| DOCKETED | |
|---|---|
| **Docket Number:** | 22-SPPE-02 |
| **Project Title:** | San Jose Data Center 04 |
| **TN #:** | 265716 |
| **Document Title:** | SJC04 Thermal and Visual Plume Memo |
| **Description:** | N/A |
| **Filer:** | Scott Galati |
| **Organization:** | DayZenLLC |
| **Submitter Role:** | Applicant Representative |
| **Submission Date:** | 8/20/2025 8:53:35 AM |
| **Docketed Date:** | 8/20/2025 |

April 12, 2023

California Energy Commission
1516 9th St
Sacramento, CA 95814

RE: Microsoft SJC04 Data Center Building Project

Dear California Energy Commission,

Capitol Airspace Group was retained to assess a planned building project in San Jose, California. The project will house two data centers, SJC04 and SJC06, for the Microsoft Corporation. In order to mitigate heat produced by the data centers, the structures will include generator and fluid coolers on the rooftops that will produce both visual and thermal plumes.

According to expert analysis conducted by Environmental Systems Design, Inc, the complete dissipation of the plumes will occur at an altitude between 182 and 189 feet above mean sea level (AMSL) with diameters no greater than 15 feet laterally (Appendix A & B). The nature of these plumes may, at times, make them visible to pilots and people on the ground.

Capitol Airspace Group is an aviation consulting firm that provides analytical, strategic, and advocacy services to airports, communities, and commercial developers. The company prides itself on helping airports and developers strike a balance between economic development and the need to preserve the national airspace system. Over the past twenty years, Capitol Airspace has successfully advocated for over 5,000 development projects which amount to over 90,000 federal filings.

There are two FAA published documents that provide some reference regarding plumes. [1] These documents generally discourage the placement of plumes close to an airport. However, neither document provides regulatory standards that can be used to differentiate between acceptable and unacceptable plumes, as well as appropriate proximity to airports. Absent clear guidance from the FAA, Capitol Airspace sought an alternative method for assessing the potential for an adverse effect of plumes on aircraft operations.

Since there are no federal or state standards for determining unacceptable risk associated with plumes, Capitol Airspace conducted analyses to determine if aircraft are operating in the same airspace as the plumes. The logic being that, if aircraft are not operating in proximity to the plumes, then there should be no concern that plumes will adversely affect aircraft operations. To do this, Capitol Airspace looked at the altitudes of aircraft operating on or near the building site through two methods:

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[1] Federal Aviation Administration Memorandum: *Technical Guidance and Assessment Tool for Evaluation of Thermal Exhaust Plume Impact on Airport Operations*, September 24, 2015.
Federal Aviation Administration Report: *Safety Risk Analysis of Aircraft Overflight of Industrial Exhaust Plumes,* January 2006

**Theoretical:**

Capitol Airspace first assessed published Instrument Flight Rules (IFR) and Visual Flight Rules (VFR) procedures that would position an aircraft low and close to the buildings (Appendix C). [2] The results of that analysis indicated the lowest altitude that an aircraft would fly over the site is 341 feet Above Mean Sea Level (AMSL), and are associated with the Norman Y. Mineta San Jose International (SJC) RNAV (GPS) Y Approach to Runway 12L. Given the plume dissipation heights, an aircraft flying the approach procedure would be at least 100 feet above the plumes and would be therefore unaffected.

**Practical:**

Capitol Airspace then assessed 2019 and 2020 historical air traffic data to determine the number of flights, if any, that would be close enough to the buildings where they might encounter the plumes. When the flight track data was analyzed, both IFR and VFR aircraft overflew the project area. However, zero flights occurred below 299 feet within 24 feet laterally of the location of the plumes. (Appendix D). Given these results, no flights in 2019 or 2020 would have been exposed to visual or thermal plumes.

In summary, an IFR procedure would position an aircraft as low as 341 feet AMSL above the SJC04 and SJC06 Data Centers. This is at least 100 feet above the greatest plume dissipation height. These findings are further evidenced by the review of 2019 and 2020 historical air traffic data, which did not identify any flights lower than 299 feet AMSL above the buildings and their footprints.

As of the date of this letter, the buildings have been filed with the FAA. The FAA is still completing their analysis of the proposed structures, and has not issued final determinations.

Any questions regarding this memo should be directed to me. I can be reached at 571-303-1124 or via email at *James.Scott@capitolairspace.com*.

Sincerely,

James R. Scott
Senior Project Manager
Director of FAA Programs
Capitol Airspace Group

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[2] The November 2022 Obstruction Evaluation and Airspace Analysis (see appendix X) was used to identify the lowest Obstacle Clearance Surface (OCS). In doing so, Capitol Airspace was also able to use the data to determine the lowest an aircraft may be flying over the project area.

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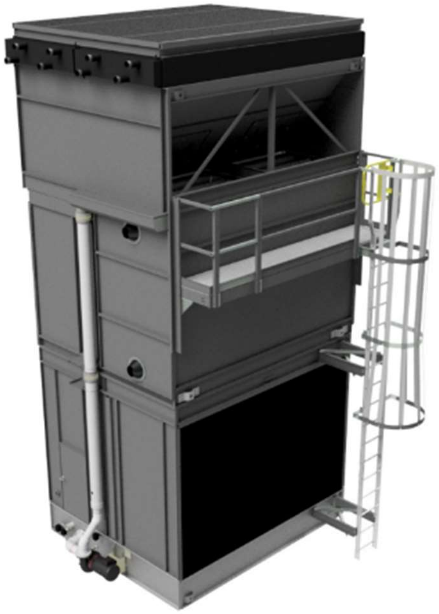
# Appendix A: BAC Fluid Cooler Study for Visual Plume

# Plume Analysis
# SJC04



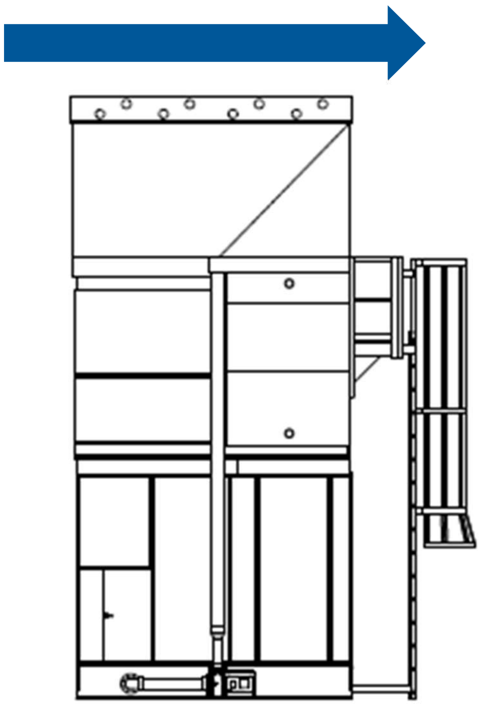
**Stephen Kline, P.E.**
**Applications Manager**
**skline@baltimoreaircoil.com**
**Feb 24, 2023**

# Plume Analysis

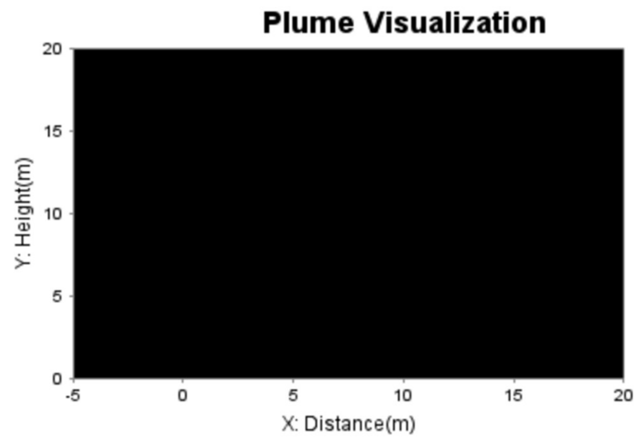
- Design parameters and selections
- Model HXV-1012C-24T-L fluid cooler
  - Flow = 345 gpm/cell water
  - Range = 16 degrees
  - Fan HP = 15 hp/cell @ 72,620 CFM
  - Dry Switchpoint = ~43F (dry operation below this temp = no plume)
  - San Jose, CA weather data
    - Point 1: 92F DB / 71F WB
    - Point 2: 50F DB / 48F WB
  - Evaluate at wind speed of 2.5 MPH

# Plume Evaluation

- Ambient wind direction assumed



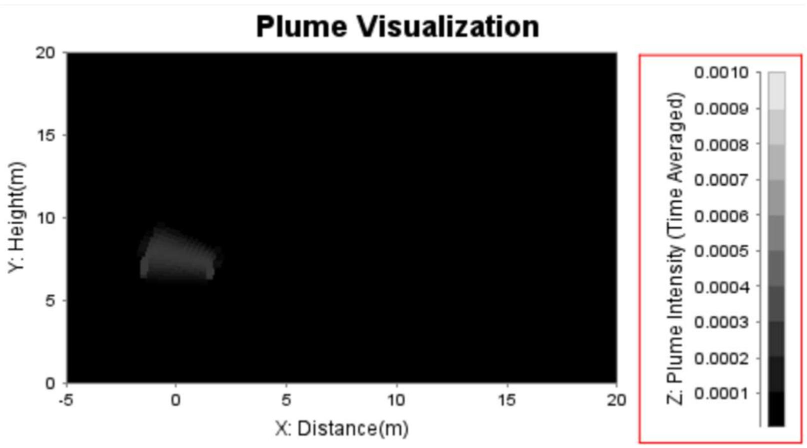
# HXV-1012C-24T-L
# Heat Load = 345 gpm water, 16F range
# Point 1: 92F DB / 71F WB ambient



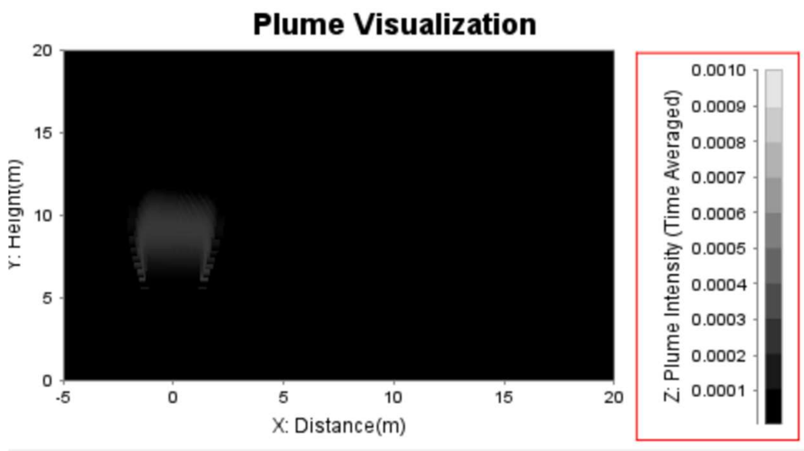

- 2.5 mph wind

**No measurable plume at summer condition**

# HXV-1012C-24T-L
# Heat Load = 345 gpm water, 16F range
# Point 2:  50F DB / 48F WB ambient

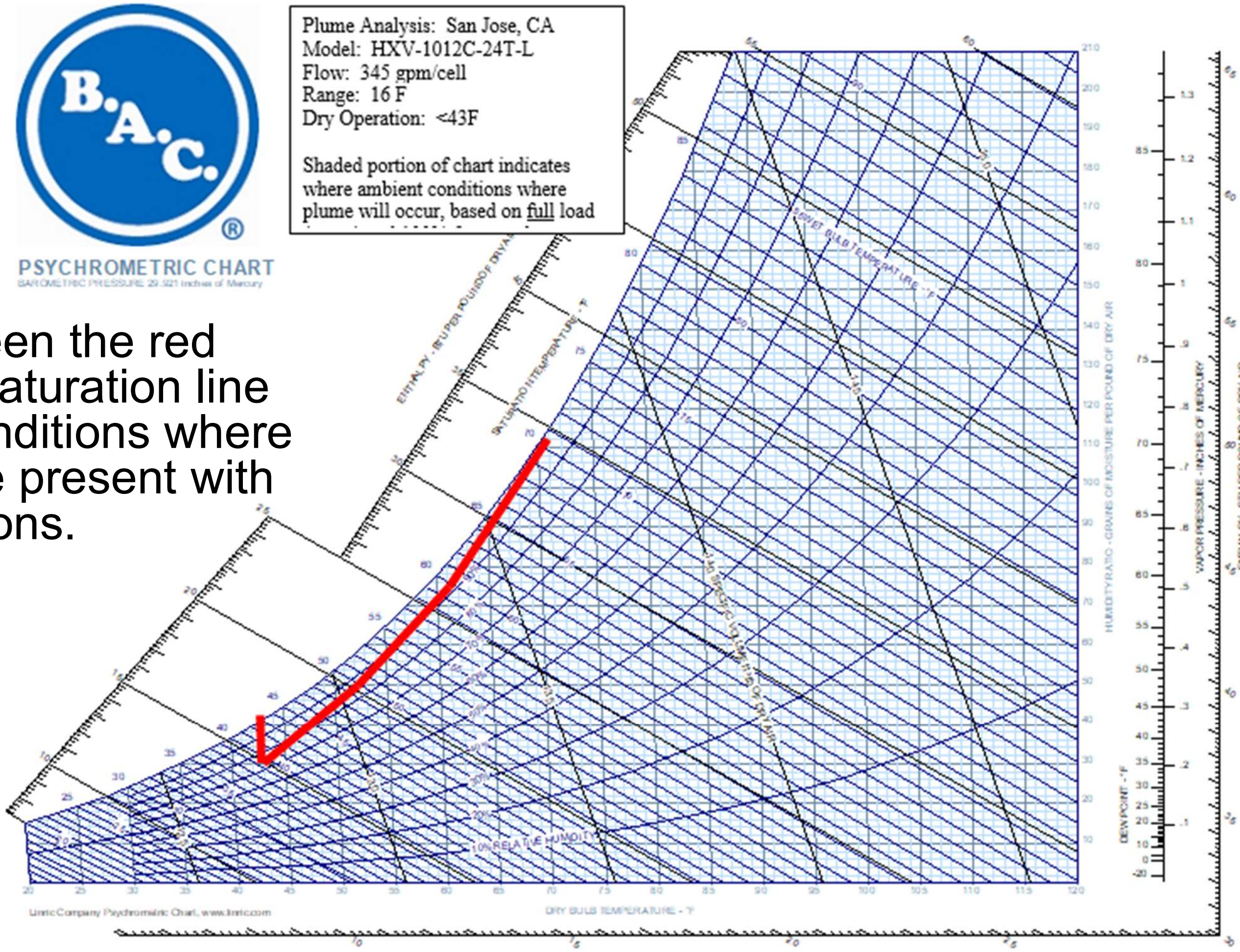



- 2.5 mph wind
- Operating at fan speed to achieve 98F in / 82F out water
- Visible plume height ~4m (13 ft) above top of unit




