

# **Enclosure 1**

(Ref. Technical Letter F500-L14-033)

**MITRE**

**Center for Advanced  
Aviation System Development**

## **Helicopter Routes Between Nuevo Aeropuerto Internacional de la Ciudad de México and Santa Lucía Military Base**

*Preliminary Report*

**Prepared for**

**Aeropuertos y Servicios Auxiliares**

**June 2014**

## 1. Introduction

In mid-February 2014, Aeropuertos y Servicios Auxiliares (ASA) requested that MITRE perform a feasibility analysis for continued Visual Flight Rules (VFR) helicopter operations at Santa Lucía Military Base (Santa Lucía), without affecting air traffic capacity and safety at the proposed Nuevo Aeropuerto Internacional de la Ciudad de México (NAICM) in nearby Texcoco. While this constituted out of scope work under the ASA-MITRE Agreement, MITRE understood the importance of the request, accepted it, and delivered a preliminary report on 28 March 2014 (refer to Enclosure No. 1 to MITRE Technical Letter F500-L14-022), showing that helicopter arrival and departure operations at Santa Lucía can coexist with operations at NAICM.

Meetings between MITRE and Fuerza Aerea Mexicana (FAM) that took place in January and February 2014 resulted in the understanding that Santa Lucía's runway will be closed and that all fixed-wing transport operations will relocate to NAICM. The possibility of retaining some helicopter operations at Santa Lucía is, however, still under consideration. If a decision is made to retain such operations, there will be a future need for VFR helicopters to transit between Santa Lucía and NAICM. In April 2014, ASA requested that MITRE determine the feasibility of developing low altitude VFR helicopter routes between Santa Lucía and NAICM. This is also an out of scope investigation, accepted by MITRE.

This report describes MITRE's analysis and provides a potentially feasible solution to allow FAM helicopters to transit between Santa Lucía and NAICM. The document is laid out in several sections. Section 2 provides a description of MITRE's approach and methodology used to conduct the work. Section 3 lists the assumptions made as part of this analysis as well as its limitations. Section 4 presents the results of MITRE's work. Section 5 discusses other considerations that affect the feasibility of low altitude VFR helicopter operations between Santa Lucía and NAICM. Section 6 summarizes the results of MITRE's work and provides some additional remarks.

Finally, it is important to mention that the work described in this report was presented to experts from Servicios a la Navegación en el Espacio Aéreo Mexicano (SENEAM) during a visit to MITRE on 5 June 2014. During that visit, SENEAM provided feedback to MITRE that was incorporated into this report. SENEAM agreed with MITRE's overall analysis, as well as the other factors that need to be considered and coordinated as part of the planning for the implementation of VFR helicopter routes between NAICM and Santa Lucía.

## 2. Approach/Methodology

MITRE approached the analysis through the following multi-step process.

- Step One: Determine the different aspects of establishing low altitude VFR helicopter routes in close proximity to both Santa Lucía and NAICM, determine what needs to be studied, and establish the different operational scenarios. Of primary importance was the necessity to avoid introducing capacity-limiting interactions with aircraft operations at NAICM, particularly as helicopter operations are to be taking place close to the final approach paths or initial departure paths of aircraft operating under

Instrument Flight Rules (IFR) at NAICM. MITRE based its analysis on work previously conducted to develop a feasible airspace design to support multi-parallel runway operations at NAICM.

- Step Two: Develop an “Airport Restricted Area” around NAICM. The Airport Restricted Area for NAICM developed by MITRE considered the dimensions of the restricted area that currently surrounds the present Aeropuerto Internacional de la Ciudad de México (AICM). The size of the Airport Restricted Area, however, was modified to be more appropriate for NAICM operations. Any VFR helicopter operation within this Airport Restricted Area would likely disrupt traffic flows at NAICM. Therefore, this would be an area where helicopters would be allowed to operate by exception, and extremely rarely through prior authorization and coordination with NAICM’s Air Traffic Control (ATC).
- Step Three: Develop the lateral course for a potential low altitude VFR helicopter route or routes using, where possible, easily visually identifiable landmarks that could be used as a guide to enable VFR helicopter pilots to maintain the proposed course of the route.
- Step Four: Having established the lateral course of the low altitude VFR helicopter routes, determine the maximum altitudes that VFR helicopters can be permitted to fly along segments of those routes, based on terrain and proposed arrival and departure procedures for NAICM.
- Step Five: Assess the overall feasibility of these routes, and determine other key considerations or factors that need to be considered prior to implementation.

