Florida Department of
TRANSPORTATION

DRAFT
NOISE STUDY REPORT
ADDENDUM

State Road 400 / I-4

Segment 1: From West of C.R. 532 (Polk/Osceola County Line) to West of S.R. 285/Beachline Expressway

Osceola County and Orange County, Florida

Financial Management Number: 431456-1-52-01(Osceola County) and 242484-8-52-01(Orange County)

The environmental review, consultation, and other actions required by applicable federal environmental laws for this project are being, or have been, carried out by FDOT pursuant to 23 U.S.C. § 327 and a Memorandum of Understanding dated December 14, 2016 and executed by FHWA and FDOT.

Florida Department of Transportation
District Five

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Florida Department of Transportation
District Five

Prepared by:
AECOM

January 2019

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1.0 INTRODUCTION

The Florida Department of Transportation (FDOT) is developing a roadway project to widen and improve State Road (S.R.) 400/I-4 in Osceola County and Orange County and to extend express lanes proposed along I-4 east of this project. Herein, this project is referred to as I-4 Beyond the Ultimate (I-4 BTU), FM 432100-1-22-01.

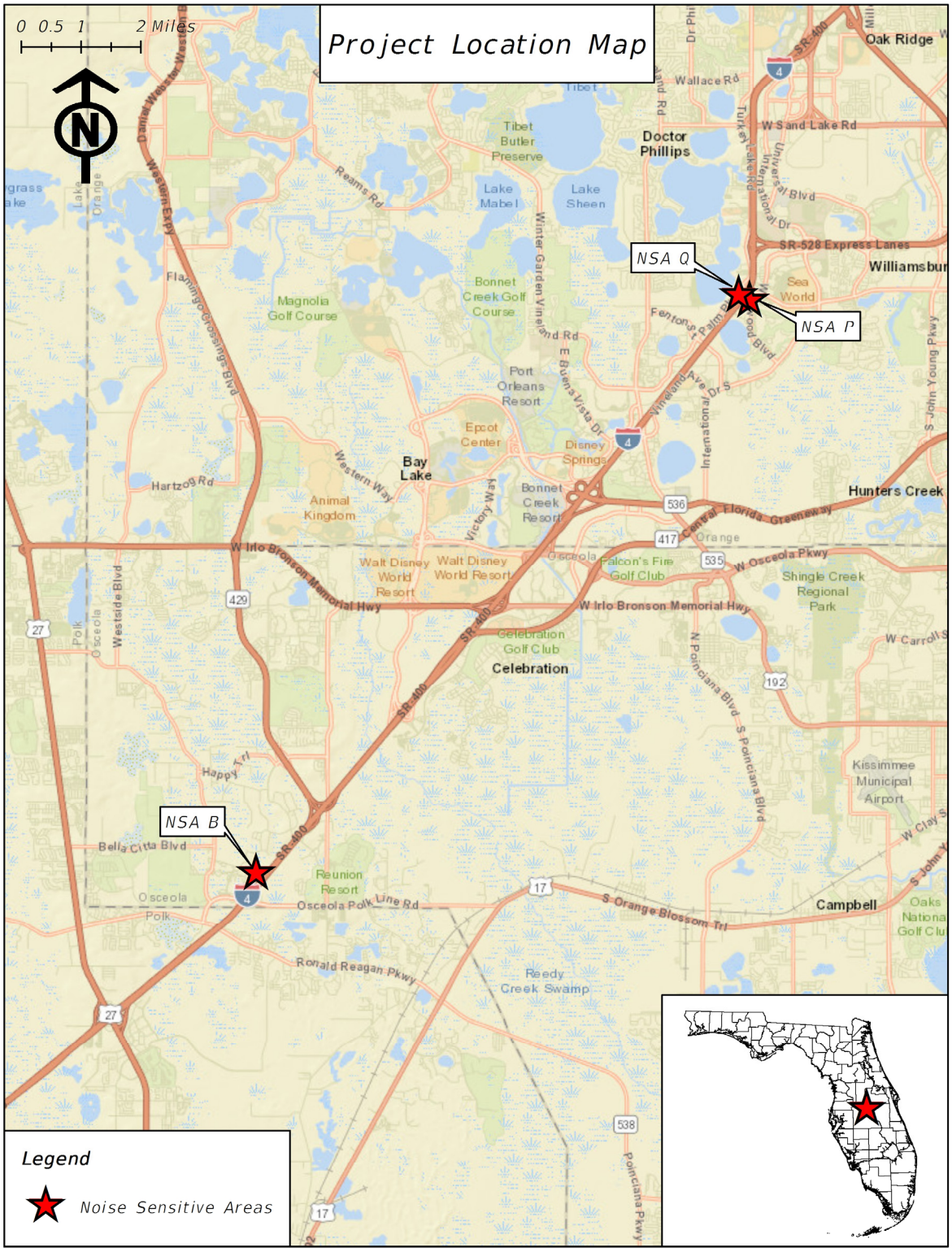
This Noise Study Report Addendum (NSRA) presents the results of a Design Phase noise barrier analysis for Segment 1 of the I-4 BTU; the limits of which are from west of C.R. 532 at the Polk/Osceola County Line to west of S.R. 528 Beachline Expressway.