- 2.5 mph wind
- Operating at 100% fan speed to achieve coldest water temp possible
- Visible plume height of ~6m (20ft) above top of unit

# Ambient Condition Plume Potential




- The area between the red curve and the saturation line are ambient conditions where plume would be present with full load conditions.

# SJC02 Plume Analysis - Summary

- San Jose ambient conditions and the reheat effect of the HXV dry coil create very few hours of plume potential during full load operation
- The maximum visible plume height is estimated at ~20 ft above the top of the unit with fans operating at 100% fan speed
- Visible plume has varying degrees of intensity (from complete opaque to see through mist). The visible plume intensity is greater at lower ambient temperatures with higher ambient humidity

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# Appendix B: ADI Calculations for Velocity Plume (Generator Flue)

**SINGLE Plume Average Vertical Velocities for Microsoft Large Emer.Gen Engine, 100% Load, and Maximum Stack Height - Winter Min***

"*Aviation Safety and Buoyant Plumes*," Peter Best, et. al.

"*The Evaluation of Maximum Updraft Speeds for Calm Conditions at Various Heights in the Plume from a Gas-Turbine Power Station at Oakey, Queensland, Australia*," Dr. K.T. Spillane

**Ambient Conditions:**

**Constants:** Assume neutral conditions ($d\theta/dz=0$ or $\theta_a=\theta_e$)

| | | | | | | |
|---|---|---|---|---|---|---|
| Ambient Potential Temp $\theta_a$ | 278.15 Kelvins | 41.0 °F | | 0.3048 meters/feet | | |
| **Plume Exit Conditions:** | | | Gravity g | 9.81 $m/s^2$ | | |
| Maximum Stack Height $h_s$ | 41.15 meters | 135 feet-inches | λ | 1.11 | | |
| Stack Diameter D | 0.7112 meters | 28 inches | $\lambda_o$ | ~1.0 | | |
| Stack Velocity $V_{exit}$ | 30.08 m/s | 98.69 ft/sec | | | | |
| Volumetric Flow | 11.95 cu.m/sec | 25,320 ACFM | $\pi V_{exit} D^2/4$ | | | Sect.2/¶1 |
| Stack Potential Temp $\theta_s$ | 750.04 Kelvins | 890 °F | | | | |
| Initial Stack Buoyancy Flux $F_o$ | 23.4761 $m^4/s^3$ | | $gV_{exit}D^2(1-\theta_a/\theta_s)/4$ = Vol.Flow$(g/\pi)(1-\theta_a/\theta_s)$ | | | Sect.2/¶1 |
| Plume Buoyancy Flux F | N/A $m^4/s^3$ | | $\lambda^2 gVa^2(1-\theta_a/\theta_p)$ for a,V,$\theta_p$ at plume height (see below) | | | |
| No.of Stacks N | 1 | 1.000 | Multiple Stack Multiplication Factor ($N^{0.25}$) | | | |

**Conditions at End (Top) of Jet Phase:**

| | | | | | |
|---|---|---|---|---|---|
| Height above Stack $z_{jet}$ | 4.445 meters* | 14.6 feet* | $z_{jet}$ = 6.25D, meters*=meters above stack top | | Sect.3/¶1 |
| Height above Ground $z_{jet}+h_s$ | 45.595 meters | **149.6** feet | | | " |
| Vertical Velocity $V_{jet}$ | 15.040 m/s | 49.34 ft/sec | $V_{jet} = 0.5V_{exit} = V_{exit}/2$ | | " |
| Plume Top-Hat Diameter $2a_{jet}$ | 1.422 meters | 4.7 feet | $2a_{jet}$ = 2D | Conservation of momentum | " |

**Spillane Methodology - Analytical Solutions for Calm Conditions for Plume Heights above Jet Phase**

**Single Plume-averaged Vertical Velocity V given by Analytical Solution in Paper where Product Va given by equations below:**

| | | | | |
|---|---|---|---|---|
| Plume Top-Hat Radius a | **Solutions in Table Below** | | $0.16(z-z_v)$, or linear increase with height | Sect.2/Eq.6 |
| Virtual Source Height $z_v$ | 1.738 meters* | 5.7 feet* | $6.25D[1-(\theta_e/\theta_s)^{1/2}]$, meters*=meters above stack top | Sect.2/Eq.6 |
| Height above Ground $z_v+h_s$ | 42.888 meters | 140.7 feet | where $(\theta_a/\theta_s)^{1/2} = (\theta_e/\theta_s)^{1/2}$= | 0.6090 |
| Vertical Velocity V | **Solutions in Table Below** | | $\{(Va)_o^3 + 0.12F_o [ (z-z_v)^2 - (6.25D-z_v)^2]\}^{(1/3)}$ / a | Sect.2.1(6) |
| Product $(Va)_o$ | 6.514 $m^2/s$ | | $V_{exit}D/2(\theta_e/\theta_s)^{1/2}$ | |

| | | | | |
|---|---|---|---|---|
| **Solve for plume-averaged vertical velocity at height** | **200.0 feet** | 60.96 | meters above ground ($z'+h_s$) | |
| Gives the following Height above Stack z' | 19.810 meters* | 65.0 feet* | | |
| Plume Top-Hat Diameter 2a' | 5.783 meters | 19.0 feet | $2a'=2*0.16(z'-z_v)$ | Sect.2/Eq.6 |
| Vertical Velocity V | **3.650 m/s** | 11.98 ft/sec | $V=\{(Va)_o^3+0.12F_o[(z-z_v)^2-(6.25D-z_v)^2]\}^{(1/3)}/(2a'/2)$ | Sect.2/Eq.6 |

| | | | | |
|---|---|---|---|---|
| **Solve for Height of CASC critical vertical velocity $V_{crit}$** | **5.30** | **m/s plume-averaged vertical velocity** | | **Critical VV > Top of Jet (Spillane)** |
| Find Height above Stack $z_{crit}$ | 11.121 meters | 36.5 feet | Solve for $x=(z-z_v)$ simultaneously in both eqs. (i.e., Va and a) | |
| Height above Ground $z_{crit}+h_s$ | 52.271 meters | **171.5** feet | for V=4.3 m/s using the cubic equation $ax^3+bx^2+cx+d=0$, where | |
| | | | a=1, c=0, and $b=-(0.12F_o)/(4.3^3 0.16^3)$= | -4.6198 |
| **Interpolated Height of critical vertical velocity in Jet Phase:** | | | and $d=[0.12F_o(6.25D-z_v)^2-(Va)_o^3]/(4.3^3 0.16^3)$= | -419.42 |
| Find Height above Stack $z_{crit}$ | #N/A meters | #N/A feet | | http://www.1728.org/cubic.htm |
| Height above Ground $z_{crit}+h_s$ | #N/A meters | **#N/A** feet | gives the real solution x = z-zv = | 9.3834 |
| | | | or z(m/above stack) = | 11.121 |
| | | | z(ft/above ground) = | 171.5 |

**Table of Plume Top-Hat Diameters (2a) and Plume-Averaged Vertical Velocities starting at end of jet phase:**

| Height (feet) above ground | (meters) above stack | Plume Radius(m) | SingleStk VertVel(m/s) | Plume Temp(K) |
|---|---|---|---|---|
| ***Stack.Rel.Ht = 135.0*** | **0.00** | **0.356** | **30.08** | |
| 140.0 | 1.52 | 0.477 | 24.93 | |
| 145.0 | 3.05 | 0.599 | 19.78 | |
| ***Top of jet = 149.6*** | **4.45** | **0.711** | **15.04** | |
| 150.0 | 4.57 | 0.453 | 14.41 | 460.76 |
| 160.0 | 7.62 | 0.941 | 7.51 | 359.39 |
| 170.0 | 10.67 | 1.428 | 5.48 | 326.44 |
| ***Spillane 5.3 m/s Height = 171.5*** | **11.12** | **1.501** | **5.30** | 323.37 |
| 180.0 | 13.71 | 1.916 | 4.54 | 310.54 |
| 190.0 | 16.76 | 2.404 | 4.00 | 301.50 |
| 200.0 | 19.81 | 2.892 | 3.65 | 295.85 |
| 210.0 | 22.86 | 3.379 | 3.40 | 292.08 |
| 220.0 | 25.91 | 3.867 | 3.20 | 289.43 |
| 230.0 | 28.95 | 4.355 | 3.05 | 287.49 |
| 280.0 | 44.19 | 6.793 | 2.57 | 282.70 |
| 330.0 | 59.43 | 9.231 | 2.30 | 280.90 |
| 380.0 | 74.67 | 11.670 | 2.12 | 280.02 |
| 430.0 | 89.91 | 14.108 | 1.99 | 279.51 |
| 480.0 | 105.15 | 16.547 | 1.89 | 279.20 |
| 530.0 | 120.39 | 18.985 | 1.80 | 278.98 |
| 580.0 | 135.63 | 21.423 | 1.73 | 278.83 |
| 680.0 | 166.11 | 26.300 | 1.61 | 278.63 |
| 780.0 | 196.59 | 31.177 | 1.52 | 278.51 |
| 880.0 | 227.07 | 36.054 | 1.45 | 278.44 |
| 980.0 | 257.55 | 40.931 | 1.39 | 278.38 |
| 1080.0 | 288.03 | 45.807 | 1.34 | 278.34 |
| 1180.0 | 318.51 | 50.684 | 1.30 | 278.31 |
| 1280.0 | 348.99 | 55.561 | 1.26 | 278.29 |
| 1380.0 | 379.47 | 60.438 | 1.22 | 278.27 |
| 1480.0 | 409.95 | 65.315 | 1.19 | 278.26 |
| 1580.0 | 440.43 | 70.191 | 1.16 | 278.24 |
| 1680.0 | 470.91 | 75.068 | 1.14 | 278.23 |
| 1780.0 | 501.39 | 79.945 | 1.11 | 278.23 |
| 1880.0 | 531.87 | 84.822 | 1.09 | 278.22 |
| 1980.0 | 562.35 | 89.699 | 1.07 | 278.21 |
| 2080.0 | 592.83 | 94.575 | 1.05 | 278.21 |

**Jet Phase Eqs:** **5 foot Intervals**

Linearly interpolated from Stack Rel.Ht to Top of Jet

**Spillane Equations:**

$V_{plume}=\{(Va)_o^3+0.12F_o[(z-z_v)^2-(6.25D-z_v)^2]\}^{1/3}$ / a

a = $0.16(z-z_v)$ **10 foot Intervals**

$\theta_p=\theta_s(1+(1-(\theta_e/\theta_s))*(V_{exit}D^2/(4V_{plume}*a^2*\lambda^2)))$

**Max<5.30 m/s**

**50 foot Intervals**

**100 foot Intervals**

*Winter Min = Monthly Mean of Minimum Daily Temperatures for 1971-2000 (Lowest in December)

NOAA Sources: Climatography of the United States No.81 *"Monthly Station Normals of Temperatures, Precipitation, and Heating and Cooling Degree Days, 1971-2000 California"* and Climatography of the United States No. 20 *"Monthly Station Climate Summaries, 1971-2000 California"*

**SINGLE Plume Average Vertical Velocities for Single Microsoft Large Emer.Gen Engine, 100% Load, and Maximum Stack Height - Summer Max***

"*Aviation Safety and Buoyant Plumes*," Peter Best, et. al.