### 3. Assumptions and Limitations

The analysis required making a number of assumptions concerning the acceptability of how such VFR helicopter operations could be accommodated.

NAICM operations were considered to be of primary importance. Very high traffic densities can be expected to be operating at NAICM from opening day, involving dual- and triple-independent arrival and departure operations to achieve maximum capacity using minimum separation distances between aircraft. VFR helicopters cannot be allowed to interrupt these busy traffic flows. Therefore, the routes and altitudes shown in this report were developed to keep helicopters at least 1000 ft vertically or 3 NM laterally from IFR flights departing from or arriving to NAICM for as long as possible. Only as the helicopters come close to the NAICM airport boundary do those distances erode. At this point it can be expected that traffic information will be passed to the relevant pilots and visual separation used to maintain an orderly and safe operation. See Sections 4 and 5 for a more detailed explanation.

Only normal operations at NAICM were considered in this analysis. Irregular operations, such as break-out maneuvers<sup>1</sup> by NAICM arrivals while close to the ground, or emergency situations such as engine-failures on takeoff from NAICM were considered to be outside the scope of this analysis. MITRE strongly recommends that FAM and other Mexican authorities study what actions should be taken to deal with these types of irregular operations.

MITRE used Google Earth to provide guidance in determining easily identifiable landmarks and ground features to aid pilot navigation. Relevant Mexican aviation authorities and FAM officials will need to verify the accuracy of the information and the ease and appropriateness of using such landmarks to navigate by. Besides, landmarks constantly change and this report deals with flights that may not take place for many years.

The routes shown in this paper provide only one solution that offers a potentially feasible way for FAM VFR helicopters to transit between Santa Lucía and NAICM. Other solutions may also be feasible and relevant Mexican aviation authorities and FAM officials will need to determine the most appropriate solution that should eventually be implemented.

MITRE considered that the routes would only be for FAM VFR helicopters operating between Santa Lucía and NAICM. No other type of operation or operator was considered in this analysis.

The proposed helicopter routes and altitudes are designed to be compatible with operations at NAICM regardless of the operating direction of NAICM (i.e., operations should be compatible with IFR arrivals landing to the south, or with IFR departures taking off to the north).

Existing man-made obstacles along the potential helicopter routes proposed by MITRE need to be considered. Existing man-made obstacles may, depending on their height, need to be marked, lighted, and published on navigational charts to ensure conspicuity. In addition, not only will current man-made obstacles need to be assessed, but also continuous monitoring and assessments should be made for any planned or potential future man-made obstacles that may affect the feasibility of helicopter routes between the Base and NAICM.

A number of helipads appear to exist today in close proximity to the proposed NAICM site, as well as in close proximity to the potential low altitude VFR helicopter routes presented in this paper. Operations to and from any existing helipads were not considered as part of this analysis since no information was available on their use or type of operation. Nevertheless, the use of existing helipads will need to be assessed in relation to operations at NAICM.

It is likely that FAM facilities will need to be located to the east of the eastern-most runway at NAICM. However, MITRE assumed that there may be several helipads associated with such a large airport. Therefore, MITRE analyzed the feasibility of developing two routes. One route approaches NAICM from the northeast that provides access to the eastern side of the airport, referred to later in this report as the "East VFR Helicopter Route". Another route approaches NAICM from the northwest and provides access to the western side of the airport, referred to

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<sup>1</sup> A break out maneuver is associated with dual- or triple-independent arrival operations. If one aircraft deviates from its approach path for any reason and enters a prescribed non-transgression zone, ATC is required to break out the aircraft that are on adjacent approach paths in order to avoid the potential for a collision, and to establish 1000 ft vertical or 3 NM lateral separation between these flights as expeditiously as possible.

later in this report as the “West VFR Helicopter Route”. Having two routes that provide access to both the eastern and western sides of NAICM, if necessary, also minimizes the need for helicopters to cross overhead the new airport.

Finally, although MITRE has presented and discussed this work to SENEAM experts, it has not yet met with officials from FAM. MITRE attempted to coordinate visits to MITRE by FAM officials in June/July without success. Therefore, MITRE’s work and results should be considered preliminary and subject to change.

## 4. Results

This section describes the results of MITRE’s examination, including the proposed Airport Restricted Area and the low altitude helicopter routes between Santa Lucía and NAICM.