The Project Development and Environment (PD&E) Study for this project was an Environmental Assessment/Finding of No Significant Action (EA/FONSI) level study that was completed in 1999 (FPN 242526 and 242483). A later Noise Study Report (NSR) was completed for the I-4 BTU project in July 2016 to address planned design changes and to reevaluate noise impacts for the improvements along the I-4 corridor planned at the time in Polk, Osceola and Orange counties. Also, this analysis would address changes in Federal Highway Administration (FHWA) and FDOT noise regulations and policies that have been implemented since completion of the original study in 1999.

This current 2018 Design Phase noise barrier analysis follows up on the 2016 NSR and specifically reevaluates noise barriers for three Noise Sensitive Areas (NSA) from the 2016 study; NSAs B, P and Q, using the latest project design plans. **Figure 1-1** depicts the locations of the three NSAs being evaluated.

This report presents a description of the methodologies used to perform the noise analysis, the predicted design year (2040) traffic noise levels, the noise barrier design concepts that were evaluated and the results of a noise barrier feasibility and reasonableness analysis.

Figure 1-1 Project Location Map



2.0 PROJECT DESCRIPTION

2.1 Existing Conditions

I-4 is an east-west limited access freeway which links the west and east coasts of Florida, from I-275 in Tampa to I-95 in Daytona Beach. The interstate traverses six counties in Central Florida. Within the limits of Segment 1 of the I-4 BTU, the typical section for I-4 is a six-lane divided urban interstate.

2.2 Planned Improvements

The proposed improvements to I-4 include widening the existing six-lane facility to a ten-lane divided highway typical section. The typical section adjacent to NSA B east of C.R. 532 will include three 12-foot general-use travel lanes with 10-foot inside and 12-foot outside shoulders and two 12-foot express-lanes with 4-foot inside and 10-foot outside shoulders in each direction (**Figure 2-1**). A barrier wall located between the adjacent shoulders will separate the express-lanes from the general-use lanes. Twelve-foot auxiliary lanes will be provided in some areas in both the eastbound and westbound directions. The typical section includes a 44-foot rail envelope in the median within a minimum 300 foot right of way. The typical section adjacent to NSAs P and Q, between Daryl Carter Parkway and Central Florida Parkway includes a partially elevated 2-lane westbound collector-distributor (WBCD) roadway and partially elevated general-use and express lanes (**Figure 2-2**).

Figure 2-1 Typical Section: NSA B-Stations 1229+60.70 to 1360+44.26

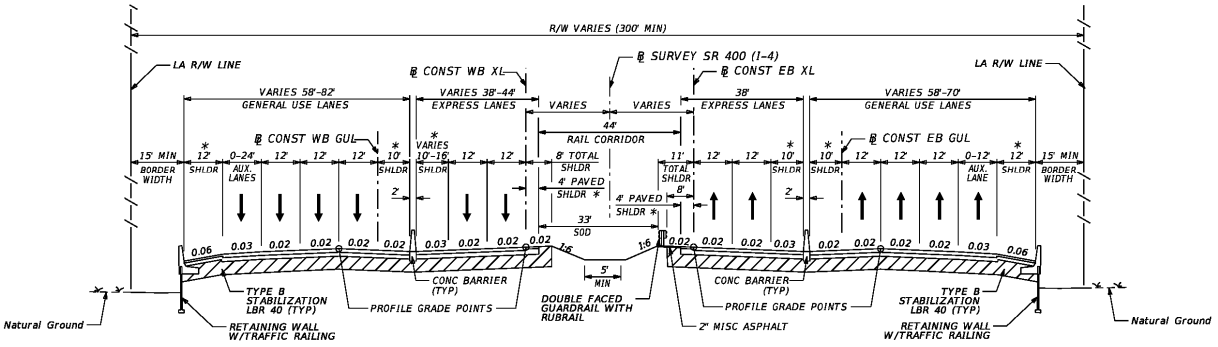
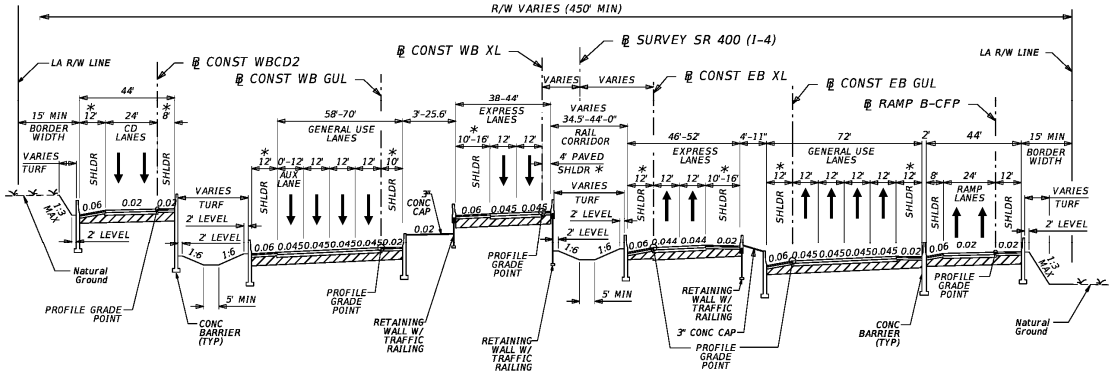