"*The Evaluation of Maximum Updraft Speeds for Calm Conditions at Various Heights in the Plume from a Gas-Turbine Power Station at Oakey, Queensland, Australia*," Dr. K.T. Spillane

| | | | | | | |
|---|---|---|---|---|---|---|
| **Ambient Conditions:** | | | | | **Constants:** Assume neutral conditions ($d\theta/dz=0$ or $\theta_a=\theta_e$) | |
| Ambient Potential Temp $\theta_a$ | 302.21 | Kelvins | 84.3 | °F | 0.3048 meters/feet | |
| **Plume Exit Conditions:** | | | | | Gravity g 9.81 $m/s^2$ | |
| Maximum Stack Height $h_s$ | 41.15 | meters | 135 | feet-inches | $\lambda$ 1.11 | |
| Stack Diameter D | 0.7112 | meters | 28 | inches | $\lambda_o$ ~1.0 | |
| Stack Velocity $V_{exit}$ | 30.08 | m/s | 98.69 | ft/sec | | |
| Volumetric Flow | 11.95 | cu.m/sec | 25,320 | ACFM | $\pi V_{exit} D^2/4$ | Sect.2/¶1 |
| Stack Potential Temp $\theta_s$ | 749.82 | Kelvins | 890 | °F | | |
| Initial Stack Buoyancy Flux $F_o$ | 22.2748 | $m^4/s^3$ | | | $gV_{exit}D^2(1-\theta_a/\theta_s)/4$ = Vol.Flow$(g/\pi)(1-\theta_a/\theta_s)$ | Sect.2/¶1 |
| Plume Buoyancy Flux F | N/A | $m^4/s^3$ | | | $\lambda^2 gVa^2(1-\theta_a/\theta_p)$ for a,V,$\theta_p$ at plume height (see below) | |
| No.of Stacks N | 1 | | | 1.000 | Multiple Stack Multiplication Factor ($N^{0.25}$) | |

**Conditions at End (Top) of Jet Phase:**

| | | | | | | |
|---|---|---|---|---|---|---|
| Height above Stack $z_{jet}$ | 4.445 | meters* | 14.6 | feet* | $z_{jet}$ = 6.25D, meters*=meters above stack top | Sect.3/¶1 |
| Height above Ground $z_{jet}+h_s$ | 45.595 | meters | **149.6** | feet | | " |
| Vertical Velocity $V_{jet}$ | 15.040 | m/s | 49.34 | ft/sec | $V_{jet} = 0.5V_{exit} = V_{exit}/2$ | " |
| Plume Top-Hat Diameter $2a_{jet}$ | 1.422 | meters | 4.7 | feet | $2a_{jet}$ = 2D Conservation of momentum | " |

**Spillane Methodology - Analytical Solutions for Calm Conditions for Plume Heights above Jet Phase**

**Single Plume-averaged Vertical Velocity V given by Analytical Solution in Paper where Product Va given by equations below:**

| | | | | | | |
|---|---|---|---|---|---|---|
| Plume Top-Hat Radius a | **Solutions in Table Below** | | | | $0.16(z-z_v)$, or linear increase with height | Sect.2/Eq.6 |
| Virtual Source Height $z_v$ | 1.623 | meters* | 5.3 | feet* | $6.25D[1-(\theta_e/\theta_s)^{1/2}]$, meters*=meters above stack top | Sect.2/Eq.6 |
| Height above Ground $z_v+h_s$ | 42.773 | meters | 140.3 | feet | where $(\theta_a/\theta_s)^{1/2} = (\theta_e/\theta_s)^{1/2}$= 0.6349 | |
| Vertical Velocity V | **Solutions in Table Below** | | | | $\{(Va)_o^3 + 0.12F_o [ (z-z_v)^2 - (6.25D-z_v)^2]\}^{(1/3)}$ / a | Sect.2.1(6) |
| Product $(Va)_o$ | 6.791 | $m^2/s$ | | | $V_{exit}D/2(\theta_e/\theta_s)^{1/2}$ | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Solve for plume-averaged vertical velocity at height** | **200.0** | **feet** | | 60.96 | meters above ground ($z'+h_s$) | |
| Gives the following Height above Stack z' | 19.810 | meters* | 65.0 | feet* | | |
| Plume Top-Hat Diameter 2a' | 5.820 | meters | 19.1 | feet | $2a'=2*0.16(z'-z_v)$ | Sect.2/Eq.6 |
| Vertical Velocity V | **3.627** | **m/s** | 11.90 | ft/sec | $V=\{(Va)_o^3+0.12F_o[(z-z_v)^2-(6.25D-z_v)^2]\}^{(1/3)}/(2a'/2)$ | Sect.2/Eq.6 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Solve for Height of CASC critical vertical velocity $V_{crit}$** | **5.30** | **m/s plume-averaged vertical velocity** | | | | **Critical VV > Top of Jet (Spillane)** |
| Find Height above Stack $z_{crit}$ | 11.212 | meters | 36.8 | feet | Solve for $x=(z-z_v)$ simultaneously in both eqs. (i.e., Va and a) | |
| Height above Ground $z_{crit}+h_s$ | 52.362 | meters | **171.8** | feet | for V=4.3 m/s using the cubic equation $ax^3+bx^2+cx+d=0$, where | |
| | | | | | a=1, c=0, and $b=-(0.12F_o)/(4.3^3 0.16^3)$= | -4.3834 |
| **Interpolated Height of critical vertical velocity in Jet Phase:** | | | | | and $d=[0.12F_o(6.25D-z_v)^2-(Va)_o^3]/(4.3^3 0.16^3)$= | -478.68 |
| Find Height above Stack $z_{crit}$ | #N/A | meters | #N/A | feet | | http://www.1728.org/cubic.htm |
| Height above Ground $z_{crit}+h_s$ | #N/A | meters | **#N/A** | feet | gives the real solution x = z-zv = | 9.5887 |
| | | | | | or z(m/above stack) = | 11.212 |
| | | | | | z(ft/above ground) = | 171.8 |

**Table of Plume Top-Hat Diameters (2a) and Plume-Averaged Vertical Velocities starting at end of jet phase:**

| Height (feet) above ground | (meters) above stack | Plume Radius(m) | SingleStk VertVel(m/s) | Plume Temp(K) |
|---|---|---|---|---|
| ***Stack.Rel.Ht = 135.0*** | ***0.00*** | **0.356** | **30.08** | |
| 140.0 | 1.52 | 0.477 | 24.93 | |
| 145.0 | 3.05 | 0.599 | 19.78 | |
| ***Top of jet = 149.6*** | ***4.45*** | ***0.711*** | ***15.04*** | |
| 150.0 | 4.57 | 0.472 | 14.43 | 475.79 |
| 160.0 | 7.62 | 0.959 | 7.60 | 381.82 |
| 170.0 | 10.67 | 1.447 | 5.52 | 350.37 |
| ***Spillane 5.3 m/s Height = 171.8*** | **11.21** | **1.534** | **5.30** | 346.85 |
| 180.0 | 13.71 | 1.935 | 4.55 | 334.91 |
| 190.0 | 16.76 | 2.422 | 3.99 | 325.98 |
| 200.0 | 19.81 | 2.910 | 3.63 | 320.34 |
| 210.0 | 22.86 | 3.398 | 3.37 | 316.54 |
| 220.0 | 25.91 | 3.885 | 3.17 | 313.85 |
| 230.0 | 28.95 | 4.373 | 3.01 | 311.87 |
| 280.0 | 44.19 | 6.811 | 2.53 | 306.95 |
| 330.0 | 59.43 | 9.250 | 2.27 | 305.08 |
| 380.0 | 74.67 | 11.688 | 2.09 | 304.16 |
| 430.0 | 89.91 | 14.127 | 1.96 | 303.64 |
| 480.0 | 105.15 | 16.565 | 1.85 | 303.31 |
| 530.0 | 120.39 | 19.003 | 1.77 | 303.08 |
| 580.0 | 135.63 | 21.442 | 1.70 | 302.92 |
| 680.0 | 166.11 | 26.319 | 1.59 | 302.72 |
| 780.0 | 196.59 | 31.195 | 1.50 | 302.59 |
| 880.0 | 227.07 | 36.072 | 1.43 | 302.51 |
| 980.0 | 257.55 | 40.949 | 1.37 | 302.45 |
| 1080.0 | 288.03 | 45.826 | 1.32 | 302.41 |
| 1180.0 | 318.51 | 50.703 | 1.27 | 302.38 |
| 1280.0 | 348.99 | 55.579 | 1.23 | 302.36 |
| 1380.0 | 379.47 | 60.456 | 1.20 | 302.34 |
| 1480.0 | 409.95 | 65.333 | 1.17 | 302.32 |
| 1580.0 | 440.43 | 70.210 | 1.14 | 302.31 |
| 1680.0 | 470.91 | 75.087 | 1.12 | 302.30 |
| 1780.0 | 501.39 | 79.963 | 1.09 | 302.29 |
| 1880.0 | 531.87 | 84.840 | 1.07 | 302.28 |
| 1980.0 | 562.35 | 89.717 | 1.05 | 302.28 |
| 2080.0 | 592.83 | 94.594 | 1.03 | 302.27 |

**Jet Phase Eqs:** **5 foot Intervals**

Linearly interpolated from Stack Rel.Ht to Top of Jet

**Spillane Equations:**

$V_{plume}=\{(Va)_o^3+0.12F_o[(z-z_v)^2-(6.25D-z_v)^2]\}^{1/3}$ / a

a = $0.16(z-z_v)$ **10 foot Intervals**

$\theta_p=\theta_s(1+(1-(\theta_e/\theta_s))*(V_{exit}D^2/(4V_{plume}*a^2*\lambda^2)))$

**Max<5.30 m/s**

**50 foot Intervals**

**100 foot Intervals**

*Summer Max = Monthly Mean of Maximum Daily Temperatures for 1971-2000 (Highest in July)

NOAA Sources: Climatography of the United States No.81 *"Monthly Station Normals of Temperatures, Precipitation, and Heating and Cooling Degree Days, 1971-2000 California"* and Climatography of the United States No. 20 *"Monthly Station Climate Summaries, 1971-2000 California"*

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# Appendix C: Obstruction Evaluation Report

# Microsoft SJC04 Data Center Project

DayZen LLC

*Santa Clara County, California*

*Obstruction Evaluation & Airspace Analysis*

November 16, 2022

Capitol Airspace Group
*capitolairspace.com*
*(703) 256 - 2485*

# Summary

Capitol Airspace conducted an obstruction evaluation and airspace analysis for the Microsoft SJC04 Data Center project in Santa Clara County, California. The purpose for this analysis was to identify the lowest obstacle clearance surfaces established by the Federal Aviation Administration (FAA) that could limit structure heights within the defined study area (black outline, ***Figure 1***).

The FAA requires that all structures exceeding 14 CFR Part 77.9 notification criteria be submitted to the FAA so that an aeronautical study can be conducted. The FAA's objective in conducting aeronautical studies is to ensure that proposed structures do not affect the safety of air navigation or the efficient utilization of navigable airspace by aircraft. The result of an aeronautical study is the issuance of a determination of 'hazard' or 'no hazard' that can be used by the proponent to obtain necessary local construction permits. It should be noted that the FAA has no control over land use in the United States and cannot enforce the findings of its studies.

The lowest obstacle clearance surfaces overlying the Microsoft SJC04 Data Center project are a constant 180 feet above mean sea level (AMSL) and are associated with an instrument approach procedure. If the FAA determines that proposed structures would affect as few as one operation per week, it could result in determinations of hazard.

Multiple terminal area navigational aid protection areas overlie the Microsoft SJC04 Data Center study area. Impact on navigational aids can result in the issuance of determinations of hazard regardless of the lack of impact on the other surfaces described in this report.

This study did not consider electromagnetic interference on FAA communication or surveillance radar systems. Impact on these systems can result in determinations of hazard regardless of the lack of impact on the physical airspace surfaces described in this report.

# Methodology

Capitol Airspace studied the proposed project based on location information provided by DayZen LLC. Using this information, Capitol Airspace generated graphical overlays to determine proximity to airports (***Figure 1***), published instrument procedures, enroute airways, FAA minimum vectoring altitude and minimum instrument flight rules (IFR) altitude charts, as well as military airspace and training routes.