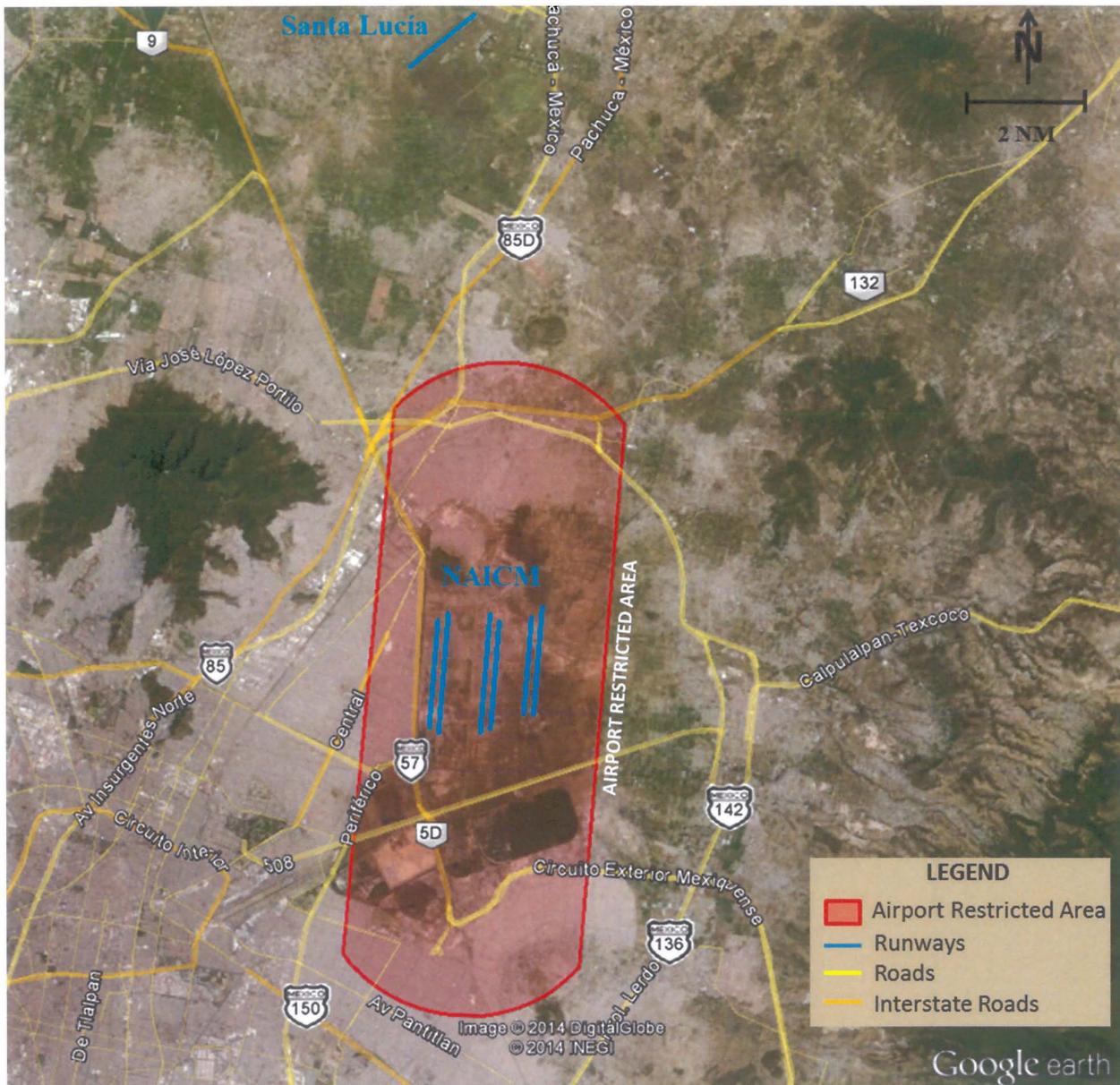
### 4.1 Airport Restricted Area

Figure 1 shows an Airport Restricted Area established around NAICM. The dimensions of this Airport Restricted Area are similar to that which exists today around AICM, but with appropriate modifications for NAICM. The NAICM Airport Restricted Area has the following dimensions:

- Lines parallel to the NAICM runways located 1 NM west of the western-most runway and 1 NM east of the eastern-most runway extending out parallel to the final approach tracks
- Arcs representing a distance of 6 NM from the most northern and southern runway thresholds

As previously mentioned, MITRE considered that any helicopters operating within this area would be likely to disrupt operations at NAICM and should not be permitted to enter the area. It would therefore be an area that helicopters would only be allowed to operate within by exception, and extremely rarely. In such a case it would only be by specific, one-at-a-time authorization and through prior coordination with the NAICM ATC.