Figure 2-2 Typical Section: NSAs P and Q-Stations 1896+95.00 to 1936+00.00



2.3 Design Changes Since the 2016 Noise Reevaluation

The original design concept for this segment of I-4 included six general-use lanes and 4 high-occupancy vehicle (HOV) lanes from C.R. 532 to southwest of World Drive and the same from Lake Avenue to S.R. 528/Beachline Expressway. The 2016 analysis evaluated a design change that converted the HOV lanes to the tolled express lanes as described above. Design changes that have been implemented since the 2016 analysis include the following:

- **NSA B**
  - The vertical profile for I-4 has been established utilizing retaining walls.
- **NSAs P & Q**
  - The vertical profile for I-4 has been established utilizing retaining walls.
  - The eastbound ramp from Central Florida Parkway to the westbound I-4 General Use Lanes has been revised to independently connect with westbound I-4. This will create two successive one-lane entrance ramps onto westbound I-4. The PD&E preferred alternative joined this ramp with the westbound Central Florida parkway to westbound I-4 General Use lanes ramp and would have connected to I-4 using one dual-lane entrance ramp.

3.0 NOISE ANALYSIS METHODOLOGY

For the purposes of this Design Phase noise barrier reevaluation, noise barriers recommended for the three NSAs identified in the Introduction (NSA B, P and Q) were reanalyzed using the latest project design plans. This reevaluation has been conducted in accordance with current FHWA and FDOT traffic noise requirements. These include:

- *Title 23 Code of Federal Regulations* (CRF) 772, *Procedures for Abatement of Highway Traffic Noise and Construction Noise* (July 13, 2010)); and,
- *Highway Traffic Noise,* Part 2, Chapter 18 of the *FDOT PD&E Manual* (June 14, 2017).

3.1 Noise Metrics

Noise levels in this document represent the hourly equivalent sound level [Leq(h)]. The Leq(h) is the steady-state sound level, that contains the same amount of acoustic energy as the actual time-varying sound level over a one-hour period. The Leq(h) is measured in A-weighted decibels [dB(A)], which closely approximate the range of frequencies a human ear can hear.

3.2 Noise Level Prediction Model

The FHWA Traffic Noise Model (TNM) Version 2.5 (February 2004) was used to predict traffic noise levels due to the planned project and to evaluate the effectiveness of any needed noise barrier design concepts. This model estimates the acoustic intensity at a noise sensitive site (the receptor) from a series of roadway segments (the source). Model-predicted noise levels are influenced by several factors, such as vehicle speed and distribution of vehicle types. Noise levels are also affected by characteristics of the source-to-receptor site path, including the effects of intervening barriers, obstructions (houses, trees, etc.), ground surface type (hard or soft) and topography.

3.3 Noise Abatement Criteria

The FDOT uses Noise Abatement Criteria (NAC) established by the FHWA. Specific NAC levels have been developed for five of the FHWA's seven Activity Categories (See

Table 3.1). These NAC levels represent maximum acceptable traffic noise level conditions and define when an impact occurs and when consideration of noise abatement analysis is required. Noise abatement measures must be considered when predicted noise levels approach or exceed the FHWA NAC levels or when a substantial noise increase occurs. The FDOT defines "approach" as within 1 dB(A) of the FHWA criteria. A substantial noise increase is defined as a predicted increase of 15 dB(A) or more above the existing noise levels resulting from a transportation improvement project. Given the results of the project's PD&E Phase noise analysis, the substantial increase criterion will not be exceeded since the widening will occur to the inside of the existing lanes. As shown in ***Table 3.1***, the criteria vary according to a property's Activity Category.

Table 3.1 Noise Abatement Criteria
[Hourly A-Weighted Sound Level-Decibels (dB(A))]

ACTIVITY CATEGORY	ACTIVITY Leq(h)[1] FHWA	FDOT	EVALUATION LOCATION	DESCRIPTION OF ACTIVITY CATEGORY
A	57	56	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B[2]	67	66	Exterior	Residential
C[2]	67	66	Exterior	Active sports areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreational areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52	51	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E[2]	72	71	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	–	–	–	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	–	–	–	Undeveloped lands that are not permitted.