Capitol Airspace evaluated all 14 CFR Part 77 imaginary surfaces, published instrument approach and departure procedures, visual flight rules operations, FAA minimum vectoring altitudes, minimum IFR altitudes, and enroute operations. All formulas, headings, altitudes, bearings, and coordinates used during this study were derived from the following documents and data sources:

- 14 CFR Part 77 Safe, Efficient Use, and Preservation of the Navigable Airspace
- FAA Order 7400.2N Procedures for Handling Airspace Matters
- FAA Order 8260.3E United States Standard for Terminal Instrument Procedures
- FAA Order 8260.58C United States Standard for Performance Based Navigation (PBN) Instrument Procedure Design
- Technical Operations Evaluation Desk Guide for Obstruction Evaluation/Airport Airspace Analysis (1.6.2)
- United States Government Flight Information Publication, US Terminal Procedures
- National Airspace System Resource Aeronautical Data

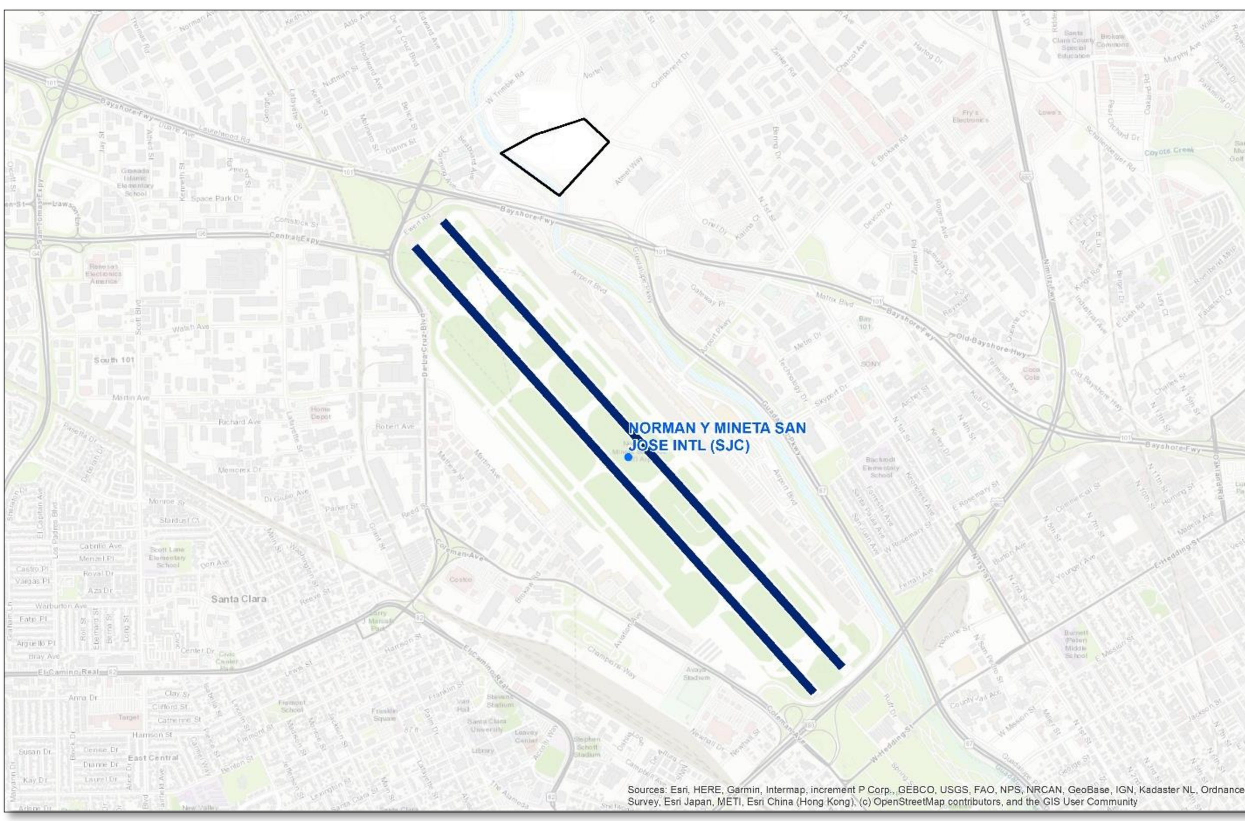



***Figure 1: Norman Y. Mineta San Jose International (SJC) in proximity to the Microsoft SJC04 Data Center project***

# Study Findings

## 14 CFR Part 77.17(a)(2) Obstruction Standard and 77.19/21/23 Imaginary Surfaces

The FAA uses level and sloping imaginary surfaces to determine if a proposed structure is an obstruction to air navigation. Structures that are identified as obstructions are then subject to a full aeronautical study and increased scrutiny. However, exceeding a Part 77 imaginary surface does not automatically result in the issuance of a determination of hazard. Proposed structures must have airspace impacts that constitute a substantial adverse effect in order to warrant the issuance of determinations of hazard.

Military and public use airport 14 CFR Part 77.17(a)(2) obstruction standard (dashed blue outline, ***Figure 2***) and imaginary surfaces (solid blue outline, ***Figure 2***) overlying the Microsoft SJC04 Data Center project:

Norman Y. Mineta San Jose International (SJC)
77.17(a)(2): 262 feet AMSL
77.19: 198 to 212 feet AMSL

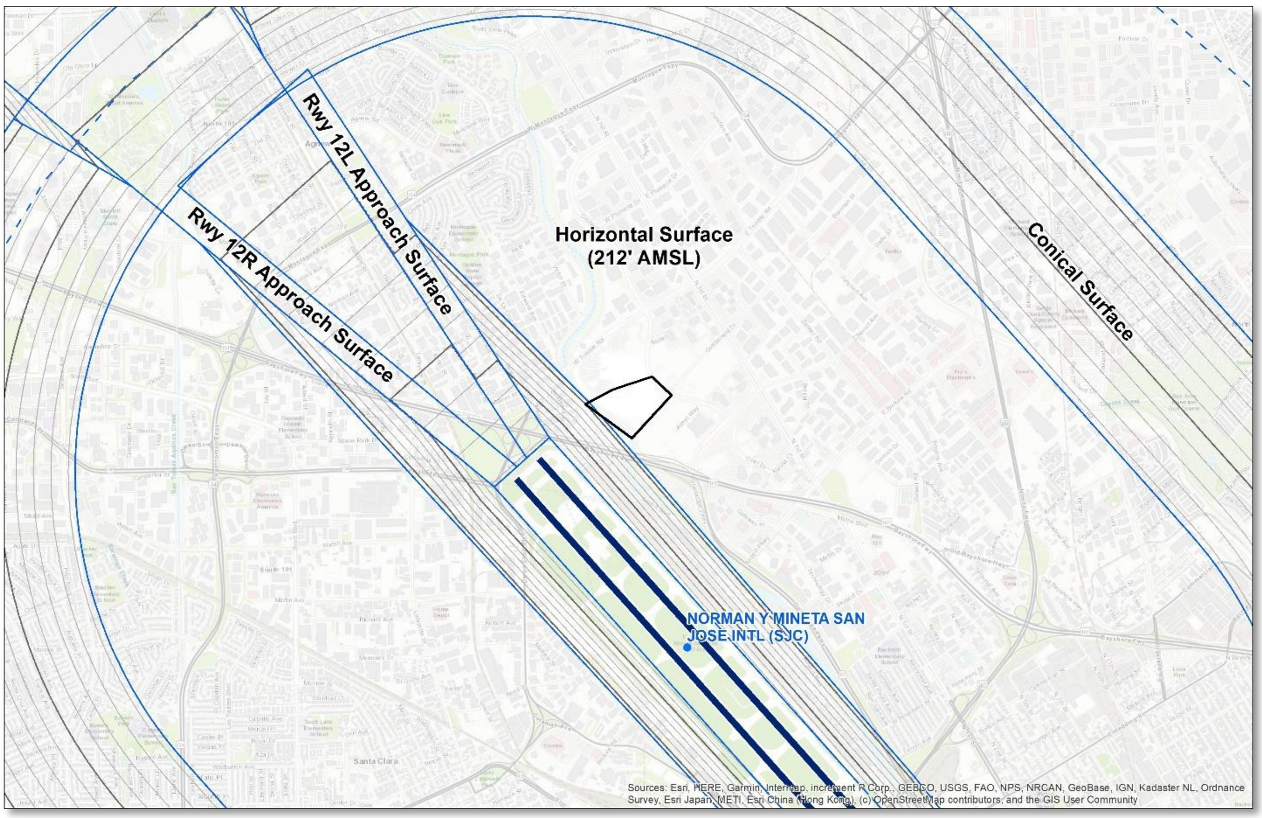



***Figure 2: 77.17(a)(2) obstruction standard (dashed blue) and 77.19 imaginary surfaces (solid blue)***

## Runway Protection Zones

The FAA has established Runway Protection Zones (RPZ) to designate areas located along the extended runway centerline where the protection of people and property on the ground is enhanced. In order to ensure enhanced safety, the FAA recommends airport control of this area to guarantee the RPZ remain clear of incompatible objects and activities. The size of the RPZ is directly related to the airplane design group and approach categories that the runway is expected to serve as well as the visibility minimums associated with instrument approach procedures.

RPZs (e.g., ***Figure 3***) do not overlie the study area. Therefore, RPZs should not limit development within the defined study area.

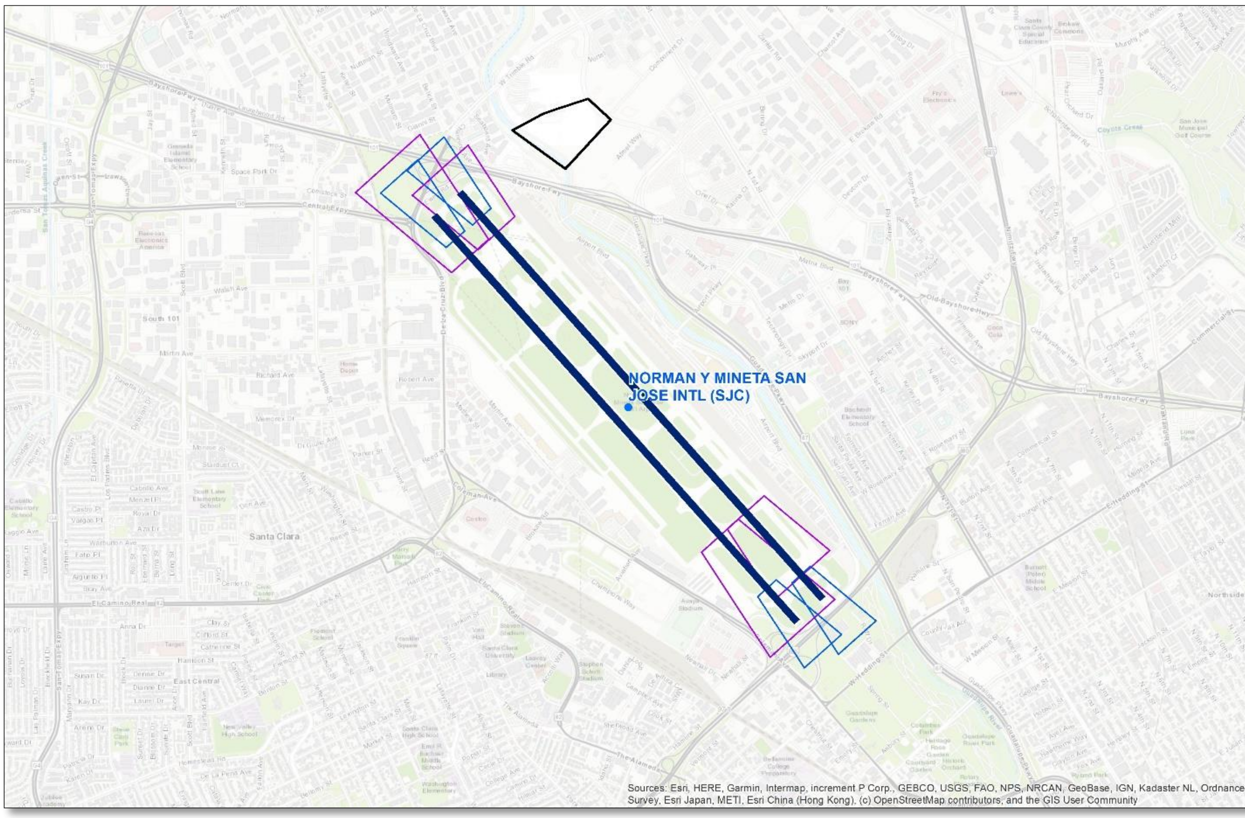



***Figure 3: Norman Y. Mineta San Jose International (SJC) approach (purple) and departure (blue) RPZs***

## One Engine Inoperative (OEI) Procedures

The FAA requires that airlines develop one engine inoperative (OEI) procedures that allow for the clearance of all terrain and obstacles in the even that an aircraft loses an engine during departure. Aircraft performance calculations based on the loss of one engine ensure that aircraft meet these clearance requirements. The introduction of new obstacles to existing OEI procedures can impact aircraft loading by decreasing the number of passengers or amount of fuel and cargo an aircraft can carry. While this impact is not currently considered by the FAA during aeronautical study, it will likely result in airline objections.

OEI procedures vary by airline, aircraft type, and runway end, and are proprietary airline information. Since these procedures are not publicly available, Capitol Airspace applied the “straight” OEI obstacle accountability areas (OAA) (e.g., ***Figure 4***) defined in FAA Advisory Circular 120-91A *Airport Obstacle Analysis* to determine the likelihood of proposed structures impacting OEI operations.

The straight-out Norman Y. Mineta San Jose International (SJC) OEI OAAs (purple outlines, ***Figure 4***) do not overlie the study area. Therefore, it is unlikely that the Microsoft SJC04 Data Center project would impact OEI operations.