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Source: Google Earth Pro

**Figure 1. Airport Restricted Area for NAICM**

## 4.2 Low Altitude VFR Helicopter Routes

MITRE examined the area in the vicinity of Santa Lucía and NAICM for ground reference points and terrain factors to determine if two low altitude VFR helicopter routes could be feasibly developed.

### 4.2.1 General Conditions

The proposed routes are designed to be operated bi-directionally when Visual Meteorological Conditions (VMC) exist. Having two routes (i.e., one to the east and one to the west of NAICM)

would also allow pilots to choose their route based on weather conditions. For example, if the weather was below VMC on the East VFR Helicopter Route, but was VMC on the West VFR Helicopter Route then pilots can chose that route instead to transit to NAICM.

Helicopter pilots would be required to stay on the right side of the route and remain within  $\frac{1}{4}$  NM of the well-defined landmark(s) denoting the route. This would permit the route to be utilized in both directions at the same time, if required. While traffic information may be passed to each of the pilots from ATC (Santa Lucía and/or NAICM) about the presence of the opposite direction flight, it will remain the responsibility of the pilots to avoid collisions. Pilots would also be required to operate at speeds that would allow them to avoid terrain, man-made obstacles, and maintain required distances from clouds to maintain VFR.

#### **4.2.2 Start and Termination Points of the Routes**

MITRE developed potential low altitude VFR helicopter routes that start and terminate within the airfield boundary of Santa Lucía. For NAICM, however, the routes start/terminate on the boundary of or within 1 NM of the Airport Restricted Area. As mentioned above, the locations of helipads at NAICM, whether for civil or military use, have not yet been determined. Therefore, the precise routing to and from these helipads to the start of, or from the termination point of the helicopter routes, cannot be defined yet. However, it can be expected that the helicopters will be required to be in direct communication with NAICM ATC and the controllers will be issuing routing instructions with visual reference to other traffic operating at NAICM.

#### **4.2.3 Visual Reporting Points/Visual Holding Points**

Visual Reporting Points (VRPs) have been identified at various points along each route where a major change in the direction of the route or a change of altitude is necessary. At or close to the Airport Restricted Area a Visual Holding Point (VHP) is indicated. This is where the helicopters would either be instructed to hold, or to proceed by visual reference to other traffic operating close by and cleared to approach and land at a designated NAICM helipad.

#### **4.2.4 Maximum Altitudes Along Helicopter Route Segments**

Maximum altitudes have been designated along segments of the helicopter routes to maintain 1000 ft vertically underneath IFR arrivals and departures at NAICM. As the helicopters will be operating close to IFR aircraft in the process of taking off and landing at NAICM, the helicopters will be required to operate at lower altitudes, in some segments no higher than approximately 250-350 ft Above Ground Level (AGL). Pilots will be required to adhere strictly to these altitudes, unless specific authorization is given by NAICM ATC to deviate from these altitudes. Any deviation from the route or the altitudes specified could result in disruption to NAICM traffic flows or constitute a safety hazard. Therefore, such authorization to deviate would only be given in rare cases, and as an exception.

#### **4.2.5 East VFR Helicopter Route**

This section provides a technical description of the East VFR Helicopter Route. Figure 2 shows the East VFR Helicopter Route (indicated in green) with the Airport Restricted Area (shown in red), the VRPs (indicted as a red triangle with a blue border) and the VHP (indicated as a solid red triangle). The description starts at Santa Lucía routing towards NAICM.

Helicopters operating from NAICM to Santa Lucía would follow the route in the reverse direction, starting at NAICM and ending at Santa Lucía.