(Based on Table 1 of 23 CFR Part 772)
[1] The Leq(h) Activity Criteria values are for impact determination only, and are not a design standard for noise abatement measures.
[2] Includes undeveloped lands permitted for this activity category.
Note: FDOT defines that a substantial noise increase occurs when the existing noise level is predicted to be exceeded by 15 decibels or more as a result of the transportation improvement project. When this occurs, the requirement for abatement consideration will be followed.

3.4 Noise Model Inputs

Project/Site Features - Model inputs for the project build conditions were developed using the project's latest construction plans. Roadway and ground elevation inputs were developed from cross-section data contained in the design plans. Pavement, ground types, barriers, buildings and other physical features were

modeled in accordance with currently accepted methodologies regarding their input into TNM. Travel lanes were modeled individually.

Traffic Data - Design year (2040) traffic data used in the TNM model inputs were derived from traffic data found in the I-4 Beyond the Ultimate *Systems Access Modification Report (SAMR) Reevaluation* dated March 2017 and from data contained in the 2012 FDOT *Quality/Level of Service Handbook* tables. These data may be found in ***Appendix A***. According to Chapter 18 of the PD&E Manual, "Maximum peak-hourly traffic representing Level of Service (LOS) "C", or demand LOS of "A", "B", or "C" will be used (unless analysis shows that other conditions create a "worst-case" level)". In cases where traffic volumes on project roadways were predicted to operate at worse than LOS C, the LOS C project data were used. In overcapacity situations, this represents the highest traffic volume traveling at the highest average speed, which typically generates the highest noise levels at a given site during a normal day.

Receptors - Representative receptor sites are used in the TNM model to estimate noise levels associated with the build conditions within the project study area. Noise sensitive receptors represent properties where frequent exterior human use occurs and where a lowered noise level would be of benefit.

Developed lands within each of the three NSAs were reassessed to identify noise sensitive receptor sites that were expected to impacted by traffic noise associated with the proposed improvements. The model receptor sites were chosen based on noise sensitivity, roadway proximity, anticipated impacts from the proposed project, and homogeneity (i.e., the site is representative of other nearby sites). For the apartments and hotel units, traffic noise levels were predicted on patios or balconies. Single representative receptor points were used for groups of sites with similar characteristics. For the other noise sensitive sites such as the pools and playground, traffic noise levels were predicted where the exterior activity occurs. Receptor sites were modeled in ten-foot increments for multi-story buildings beginning with a height of five feet above the local ground elevation for first-floor patios. Receptors for pools and playgrounds were modeled at a height of five feet above the local ground elevation. A summary of the noise sensitive sites found in the NSAs evaluated for this study is shown in ***Appendix B*** and **Table 3.2**.

Table 3.2 Noise Sensitive Sites

NOISE SENSITIVE AREA	LOCATION	FHWA NOISE ABATEMENT CRITERIA	TYPES OF NOISE SENSITIVE SITES	NUMBER OF NOISE SENSITIVE SITES
B	Tuscana Resort Orlando	E - [72 dB(A)]	Common-use pool.	1 Pool
P	Marriot Vacation Club Harbour Lake	E - [72 dB(A)]	Six-story buildings. Patios and balconies for individual hotel units. Common-use pools.	114 Units 3 Pools
	Residence Inn SeaWorld	E - [72 dB(A)]	Common-use pool.	1 Pool
	Axis West Luxury Apartments	B, C - [67 dB(A)]	Four-story buildings. Patios and balconies for individual apartments. Common-use pool.	60 Units 1 Pool
	Integra Cove Apartments	B, C - [67 dB(A)]	Four-story buildings. Patios and balconies for individual apartments. Common-use pool.	68 Units 1 Pool
Q	Altis Sand Lake Apartments	B, C - [67 dB(A)]	Three-story buildings. Patios and balconies for individual apartments. Common-use playground and pool.	147 Units 1 Playground 1 Pool

4.0 2016 PD&E Noise Reanalysis

The 2016 noise analysis determined that noise impacts were expected to occur as a result of the proposed improvements, including the planned design changes, and identified potential noise abatement measures. A summary of the findings of the July 2016 analysis for the three NSAs that are included in the scope of this current reevaluation are presented below.

4.1.1 NSA B

Traffic noise impacts were predicted to occur at 20 sites in the Tuscana Orlando Resort. Several ground-mounted and shoulder-mounted noise barrier design concepts were evaluated for feasibility and reasonableness. Based on the information available at the time of the 2016 analysis, the most reasonable and feasible design concept included a 619-foot long, 22-foot tall ground-mounted noise barrier between the westbound lanes and the northern right-of-way line. This noise barrier concept provided an average insertion loss of 7.3 dB(A) for 11 benefited receptors at an overall cost of $408,693 and a cost per benefited site of $37,154. Therefore, this noise barrier design concept was considered to be feasible and reasonable, and it was recommended for further consideration.