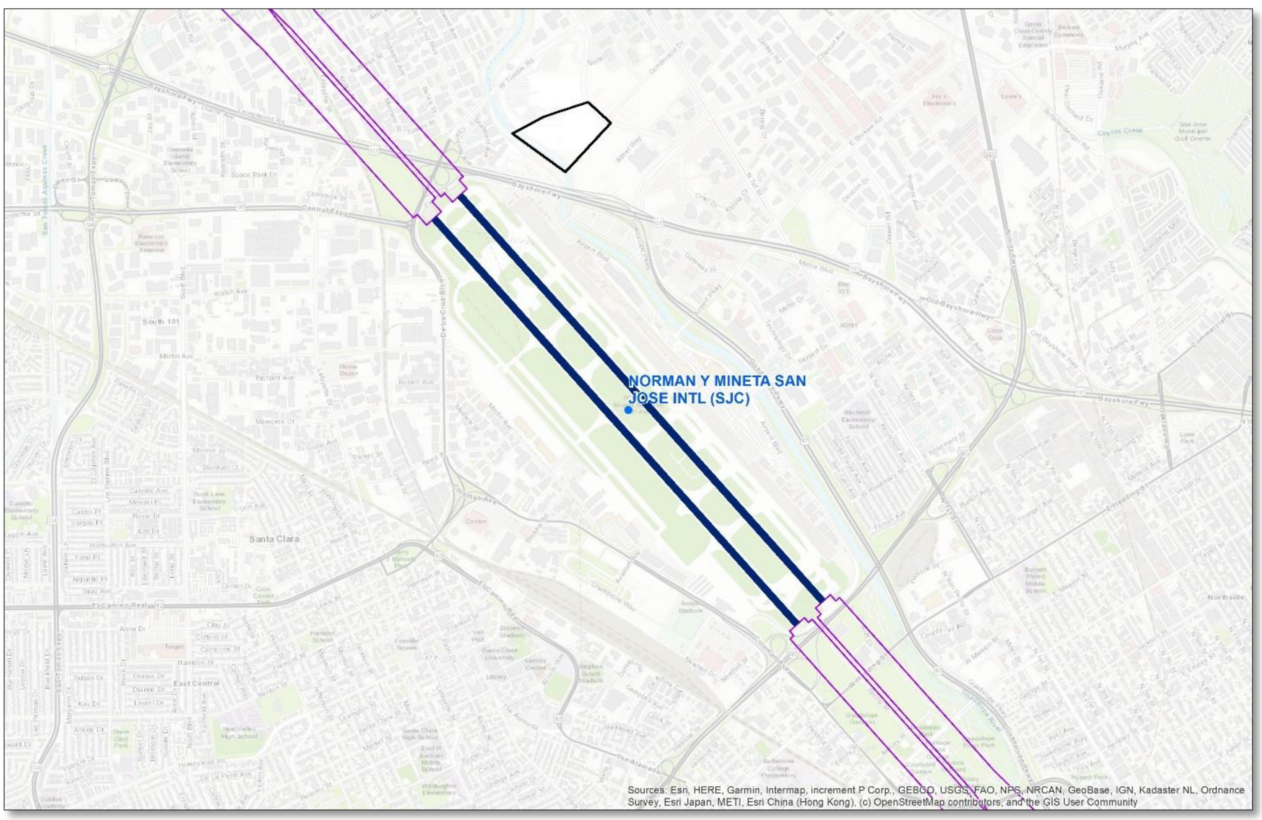



***Figure 4: Norman Y. Mineta San Jose International (SJC) OEI OAAs (purple)***

### Visual Flight Rules (VFR) Traffic Pattern Airspace

VFR traffic pattern airspace is used by pilots operating during visual meteorological conditions (VMC). The airspace dimensions are based upon the category of aircraft which, in turn, is based upon the approach speed of the aircraft. 14 CFR Part 77.17(a)(2) and 77.19 (as applied to a *visual* runway) imaginary surfaces establish the obstacle clearance surface heights within VFR traffic pattern airspace.

VFR traffic pattern airspace obstacle clearance surfaces (***Figure 5***) are in excess of other, lower surfaces and do not result in the lowest height constraint overlying the Microsoft SJC04 Data Center project.

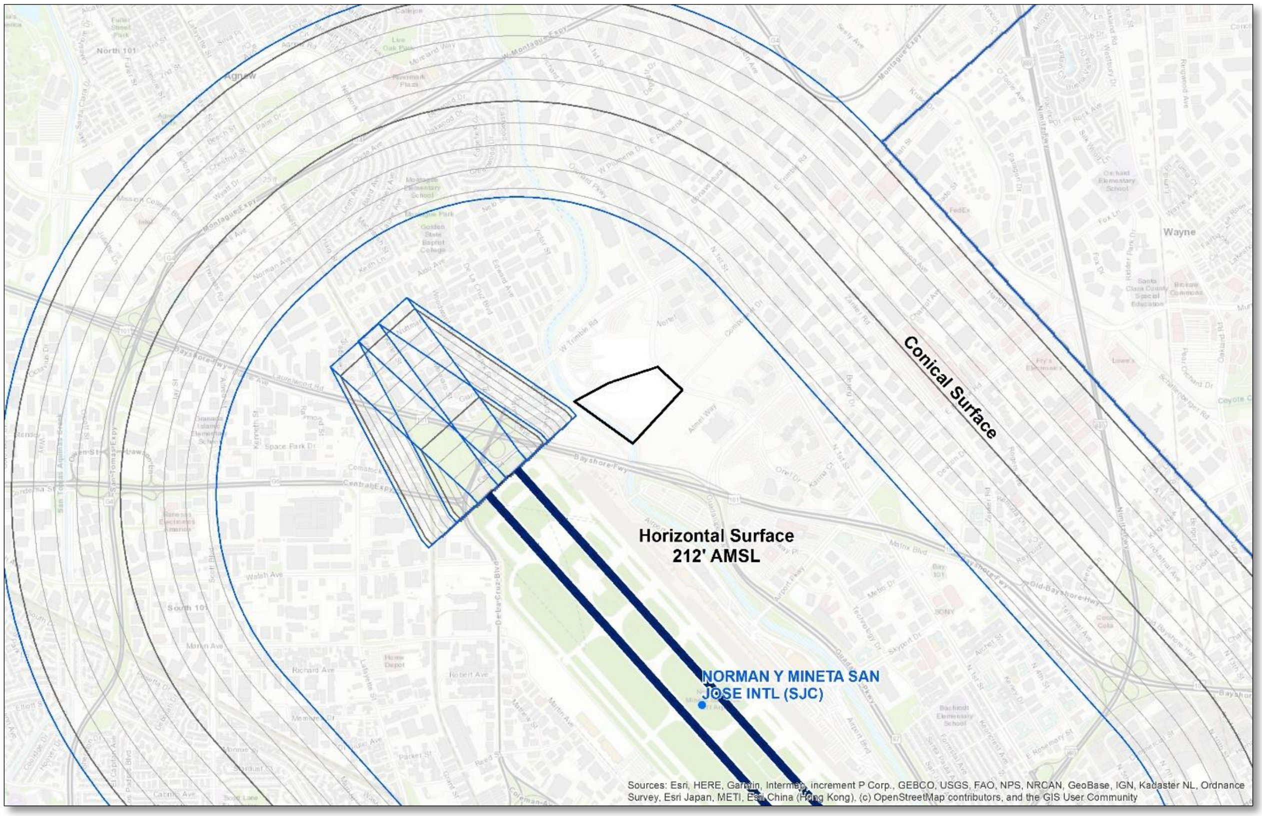



***Figure 5: Norman Y. Mineta San Jose International (SJC) VFR traffic pattern airspace overlying the Microsoft SJC04 Data Center project***

### Instrument Departures

In order to ensure that aircraft departing during marginal weather conditions do not fly into terrain or obstacles, the FAA publishes instrument departure procedures that provide obstacle clearance to pilots as they transition between the terminal and enroute environments. These procedures contain specific routing and minimum climb gradients to ensure clearance from terrain and obstacles.

Proposed structures that exceed instrument departure procedure obstacle clearance surfaces would require an increase to instrument departure procedure minimum climb gradients. If the FAA determines that this impact would affect as few as one operation per week, it could be used as the basis for determinations of hazard.

Instrument departure procedure obstacle clearance surfaces (e.g., ***Figure 6***) are in excess of other, lower surfaces and do not result in the lowest height constraint overlying the Microsoft SJC04 Data Center project.

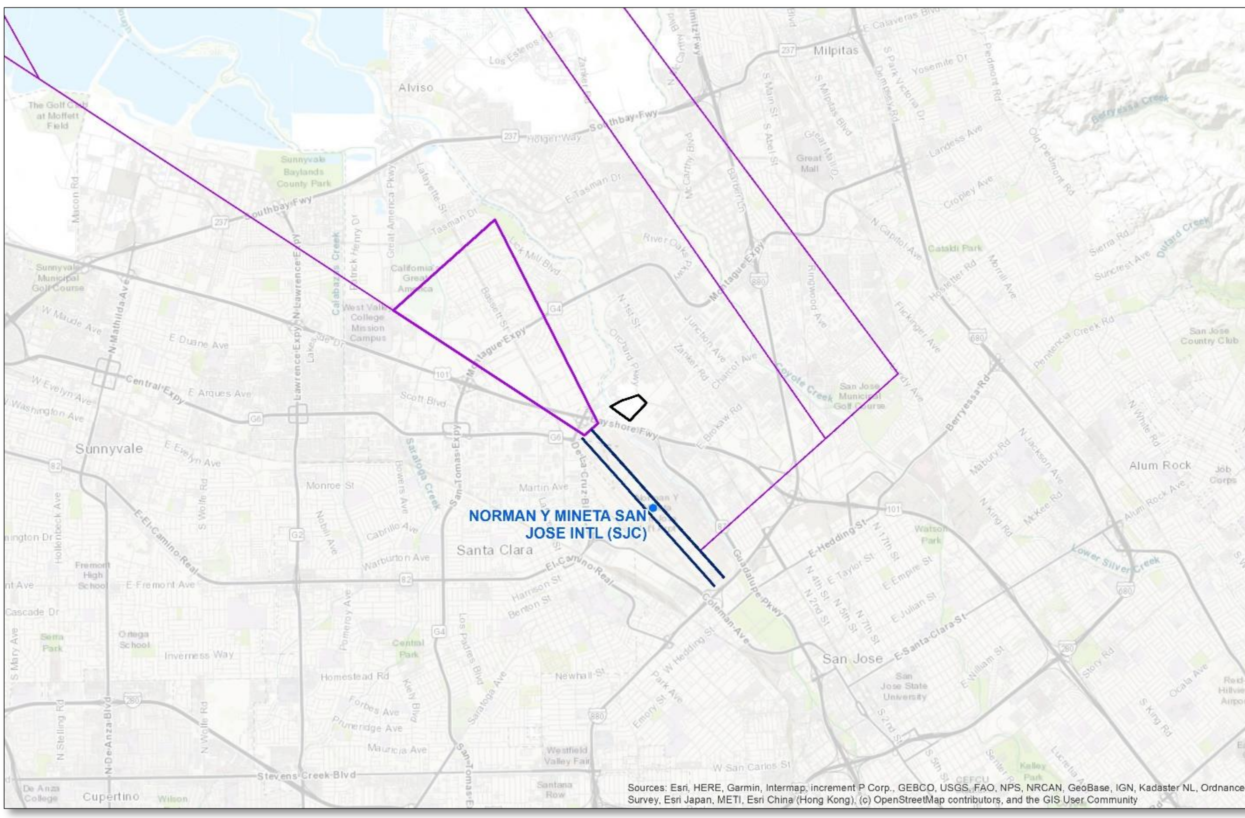



***Figure 6: Norman Y. Mineta San Jose International (SJC) Runway 30R obstacle departure procedure***

## Instrument Approaches

Pilots operating during periods of reduced visibility and low cloud ceilings rely on terrestrial and satellite based navigational aids (NAVAIDS) in order to navigate from one point to another and to locate runways. The FAA publishes instrument approach procedures that provide course guidance to on-board avionics that aid the pilot in locating the runway. Capitol Airspace assessed 12 published instrument approach procedures at Norman Y. Mineta San Jose International (SJC) in proximity to the Microsoft SJC04 Data Center project:

Norman Y. Mineta San Jose International (SJC)
ILS or Localizer Approach to Runway 12R
ILS or Localizer Approach to Runway 30L
ILS Approach to Runway 30L (SA CAT I & II)
RNAV (RNP) Z Approach to Runway 12L
RNAV (RNP) Z Approach to Runway 12R
RNAV (RNP) Z Approach to Runway 30L
RNAV (RNP) Z Approach to Runway 30R
RNAV (GPS) Y Approach to Runway 12L
RNAV (GPS) Y Approach to Runway 12R
RNAV (GPS) Y Approach to Runway 30L
RNAV (GPS) Y Approach to Runway 30R
Fairgrounds Visual Approach to Runways 30L/R

Proposed structures that exceed instrument approach procedure obstacle clearance surfaces would require an increase to their minimum altitudes. Increases to these altitudes, especially critical *decision altitudes (DA)* and *minimum descent altitudes (MDA)*, can directly impact the efficiency of instrument approach procedures. If the FAA determines this impact would affect as few as one operation per week, it could be used as the basis for determinations of hazard.

