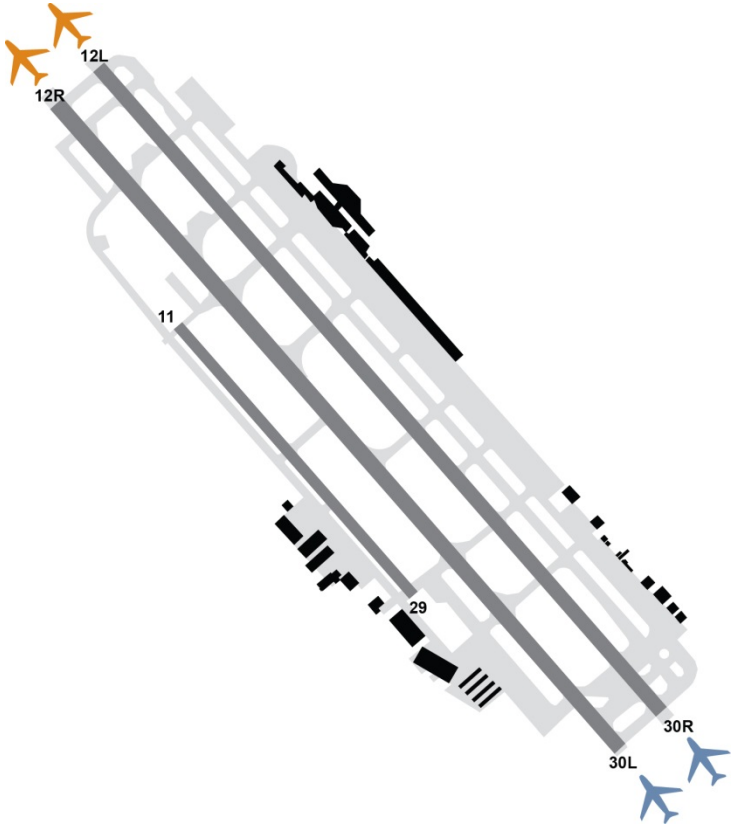
Source: U.S. Department of Transportation, Federal Aviation Administration, Airport Diagrams [http://www.faa.gov/airports/runway_safety/diagrams/ (accessed October 2013)]; FAA ASPM (retrieved February 2012); Oakland Center and Northern California TRACON Letter of Agreement, February 2008.

Prepared By: ATAC Corporation, October 2013.

**Exhibit 1-11 SJC Runway Operating Configurations**




**SJC: East Runway**
**Operating Configuration – 13.0%**




**SJC: West Runway**
**Operating Configuration – 86.7%**

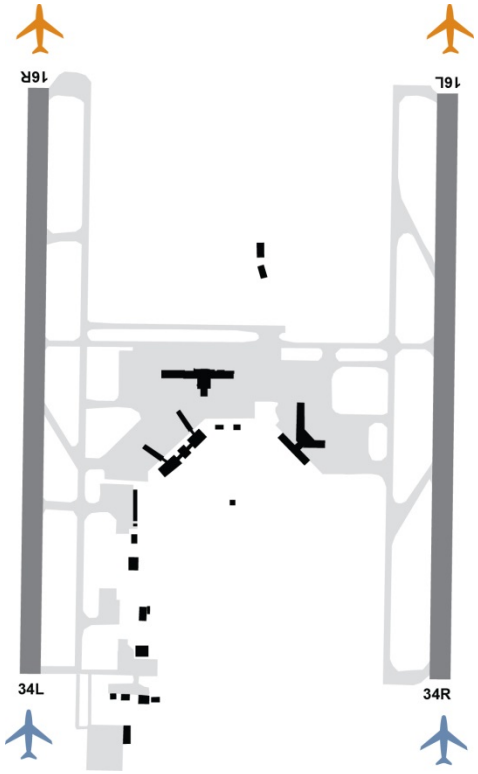
**Primary Arrival** **Primary Departure**

*Notes: 0.3% of operations conducted in mixed configuration.*

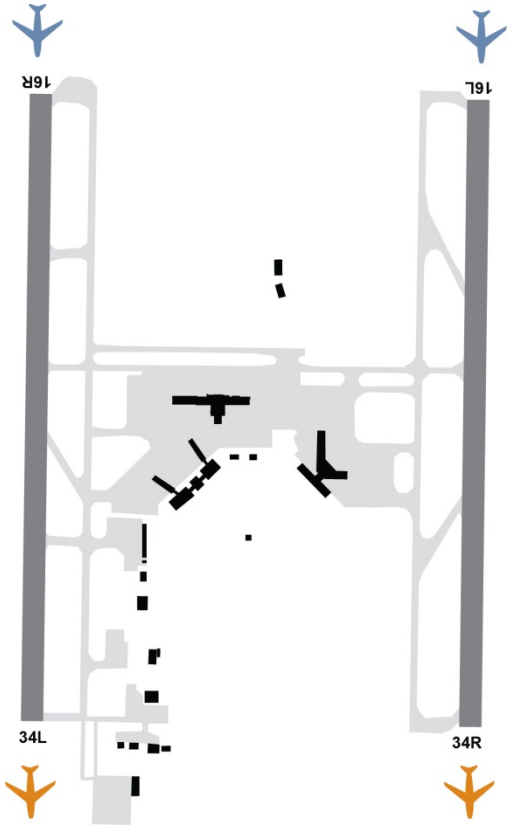
Source: U.S. Department of Transportation, Federal Aviation Administration, Airport Diagrams [http://www.faa.gov/airports/runway_safety/diagrams/ (accessed October 2013)]; FAA ASPM (retrieved February 2012); Oakland Center and Northern California TRACON Letter of Agreement, February 2008.

Prepared By: ATAC Corporation, October 2013.

**Exhibit 1-12 SMF Runway Operating Configurations**




**SMF: North Flow**
**Operating Configuration – 29.2%**




**SMF: South Flow**
**Operating Configuration – 70.8%**

**Primary Arrival** **Primary Departure**

Source: U.S. Department of Transportation, Federal Aviation Administration, Airport Diagrams [http://www.faa.gov/airports/runway_safety/diagrams/ (accessed October 2013)]; FAA ASPM (retrieved February 2012); Oakland Center and Northern California TRACON Letter of Agreement, February 2008.

Prepared By: ATAC Corporation, October 2013.

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