4.1.2 NSA P

Traffic noise impacts were predicted to occur at 12 Category B and C sites in the Integra Cove Apartments. Several ground-mounted and shoulder-mounted noise barrier design concepts were evaluated for feasibility and reasonableness. Based on the information available at the time of the 2016 analysis, the most reasonable and feasible design concept included a 489-foot long, 22-foot tall ground-mounted noise barrier between the eastbound mainline lanes and off-ramp and the southern right-of-way line. This noise barrier concept provided an average insertion loss of 7.3 dB(A) for 10 benefited receptors at an overall cost of $322,524 and a cost per benefited site of $32,252. Therefore, this noise barrier design concept was considered to be feasible and reasonable, and it was recommended for further consideration.

4.1.3 NSA Q

Traffic noise impacts were predicted to occur at 56 Category B sites in the Altis Sand Lake Apartments. Several ground-mounted and shoulder-mounted noise barrier design concepts were evaluated for feasibility and reasonableness. Based on the information available at the time of the 2016 analysis, the most reasonable and feasible design concept included a 1,223-foot long, 18-foot tall ground-mounted noise barrier between the westbound mainline lanes and the northern right-of-way line. This noise barrier concept provided an average insertion loss of 6.8 dB(A) for 86 benefited receptors at an overall cost of $660,326 and a cost per benefited site of $7,678. Therefore, this noise barrier design concept was considered to be feasible and reasonable, and it was recommended for further consideration.

5.0 Design Phase Noise Barrier Analysis

The results and recommendations of the 2016 PD&E Noise Reanalysis for the three NSAs being assessed at this time were reevaluated for the current Design Phase Noise Barrier Analysis using the latest project design plans.

5.1 Predicted Traffic Noise Levels

The TNM results for the worst-case traffic conditions for the planned project during the design year are presented in ***Table 5.1*** and are summarized below.

Table 5.1 Predicted Traffic Noise Levels

NOISE SENSITIVE AREA	LOCATION	TYPES OF NOISE SENSITIVE SITES	FHWA NOISE ABATEMENT CRITERIA	RANGE OF PREDICTED BUILD ALTERNATIVE NOISE LEVELS [Leq(h), dB(A)]	NUMBER OF IMPACTED SITES
B	Tuscana Orlando Resort	Pool	E - [72 dB(A)]	52.2	0
P	Marriot Vacation Club Harbour Lake	Resort Patios/Balconies	E - [72 dB(A)]	61.7 – 69.5	0
		Pool	E - [72 dB(A)]	63.2	0
	Residence Inn SeaWorld	Pool	E - [72 dB(A)]	58.6	0
	Axis West Luxury Apartments	Apartment Patios/Balconies	B - [67 dB(A)]	66.2 – 78.9	60
		Pool	C - [67 dB(A)]	60.9	0
	Integra Cove Apartments	Apartment Patios/Balconies	B - [67 dB(A)]	64.4 – 74.9	66
		Pool	C - [67 dB(A)]	55.7	0
Q	Altis Sand Lake Apartments	Apartment Patios/Balconies	B - [67 dB(A)]	56.4 – 75.4	101
		Pool and Playground	C - [67 dB(A)]	65.0 – 67.3	1 (Playground)

5.1.1 NSA B

Tuscana Orlando Resort – Please see ***Sheet 1 in Appendix B***. The Tuscana Resort operates as a hotel, rather than a condominium complex as previously analyzed. Therefore, a review of the frequently used exterior noise sensitive areas on the property determined that the resort's pool was the only area considered to be noise

sensitive. Based on the latest roadway design plans, the traffic noise level at the pool is predicted to be 52.2 dB(A), which does not approach or exceed the applicable FHWA NAC [72 dB(A)].

5.1.2 NSA P

Marriott Vacation Club Harbour Lake - Please see ***Sheet 2 in Appendix B***. Based on the latest roadway design plans, traffic noise levels at the resort patios and balconies are predicted to range from 61.7 to 69.5 dB(A). None of the resort's units are predicted to experience traffic noise levels approaching or exceeding the FHWA NAC [72 dB(A)].

The traffic noise level at the resort's pool is predicted to be 63.2 dB(A), which does not approach or exceed the applicable FHWA NAC [72 dB(A)].

Residence Inn SeaWorld - Please see ***Sheet 2 in Appendix B***. The traffic noise level at the resort's pool is predicted to be 58.6 dB(A), which does not approach or exceed the applicable FHWA NAC [72 dB(A)].

Axis West Luxury Apartments - Please see ***Sheet 2 in Appendix B***. Traffic noise levels at the patios and balconies for the residences at the Axis West Luxury Apartments are predicted to range from 66.2 to 78.9 dB(A). Sixty (60) of these residences are predicted to experience traffic noise levels approaching or exceeding the FHWA NAC [67 dB(A)].

The traffic noise level at the apartment complex's pool is predicted to be 60.9 dB(A), which does not approach or exceed the applicable FHWA NAC [67 dB(A)].