## Norman Y. Mineta San Jose International (SJC)

*RNAV (GPS) Y Approach to Runway 12L*

The final approach segment (purple outline, ***Figure 7***) and missed approach segment (blue outline, ***Figure 7***) obstacle clearance surfaces are a constant 180 feet AMSL where they overlie the study area and are the lowest height constraints overlying the Microsoft SJC04 Data Center project.

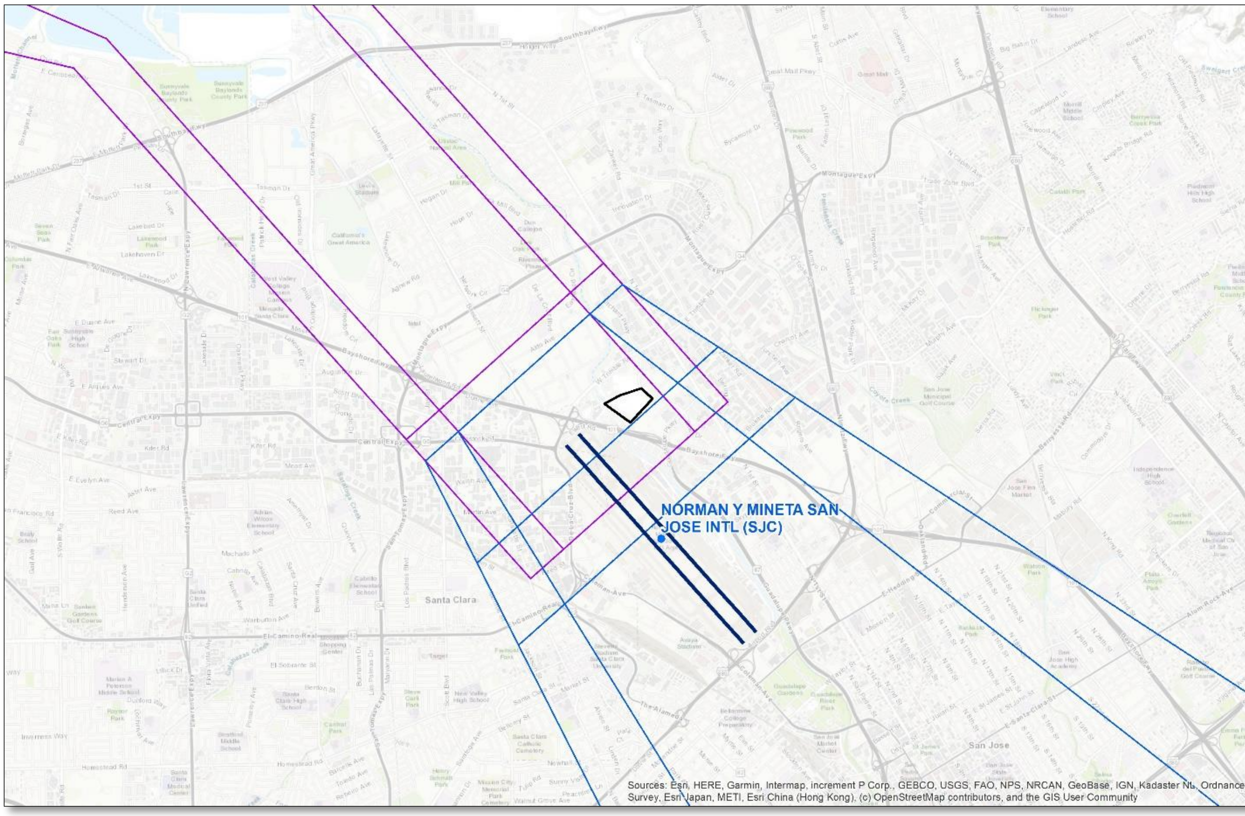



***Figure 7: Norman Y. Mineta San Jose International (SJC) RNAV GPS Approach to Runway 12L with LNAV/VNAV final and missed approach segments***

## Enroute Airways

Enroute airways provide pilots a means of navigation when flying from airport to airport and are defined by radials between VHF omni-directional ranges (VORs). The FAA publishes minimum altitudes for airways to ensure clearance from obstacles and terrain. The FAA requires that each airway have a minimum obstacle clearance of 1,000 feet in non-mountainous areas and normally 2,000 feet in mountainous areas.

Proposed structures that exceed enroute airway obstacle clearance surfaces would require an increase to their minimum obstruction clearance altitudes (MOCA) and/or minimum enroute altitudes (MEA). If the FAA determines that this impact would affect as few as one operation per week, it could be used as the basis for determinations of hazard.

Low altitude enroute airway obstacle clearance surfaces (e.g., ***Figure 8***) are in excess of other, lower surfaces and do not result in the lowest height constraint overlying the Microsoft SJC04 Data Center project.


*Figure 8: Low altitude enroute chart L-3 with V334 (purple) and T259 (brown) obstacle evaluation areas*

### Minimum Vectoring/IFR Altitudes

The FAA publishes minimum vectoring altitude (MVA) and minimum IFR altitude (MIA) charts that define sectors with the lowest altitudes at which air traffic controllers can issue radar vectors to aircraft based on obstacle clearance. The FAA requires that sectors have a minimum obstacle clearance of 1,000 feet in non-mountainous areas and normally 2,000 feet in mountainous areas.

Proposed structures that exceed MVA/MIA sector obstacle clearance surfaces would require an increase to the altitudes usable by air traffic control for vectoring aircraft. If the FAA determines that this impact would affect as few as one operation per week, it could result in determinations of hazard.

MVA and MIA obstacle clearance surfaces (e.g., ***Figure 9***) are in excess of other, lower surfaces and do not result in the lowest height constraint overlying the Microsoft SJC04 Data Center project.

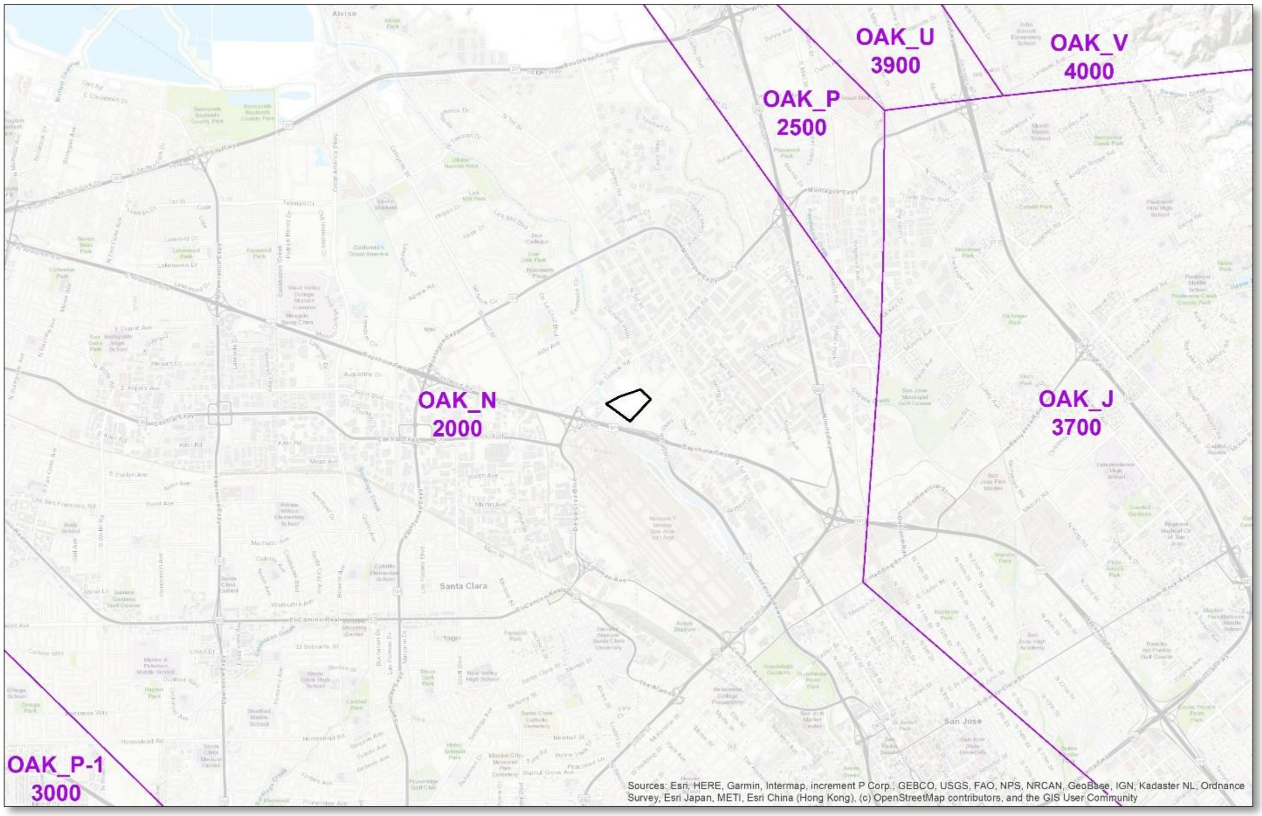



***Figure 9: Northern California (NCT) TRACON MVA FUS 3 sectors and the Microsoft SJC04 Data Center project***

### Terminal and Enroute Navigational Aids

The FAA has established protection areas in order to identify proposed structures that may have a physical and/or electromagnetic effect on navigational aids (NAVAIDs). The protection area dimensions vary based on the proposed structure type as well as the NAVAID type. Proposed structures within these areas may interfere with NAVAID services and will require further review by FAA Technical Operations. If further review determines that proposed structures would have a significant physical and/or electromagnetic effect on NAVAIDs, it could result in determinations of hazard.

#### San Jose (SJC) VOR/DME [1]

The Microsoft SJC04 Data Center project is located within the two nautical mile (NM) protection area of the *San Jose (SJC) VOR/DME* (blue outline, ***Figure 10***). As a result, the Microsoft SJC04 Data Center project may be subject to further review by FAA Technical Operations.

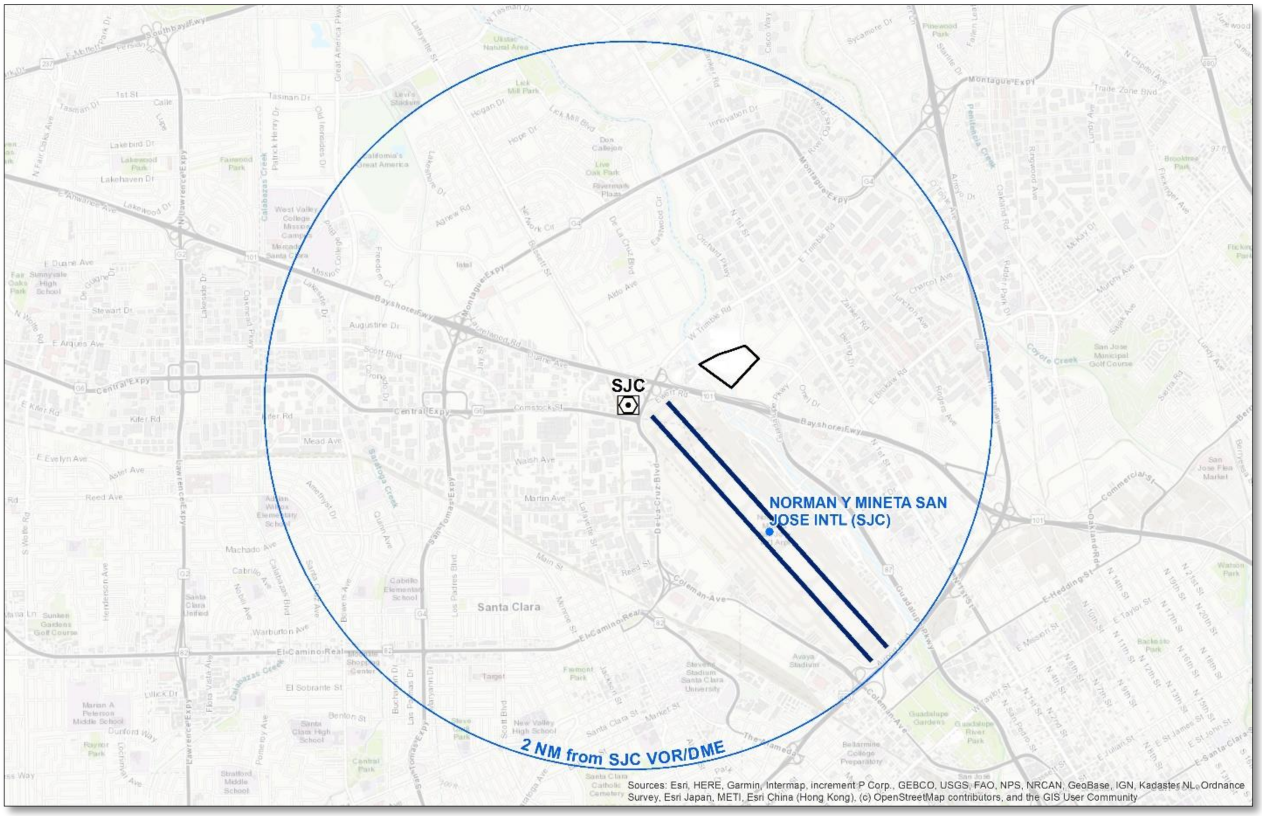



***Figure 10: San Jose (SJC) VOR/DME protection area overlying the Microsoft SJC04 Data Center project***

[1] In accordance with Technical Operations Evaluation Desk Guide for Obstruction Evaluation/Airport Airspace Analysis (1.6.1), Chapter 6.2, the methodology to analyze a VOR will be used to protect TACAN and DME services until a separate DME siting criteria order can be approved. Therefore, Capitol Airspace applied the VOR protection area criteria to this TACAN facility.