Helicopters using the East VFR Helicopter Route depart Santa Lucía toward the southern airport boundary at VRP A (defined by the railroad siding entrance to the military base at  $19^{\circ} 43' 16.35''\text{N}/98^{\circ} 59' 00.95''\text{W}$ <sup>2</sup>). The route then follows railroad tracks heading east and southeast for a distance of approximately 7.5 NM to VRP B. VRP B is defined as the intersection of the railroad tracks and Mexico Route 132 (at  $19^{\circ} 39' 23.39''\text{N}/98^{\circ} 52' 20.86''\text{W}$ ). The route turns to the southwest following the railroad tracks towards VRP C. VRP C is defined as the intersection of the railroad tracks and the Nexquipayac Canal (at  $19^{\circ} 36' 48.47''\text{N}/98^{\circ} 55' 18.81''\text{W}$ ). The route then follows the canal to the VHP (defined as the intersection of Mexico Route 142 with the Nexquipayac Canal at  $19^{\circ} 35' 27.48''\text{N}/98^{\circ} 55' 38.12''\text{W}$ ). This VHP is where helicopters would either be instructed to hold or to proceed by visual reference to other traffic and cleared to approach and land at a designated NAICM helipad.

Table 1 indicates the maximum altitudes that helicopters can be permitted to operate on the segments between the VRPs/VHP.

#### 4.2.6 West VFR Helicopter Route

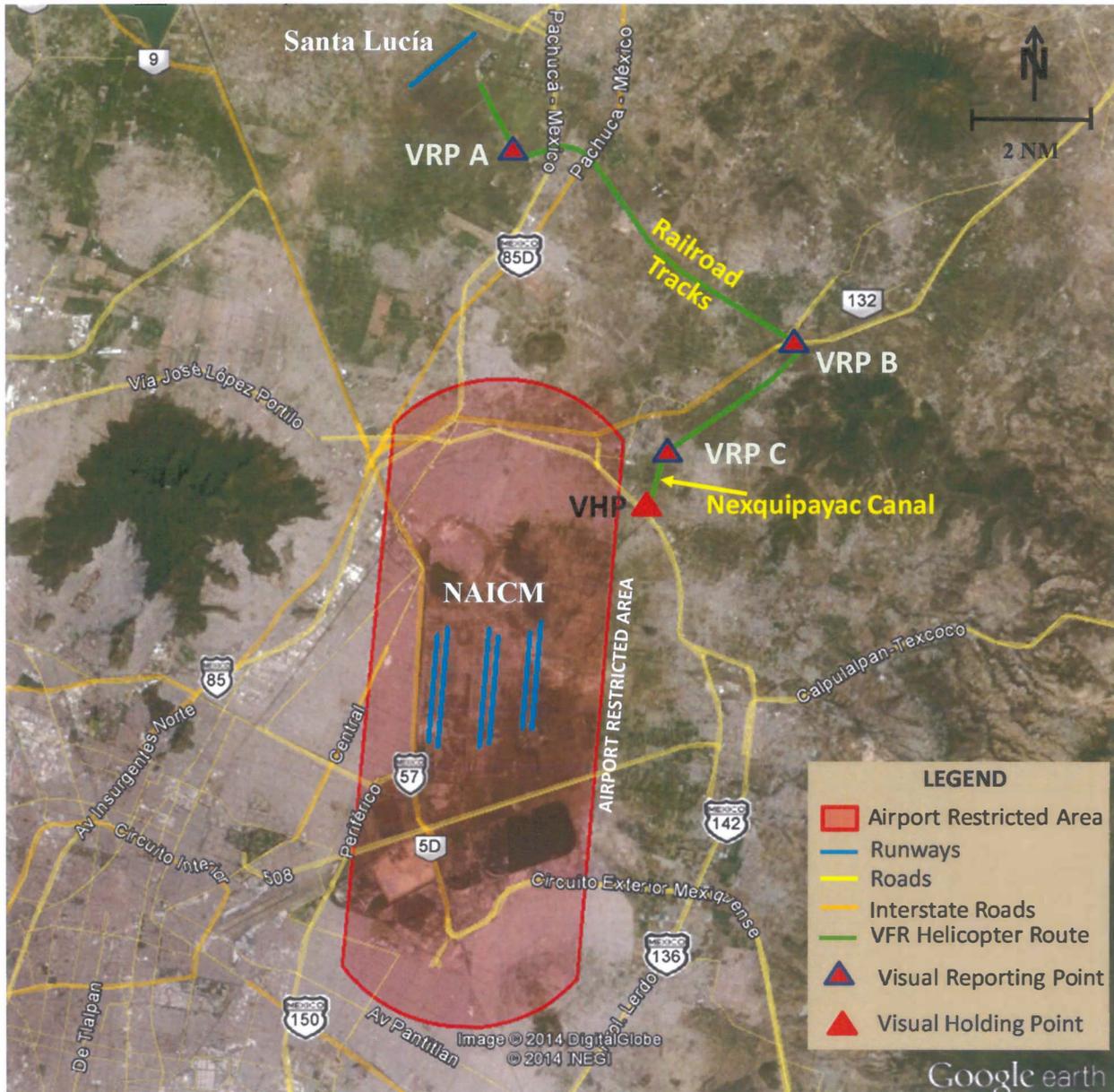
This section provides a technical description of the West VFR Helicopter Route. Figure 3 shows the West VFR Helicopter Route (indicated in green) with the Airport Restricted Area (shown in red), the VRPs (indicted as a red triangle with a blue border) and the VHP (indicated as a solid red triangle). The description starts at Santa Lucía routing towards NAICM. Helicopters operating from NAICM to Santa Lucía would follow the route in the reverse direction, starting at NAICM and ending at Santa Lucía.