Integra Cove Apartments - Please see ***Sheet 2 in Appendix B***. Traffic noise levels at the patios and balconies for the residences at the Integra Cove Apartments are predicted to range from 64.4 to 74.9 dB(A). Sixty-six (66) of these residences are predicted to experience traffic noise levels approaching or exceeding the FHWA NAC [67 dB(A)].

The traffic noise level at the apartment complex's pool is predicted to be 55.7 dB(A), which does not approach or exceed the applicable FHWA NAC [67 dB(A)].

5.1.3 NSA Q

Altis Sand Lake Apartments - Please see ***Sheet 2 in Appendix B***. Based on the latest roadway design plans, traffic noise levels at the patios and balconies for the residences at the Altis Sand Lake Apartments are predicted to range from 56.4 to 75.4 dB(A). One-hundred one (101) of these residences are predicted to experience traffic noise levels approaching or exceeding the FHWA NAC [67 dB(A)].

The traffic noise levels at the apartment complex's pool and playground are predicted to range from 65.0 to 67.3 dB(A). The noise level at the playground exceeds the applicable FHWA NAC [67 dB(A)].

5.2 Noise Impact Analysis

Future conditions along I-4 adjacent to NSAs P and Q will also include additional general-use, express and CD lanes. Also, the corridor will include new elevated structures adjacent to many of the nearby noise sensitive sites on both sides of the roadway. These elevated lanes will include the westbound CD lanes near the east end of this segment, the westbound general-use lanes at both ends of this segment and the flyover from Central Florida Parkway onto westbound I-4.

Exterior locations at approximately 275 apartment/condominium patios and balconies and 114 hotel/resort patios and balconies with the potential to be impacted by the proposed improvements were identified within the project study area. In addition, eight pools and one playground were identified in the project study area.

With the latest project design, traffic noise levels are predicted to approach or exceed the FHWA NAC at 227 apartment/condominium patios or balconies. Traffic noise levels are also predicted to exceed the FHWA NAC of 67 dB(A) at the playground at the Altis Sand Lake Apartments. These results confirm and generally agree with the findings presented in the July 2016 NSR.

5.3 Noise Barrier Analysis

In accordance with FDOT and FHWA requirements, noise abatement was considered for all noise sensitive sites where the NAC was predicted to be approached or exceeded.

5.3.1 Design Considerations

Due to the layout of the project roadways, the most likely form of noise abatement for the impacted sites remains noise barriers. Noise barriers reduce noise by blocking the sound path between a roadway and a noise sensitive area. In order to be effective, a noise barrier should be long, continuous, and be of sufficient height to effectively block the path between the noise source and the receptor site. A number of factors were evaluated to determine the feasibility and reasonableness of noise barriers for the impacted sites.

5.3.1.1 Feasibility

Noise barrier feasibility primarily concerns engineering considerations including the ability to construct a noise barrier using standard construction methods and techniques and the ability to provide a noise level reduction (i.e., insertion loss) of at least 5 dB(A) to the impacted receptor sites as required by FDOT. These considerations are dependent on site-specific features that may impact the ability to at least achieve the minimum acceptable noise reduction [i.e., 5 dB(A)] such as topography and access, drainage, utility, safety, or maintenance requirements.

The FDOT's structural standards require that noise barriers located within the roadway clear recovery zone (e.g., at the edge-of-pavement) meet crash test requirements stipulated by National Cooperative Highway Research Program (NCHRP) 350 Test Level 4 criteria. Crash tested and approved noise barrier designs currently permitted by FDOT are limited to a maximum height of 8 feet on structures and 14 feet on fill unless a design variation for a taller noise barrier is granted. Ground-mounted noise barriers not located within the roadway clear recovery zone are limited by FDOT to a maximum height of 22 feet.

5.3.1.2 Reasonableness

Noise barrier reasonableness implies that common sense and good judgment were applied in a decision related to noise abatement. A reasonableness analysis includes consideration of the cost of abatement, the amount of noise abatement benefit and the consideration of the viewpoints of the impacted and benefitted property owners and residents. To be deemed reasonable, a noise barrier must, at a minimum, meet the following FDOT criteria:

- The estimated construction cost cannot exceed the FDOT's reasonable cost criteria of $42,000 per benefitted receptor site based on FDOT's current statewide average noise barrier unit cost ($30 per square-foot); and,
- The noise barrier must reduce noise levels by at least 7 dB(A) at one or more impacted receptor sites.

5.3.2 NSA P – Axis West Luxury Apartments and Integra Cove Apartments

Design year traffic noise levels at the patios and balconies at the Axis West Luxury Apartments and the Integra Cove Apartments are predicted to range from 64.4 to 78.9 dB(A). One-hundred twenty-six (126) of the apartments are predicted to experience traffic noise levels approaching or exceeding the FHWA NAC [67 dB(A)]. No other sites in this NSA are predicted to be impacted by traffic noise from the planned project.