## Norman Y. Mineta San Jose International (SJC)

*Runway 12R Localizer (I-SLV) and Glideslope (I-SLV_GS)*

The Runway 12R localizer and glideslope protection area (purple outline, ***Figure 11***) overlies the Microsoft SJC04 Data Center project. As a result, the Microsoft SJC04 Data Center project may be subject to further review by FAA Technical Operations.

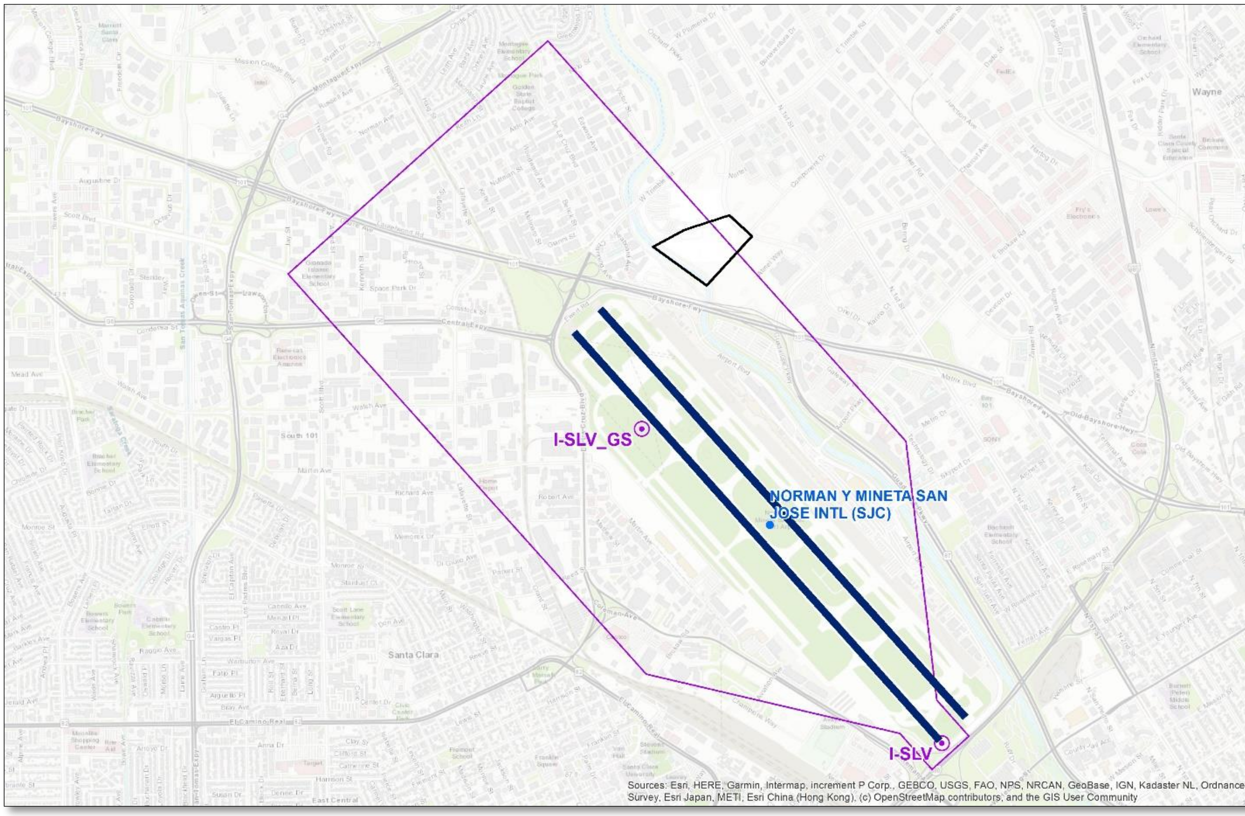



***Figure 11: Norman Y. Mineta San Jose International (SJC) Runway 12R Localizer and Glide Slope protection area (purple) overlying the Microsoft SJC04 Data Center project***

# Conclusion

Proposed structures that exceed 14 CFR Part 77.17(a)(2) obstruction standard or 77.19 imaginary surfaces (***Figure 2***) will be identified as obstructions. Additionally, proposed structures that exceed 14 CFR Part 77.17(a)(1) – a height of 499 feet above ground level at the site of the object – will be identified as obstructions regardless of their location. However, exceeding these surfaces does not automatically result in the issuance of a determination of hazard. Proposed structures must have airspace impacts that constitute a substantial adverse effect in order to warrant the issuance of determinations of hazard.

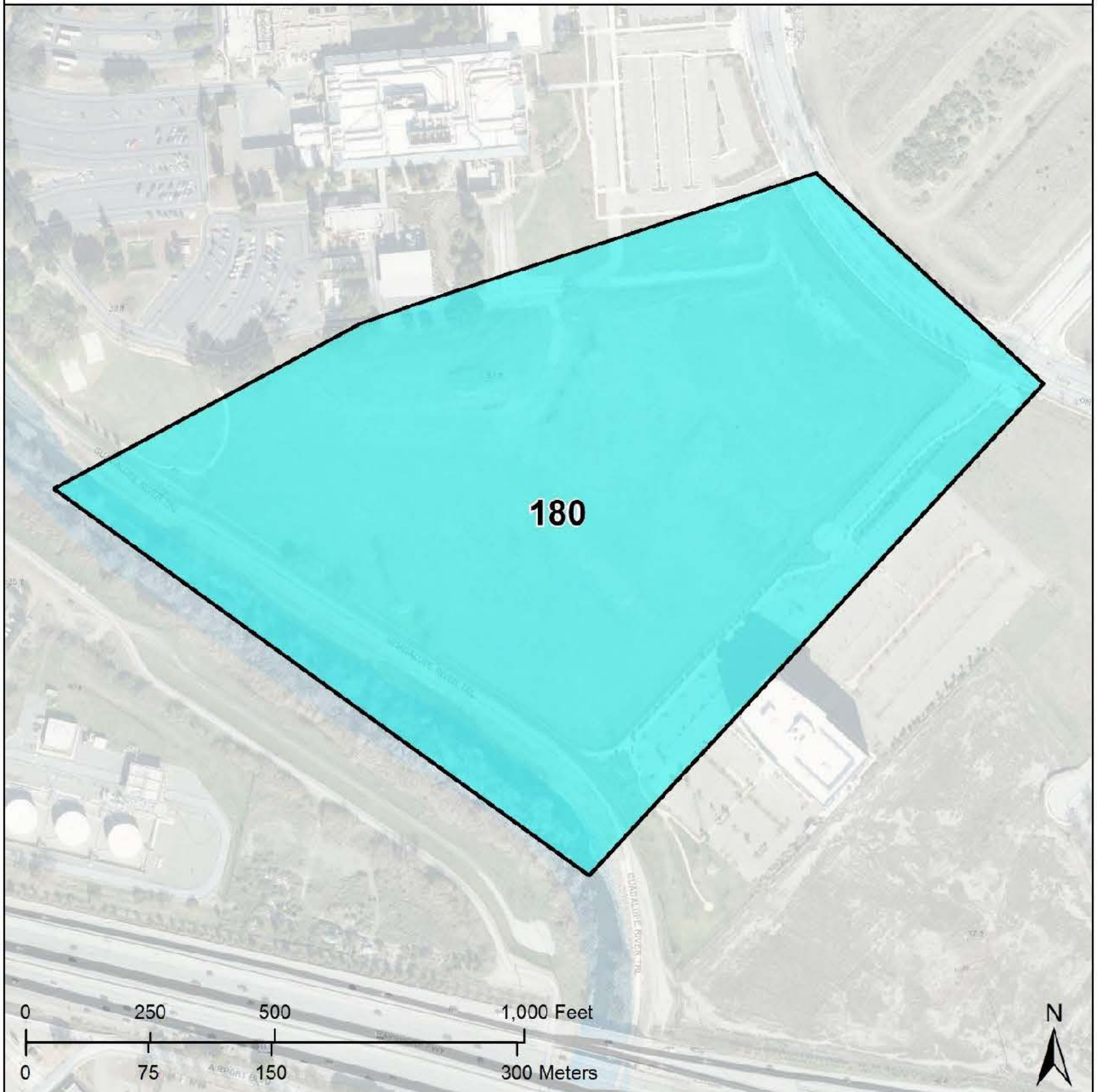
The lowest obstacle clearance surfaces overlying the Microsoft SJC04 Data Center project are a constant 180 feet AMSL (***Figure 13***) and are associated with the Norman Y. Mineta San Jose International (SJC) RNAV (GPS) Y Approach to Runway 12L (***Figure 7***). If the FAA determines that this impact would affect as few as one operation per day, it could result in determinations of hazard.

Proposed structures within enroute or terminal protection areas (***Figure 10*** & ***Figure 11***) will be forwarded for further review by FAA Technical Operations. If further review determines that structures would have a substantial adverse effect on navigational aids, it could result in determinations of hazard.

Cranes and other construction equipment that exceed the height or the footprint of the proposed structures must also be filed with the FAA and receive favorable determinations. If temporary equipment required to construct the Microsoft SJC04 Data Center project exceeds FAA obstacle clearance surfaces, it may not receive favorable temporary determinations.

If you have any questions regarding the findings of this study, please contact ***James Scott*** or ***Kevin Van Dam*** at (703) 256-2485.

Proposed structures that exceed 14 CFR Part 77.17(a)(1) - a height of 499 feet AGL at the site of the object - will be identified as obstructions regardless of location.




**Obstacle Clearance Surface**

**Height - AMSL Feet**

180

All heights above mean sea level (AMSL)

**Microsoft SJC04 Data Center Project**
Composite Height Constraint Map

**Plot Date:**
16 November 2022

**Coordinate System:**
NAD 1983 UTM Zone 10N

kvandam

**Figure 12**

Capitol Airspace Group

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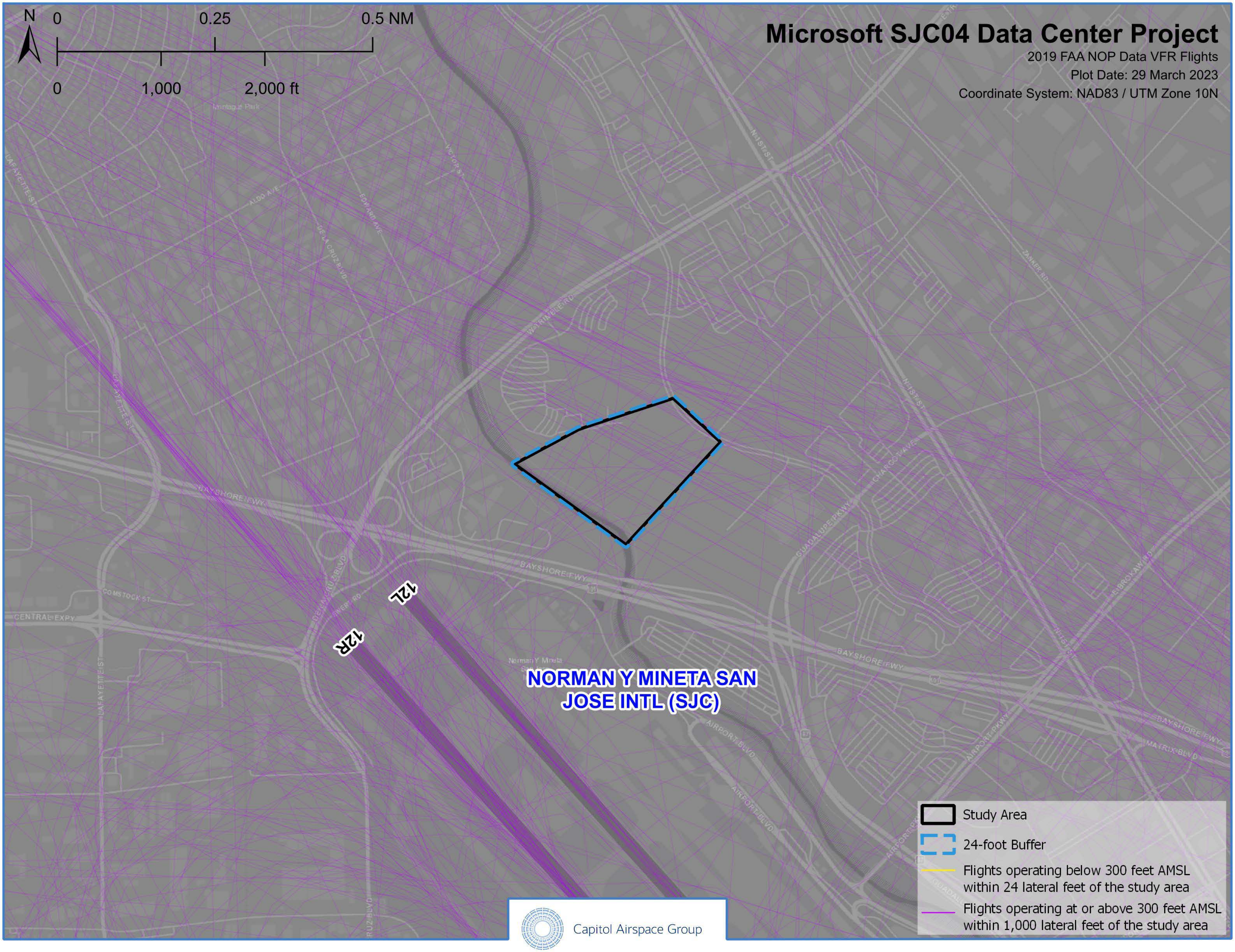
Alexandria, VA 22310
703-256-2485
capitolairspace.com