Helicopters using the West VFR Helicopter Route depart Santa Lucía to the southwest starting at VRP W (approximately the current threshold of Runway 04 at  $19^{\circ} 44' 42.65''\text{N}/99^{\circ} 01' 44.22''\text{W}$ ). The route follows the railroad tracks that run along the northwestern edge of the military base to the southwest for 4.1 NM to VRP X, (defined as the intersection with Mexico Route 57 [also called *Circuito Exterior Mexiquense*] at  $19^{\circ} 42' 02.42''\text{N}/99^{\circ} 05' 01.72''\text{W}$ ). The route then turns southeast and follows Mexico Route 57 southeast for approximately 4.2 NM to VRP Y (defined as abeam the *Universidad del Bicentenario Tecamac* at  $19^{\circ} 38' 15.50''\text{N}/99^{\circ} 03' 09.71''\text{W}$ ). The route continues to follow Mexico Route 57 for a further 1.4 NM to VRP Z (defined as the intersection of Mexico Route 57 and Mexico Route 142 at  $19^{\circ} 36' 51.18''\text{N}/99^{\circ} 02' 26.76''\text{W}$ ). The route continues southeast a further 2.0 NM to the VHP. The VHP is defined as abeam the *Centro Comercial Las Américas en Ecatepec* (at  $19^{\circ} 35' 01.80''\text{N}/99^{\circ} 01' 36.56''\text{W}$ ). At this VHP, helicopters would either be instructed to hold or to proceed by visual reference to other traffic and cleared to approach and land at a designated NAICM helipad.

Table 2 indicates the maximum altitudes that helicopters can be permitted to operate on the segments between the VRPs/VHP.

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<sup>2</sup> All coordinates in this report are approximate and based on World Geodetic System 1984.