Adequate right-of-way is available along this segment of I-4 for a ground-mounted noise barrier located between the off-ramp to Central Florida Parkway (Ramp B_CFP) and the southern limited-access right-of-way line. However, due to the elevation of the eastbound general-use and express lanes over Central Florida Parkway, a shoulder/structure-mounted noise barrier segment was also considered along the outside edge of the eastbound general-use lanes. Due to utilities and drainage near end of Ramp B_CFP, a shoulder-mounted noise barrier segment was evaluated at the east end of the ramp as it ties into Central Florida Parkway. Therefore, shoulder, structure and ground-mounted noise barrier design concepts of various lengths and heights were evaluated for these apartments.

At this time, no additional costs specifically associated with construction of this noise barrier, other than the cost of the noise barrier itself, are expected. Therefore, the

FDOT's statewide average noise barrier unit cost of $30 per square-foot was used to calculate the construction cost of this noise barrier.

Based on the latest project design plans, a 22-foot tall ground-mounted noise barrier located adjacent to the southern limited-access right-of-way line and along the shoulder of Ramp B_CFP between Sta. 252+60 and 267+65 was considered to be the most feasible and effective noise abatement alternative for the apartments. Due to drainage along the ramp, this noise barrier would consist of two segments, both 22-feet tall. The ground-mounted segment would extend between Sta. 252+60 and 264+00. The shoulder-mounted segment would be located between Sta. 263+00 and 267+65, overlapping the east end of ground-mounted segment by 100 feet. The location of the recommended noise barrier design concept, referred to as AWIC-CD3, is shown on ***Sheet 2 in Appendix B*** and the results of an acoustic and cost-benefit analysis for all of the noise barrier design concepts that were considered are provided in ***Table 5.2***.

This 22-foot tall, 1,640-foot long noise barrier is expected to provide the greatest balance of noise level reduction, benefit to the impacted homes, reasonable cost and visual benefit/impact for this location. This noise barrier design concept is predicted to result in traffic noise levels at the benefitted sites ranging from 58.7 to 67.2 dB(A), representing a reduction of up to 11.4 dB(A) during peak periods. Noise levels at 36 of the 126 impacted residences in this community are expected to be reduced by at least 5 dB(A) with this configuration. Due to the elevation of I-4 as it crosses Central Florida Parkway, it was not possible to benefit most of the noise sensitive sites above the second-floor units.

Table 5.2 Noise Barrier Analysis – Axis West Luxury Apartments and Integra Cove Apartments

NOISE BARRIER DESIGN CONCEPT	TYPE	LIMITS (Station)	HEIGHT (feet)	LENGTH (feet)	NUMBER OF IMPACTED RECEPTOR SITES	AVERAGE (MAXIMUM) NOISE REDUCTION FOR IMPACTED RECEPTOR SITES [dB(A)]	NUMBER OF BENEFITED RECEPTOR SITES			AVERAGE (MAXIMUM) NOISE REDUCTION FOR ALL BENEFITED RECEPTOR SITES [dB(A)]	COST (@ $30 per square foot)	AVERAGE COST/SITE BENEFITED	COMMENTS
							Impacted	Not Impacted	Total				
AWIC-CD1	Ground-Mounted (Ramp B_CFP)	252+60 To 265+50	22	1,300	126	9.3 (11.4)	29	0	29	9.3 (11.4)	$858,000	$29,586	Not Recommended. Noise barrier stops before drainage swale. There are better noise barrier concepts.
AWIC-CD2	Ground-Mounted (Ramp B_CFP)	252+60 To 264+00	22	1,140	126	9.5 (11.4)	29	0	29	9.5 (11.4)	$962,400	$33,186	Not Recommended. Includes 14-foot tall shoulder-mounted segment along Ramp B_CFP. There are better noise barrier concepts.
	Shoulder-Mounted (Ramp B_CFP)	263+00 To 267+25	14	440									
AWIC-CD3	**Ground-Mounted (Ramp B_CFP)**	**252+60 To 264+00**	**22**	**1,140**	**126**	**9.0 (11.4)**	**36**	**0**	**36**	**9.0 (11.4)**	**$1,082,400**	**$30,067**	**Recommended. Benefits 36 of the 126 impacted sites. Not possible to benefit other impacted sites due to elevation. If in clear-zoned, will need to be protected by/placed behind standard FDOT traffic railing. Cost is within FDOT's Reasonable Cost Criteria and attains FDOT's Noise Level Reduction Criteria.**
	Shoulder-Mounted (Ramp B_CFP)	**263+00 To 267+65**	**22**	**500**									
AWIC-CD4	Ground-Mounted (Ramp B_CFP)	252+60 To 264+00	22	1,140	126	9.1 (11.8)	41	0	41	9.1 (11.8)	$1,320,000	$32,195	Not Recommended. The increase in cost in relation to the minimal increase in benefited sites is not considered reasonable.
	Shoulder-Mounted (Ramp B_CFP)	263+00 To 267+25	22	500									
	Structure-Mounted (EBGU)	3938+70 To 3948+60	8	990									

The estimated cost of this noise barrier design concept is $1,082,400 overall and $30,067 per benefited site. Therefore, the cost per benefited site of this noise barrier is within the FDOT's $42,000 per benefited site noise barrier cost criteria.