# Appendix D: Traffic Flow Analysis


Microsoft SJC04 Data Center Project
2019 FAA NOP Data VFR Flights
Plot Date: 29 March 2023
Coordinate System: NAD83 / UTM Zone 10N
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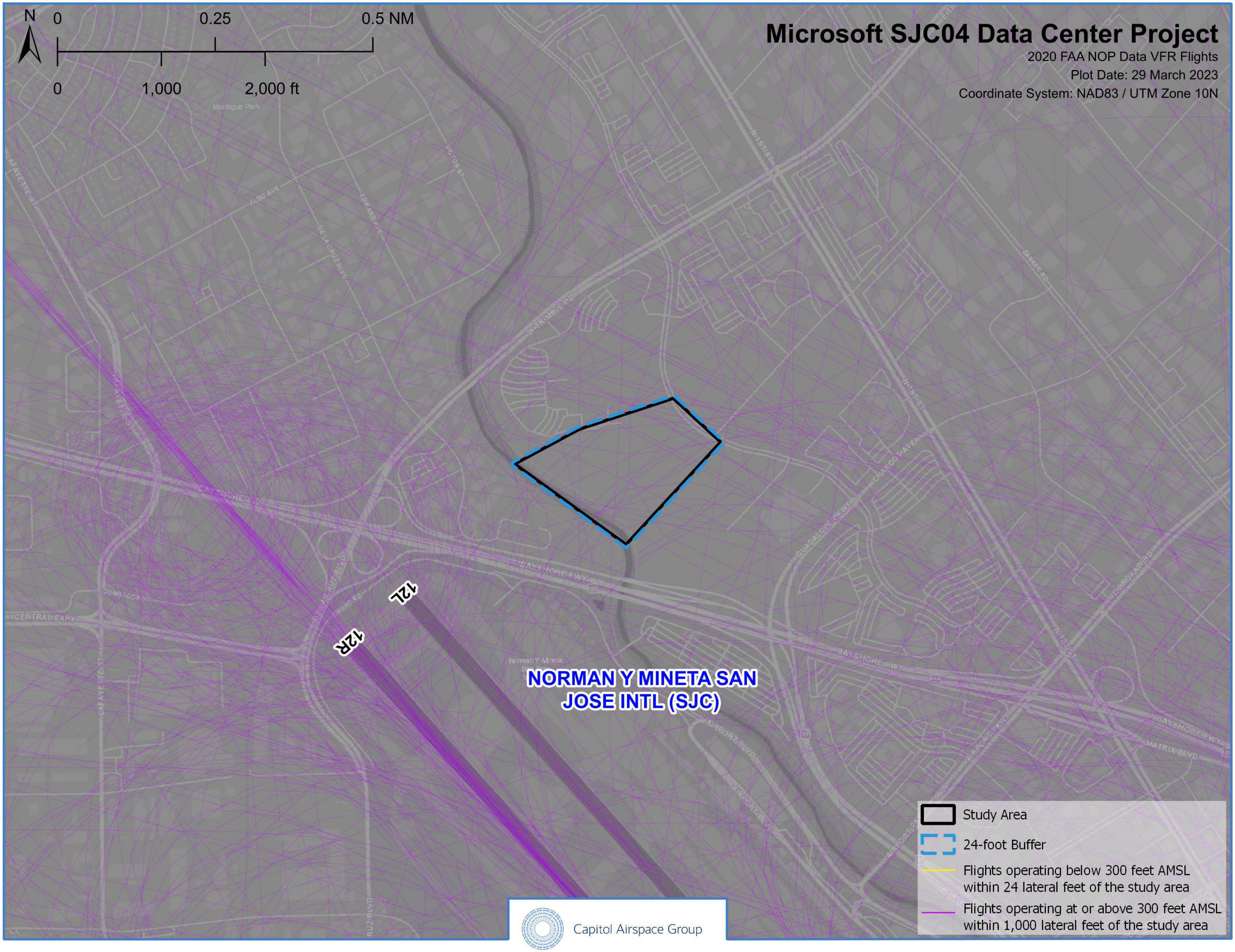
2,000 ft
12L
12R
NORMAN Y MINETA SAN JOSE INTL (SJC)
BAYSHORE FWY
CENTRAL EXPY
AIRPORT BLVD
Study Area
24-foot Buffer
Flights operating below 300 feet AMSL within 24 lateral feet of the study area
Flights operating at or above 300 feet AMSL within 1,000 lateral feet of the study area
Capitol Airspace Group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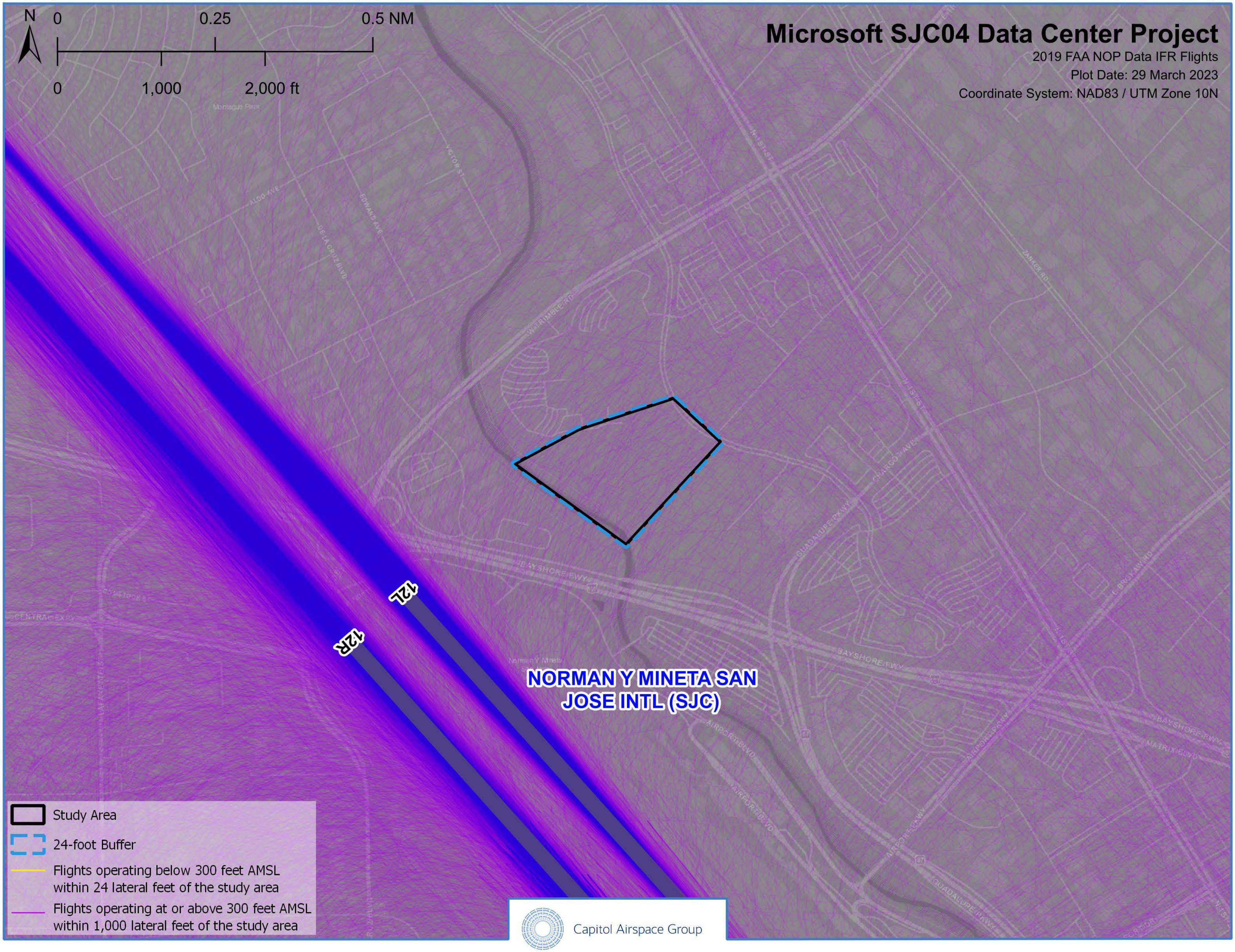

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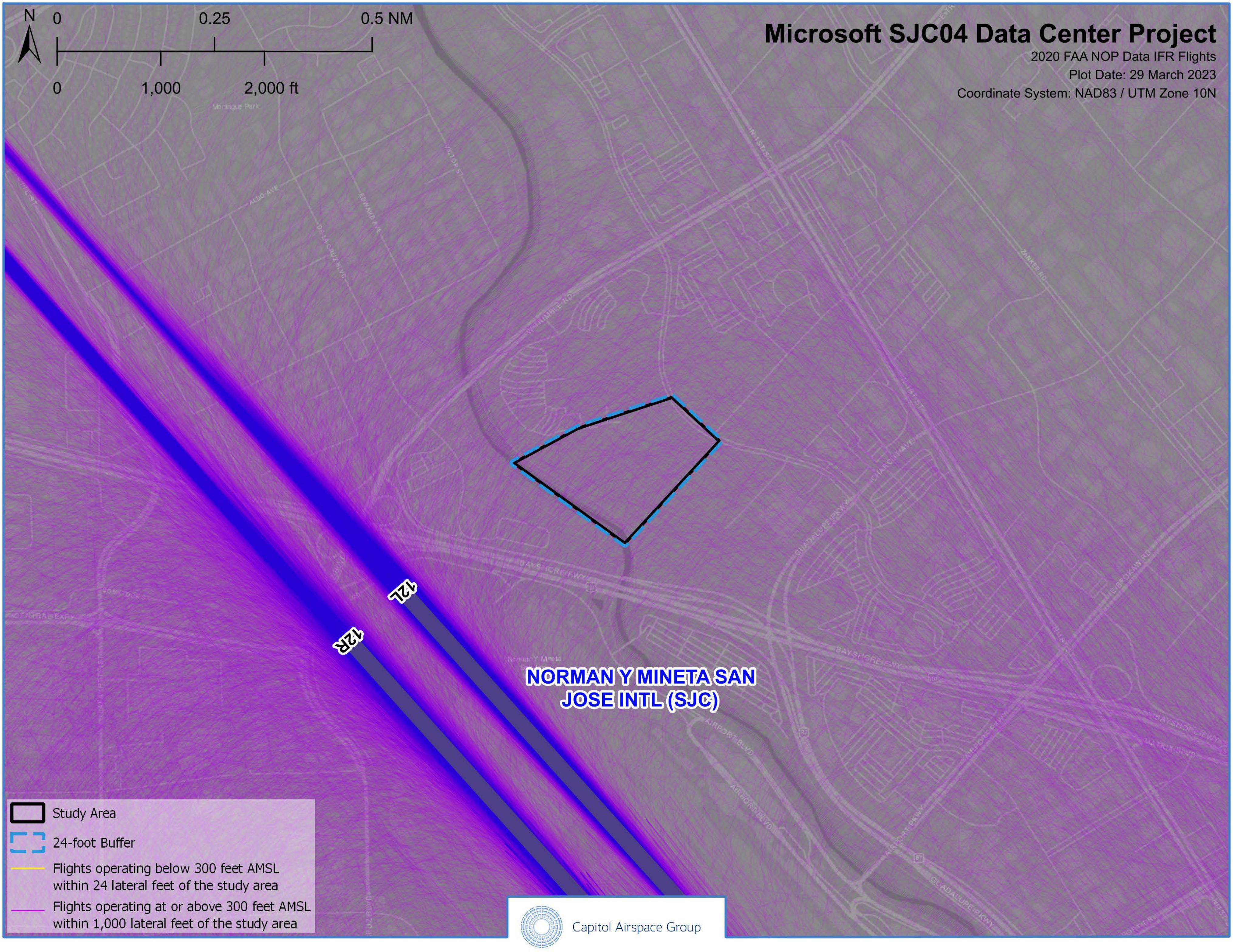
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