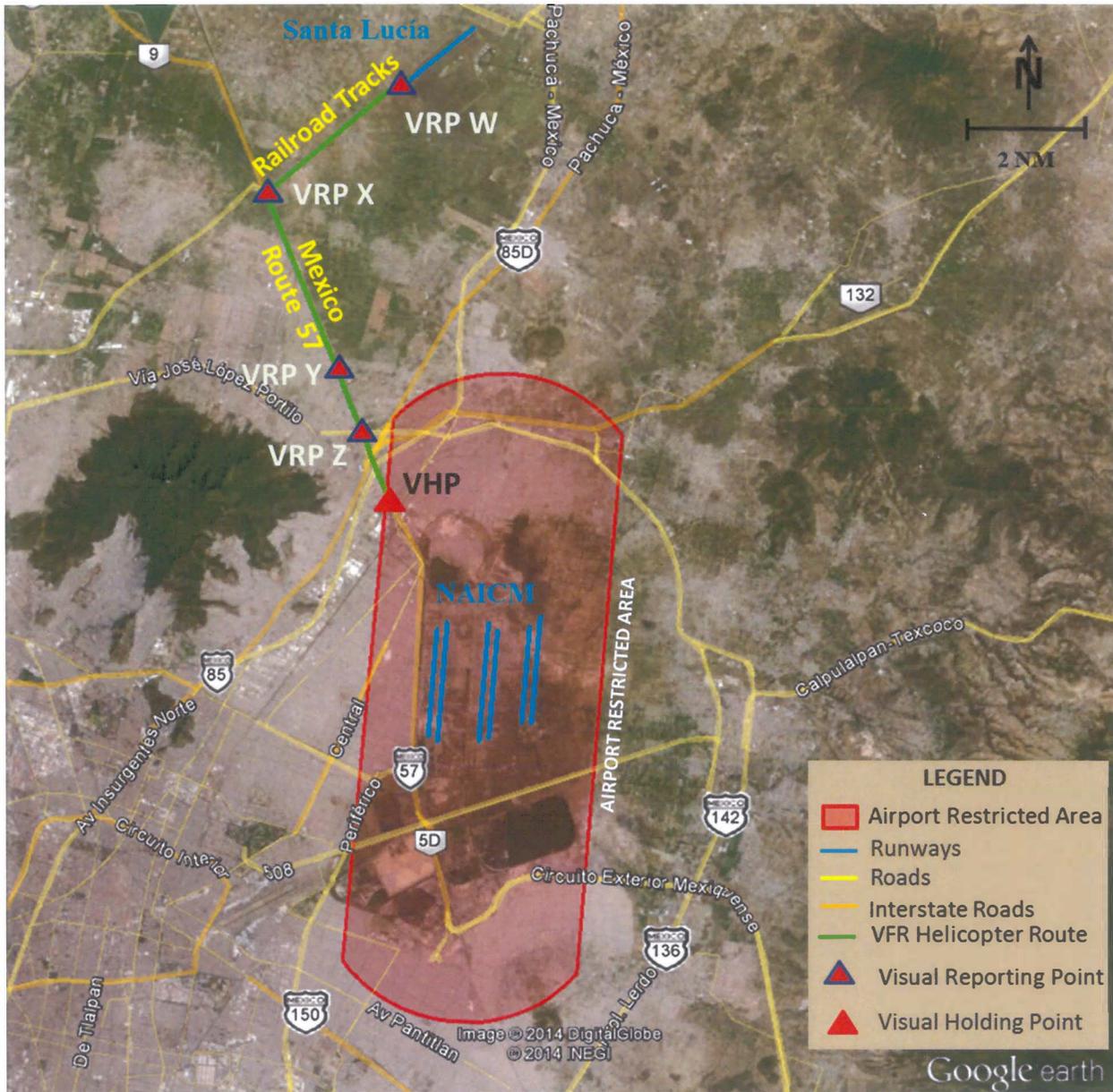


Source: Google Earth Pro

Figure 2. East VFR Helicopter Route

Table 1. East VFR Helicopter Route – Maximum Operating Altitudes

East VFR Helicopter Route	
Cross VRP A	Not Above 8500 ft Mean Sea Level (MSL)
Cross VRP B	Not Above 8500 ft MSL
Cross VRP C	Not Above 8000 ft MSL
Cross or Hold at VHP	Not Above 7700 ft MSL



Source: Google Earth Pro

Figure 3. West VFR Helicopter Route

Table 2. West VFR Helicopter Route – Maximum Operating Altitudes

West VFR Helicopter Route	
Cross VRP W	Not Above 8500 ft MSL
Cross VRP X	Not Above 8500 ft MSL
Cross VRP Y	Not Above 8000 ft MSL
Cross VRP Z	Not Above 7700 ft MSL
Cross or Hold at VHP	Not Above 7700 ft MSL

## 5. Other Considerations

Numerous factors need to be considered as part of the planning for the implementation of VFR helicopter routes between NAICM and Santa Lucía. This section discusses some of the most significant factors to consider.

### 5.1 Airspace Classification at NAICM and Santa Lucía

As part of the planning and implementation of NAICM, a total redesign of the airspace in and around the Mexico City basin will be required. As part of this process it will be necessary to consider the reclassification of the airspace in and around NAICM and Santa Lucía. All relevant stakeholders must consider what would be the most appropriate airspace classification to support NAICM operations. This includes the definition of new airspace structures such as Control Zones and Control Areas with appropriate lateral and vertical dimensions. Decisions concerning these airspace structures and airspace classification will also impose certain operational requirements on pilots. For example, minimum equipment requirements will be stipulated to be carried on helicopters operating on the low-altitude VFR helicopter routes. Such requirements could include the use of radios and Secondary Surveillance Radar transponders, prior filing of flight plans, and obtaining and following ATC clearances. Higher airspace classifications (Class A, B, or C) could preclude VFR operations altogether, or impose requirements that controllers provide a minimum of 1000 ft vertical or 3 NM lateral separation between not only IFR traffic, but also between IFR and VFR flights and between VFR flights.

### 5.2 Transfer of Control and Communications Between Santa Lucía and NAICM

As part of the implementation planning for low altitude VFR helicopter operations using these routes, all relevant stakeholders will need to determine appropriate points for the transfer of control (and therefore responsibility), as well as communications between the control tower at Santa Lucía and NAICM ATC. In some cases (e.g., when departing Santa Lucía on the East VFR Helicopter Route), clearance from NAICM ATC to proceed along the route may be required at or before a helicopter is passing the Santa Lucía airport boundary (VRP A). This becomes more of an issue as a helicopter is arriving to Santa Lucía using this route and, therefore, the location of the Transfer of Control point will need to be agreed to between the relevant Mexican aviation authorities. The designated transfer of control and communications should, where possible, be the same, no matter which direction the helicopter route is being flown. This is to avoid helicopters traveling in opposite directions being in communication with separate control authorities.

Due to the close proximity of these routes to other aircraft operations, it is recommended that positive communication and control be maintained along the entire route regardless of airspace classification so that appropriate traffic information can be passed, as necessary, about other FAM helicopters operating on the same route.

### 5.3 Weather Criteria

Associated with any VFR operation are minimum weather limits below which VFR operations are not permitted. Helicopters wishing to fly below these weather limits must either fly IFR, or if regulations permit, operate under Special VFR.

Current procedures for VFR helicopter operations in the Mexico City terminal airspace require that pilots comply with certain weather minima and velocities to adequately see and avoid terrain, man-made obstacles, and other aircraft. Relevant Mexican stakeholders will need to determine what future procedures and operating requirements are appropriate for flights between Santa Lucía and NAICM. This may include whether low altitude VFR helicopter routes should be used as one-way or two-way routes, as well as when use of these low altitude VFR helicopter routes must be terminated.

### 5.4 Helicopter Equipment

As previously mentioned, airspace classification, as well as other considerations may impose minimum equipment requirements for helicopters using these low altitude VFR helicopter routes. To allow FAM helicopters to be more visible to pilots of other aircraft, particularly when operating in close proximity to other aircraft close to NAICM, these requirements may extend to include operating with navigation lights, rotating beacon/strobe lights, and landing lights. These requirements could also be required whenever operating on these routes regardless of weather conditions. Finally, while Global Positioning System (GPS) navigation is not required to fly these routes, MITRE would highly recommend its use to assure close compliance with the designated flight track.

### 5.5 Potential for Wake Vortex Encounters

Pilots operating along these low altitude VFR helicopter routes will need to be alert to potential wake vortex encounters caused by IFR aircraft departing and landing at NAICM considering that, unlike AICM, this is a far more complex airport. Consideration of this factor is needed when determining the designation of low altitude helicopter routes close to NAICM runways and their extended centerlines, and when helicopters are operating within the airport boundaries.

### 5.6 Existing and New Man-made Obstacles

Although the routes examined by MITRE have maximum altitudes assigned along particular segments, these altitudes do not provide obstacle clearance protection. As these are VFR routes, pilots are responsible for seeing and avoiding terrain and obstacles. Additionally, new man-made obstacles are likely to be created between now and when NAICM opens for operation and these routes become operational. New man-made obstacles will need to be considered as part of the process for implementing such routes.

### 5.7 Charting

Appropriate charts will need to be developed to depict the low altitude VFR helicopter routes and the most significant and relevant obstacles along and in the vicinity of the route. However, these charts are not able to depict complete obstacle information due to the high concentration of

obstacles in many areas along the routes. Prominent obstacles and other features, such as power transmission lines are likely to be depicted on charts for landmark value, but primarily to aid with pilot navigation.

## 6. Summary/Closing Remarks

MITRE has determined that low altitude VFR helicopter routes between Santa Lucía and NAICM can be developed with the following restrictions:

- Helicopter pilots must adhere strictly to the prescribed routes and altitudes along each segment of the routes described in this report
- Helicopter pilots must receive a clearance and communicate with either Santa Lucía or NAICM ATC along the entire route
- Helicopter pilots must receive a clearance and communicate with NAICM ATC at the appropriate transfer of control points
- Minimum weather requirements must be complied with
- Helicopter pilots remain responsible for avoiding collisions with terrain, obstacles, and other aircraft

Other considerations mentioned in this document, such as airspace classification, transfer of control and communications, weather criteria, and more, can affect the feasibility of establishing these routes and must be addressed.

Finally, it is important that MITRE discusses and reviews the results of this report with officials from FAM and other interested agencies in a collaborative manner so that appropriate feedback can be obtained.