Adding a structure-mounted noise barrier segment along the eastbound mainline near these apartments was only predicted to benefit an additional five impacted sites at an estimated cost of $1,320,000 overall and $32,195 for each of the 41 benefited sites. This design concept is not recommended due to the increase in cost in relation to the minimal increase in benefited sites.

At this time, noise barrier design concept AWIC-CD3 appears to be feasible as proposed. If located in the clear zone, the shoulder-mounted noise barrier segment between Sta. 263+00 and 267+65 will need to be placed behind a standard FDOT concrete traffic railing. Ongoing design feasibility analyses may result in minor modifications to this noise barrier design concept.

Therefore, noise barrier design concept AWIC-CD3 is recommended for further consideration and public input. Of all of the noise barrier design concepts assessed, this concept provides reasonable noise abatement performance at a cost within the FDOT noise barrier cost criteria. This noise barrier design also attains the FDOT's noise reduction reasonableness requirement of at least a 7 dB(A) reduction for at least one impacted receptor site. In addition, this noise barrier concept satisfies the other reasonableness and feasibility factors considered in the evaluation of noise abatement measures including safety, constructability, utilities and drainage. This noise barrier concept does not have any sight distance issues, any substantial conflicts with utilities or drainage facilities signs and it can be constructed using standard construction methods.

5.3.3 NSA Q – Altis Sand Lake Apartments

Design year traffic noise levels at the patios and balconies at the Altis Sand Lake Apartments are predicted to range from 56.4 to 75.4 dB(A). One-hundred one (101) of the apartments and one playground are predicted to experience traffic noise levels approaching or exceeding the FHWA NAC [67 dB(A)].

Adequate right-of-way is available along this segment of I-4 for a ground-mounted noise barrier located between the WBCD and the westbound I-4 on-ramp from Central Florida Parkway (Ramp A_CFP) and the north right-of-way line. However, due to the elevation of the WBCD, westbound general-use lanes and westbound express lanes, shoulder/structure-mounted noise barrier segments were also considered along the outside edge of the WBCD and westbound general-use lanes. Therefore, shoulder, structure and ground-mounted noise barrier design concepts of various lengths and heights were evaluated for these apartments.

At this time, no additional costs specifically associated with construction of this noise barrier, other than the cost of the noise barrier itself, are expected. Therefore, the FDOT's statewide average noise barrier unit cost of $30 per square-foot was used to calculate the construction cost of this noise barrier.

Based on the latest project design plans, a 22-foot tall ground-mounted noise barrier located adjacent to the northern limited-access right-of-way line between Sta. 7096+35 and 7104+95 and along the shoulder of westbound general-use lanes between Sta. 4947+80 and 4958+65 was considered to be the most feasible and effective noise abatement alternative for these apartments. The location of this noise barrier design concept, referred to as ASL-CD3, is shown on ***Sheet 2 in Appendix B*** and the results of an acoustic and cost-benefit analysis for all of the noise barrier design concepts that were considered are provided in ***Table 5.3***.

This 22-foot tall, 1,005-foot long ground-mounted noise barrier and 14-foot tall, 1,085-foot long shoulder-mounted noise barrier system is predicted to result in traffic noise levels at the benefitted sites ranging from 63.9 to 69.8 dB(A), representing a reduction of up to 8.5 dB(A) during peak periods. Noise levels at 15 of the 102 impacted sites in this community are expected to be reduced by at least 5 dB(A) with this configuration. Due to the elevation of the nearby WBCD and other I-4 lanes, it was only possible to benefit the apartments at the western extent of this complex. The estimated cost of this noise barrier design concept is $1,119,000 overall and $74,600 per benefited site. Therefore, the cost per benefited site of this noise barrier exceeds the FDOT's $42,000 per benefited site noise barrier cost criteria. No other noise barrier designs were predicted to cost less than $42,000 per benefited site.

Table 5.3 Noise Barrier Analysis – Altis Sand Lake Apartments

NOISE BARRIER DESIGN CONCEPT	TYPE	LIMITS (Station)	HEIGHT (feet)	LENGTH (feet)	NUMBER OF IMPACTED RECEPTOR SITES	AVERAGE (MAXIMUM) NOISE REDUCTION FOR IMPACTED RECEPTOR SITES [dB(A)]	NUMBER OF BENEFITED RECEPTOR SITES			AVERAGE (MAXIMUM) NOISE REDUCTION FOR ALL BENEFITED RECEPTOR SITES [dB(A)]	COST (@ $30 per square foot)	AVERAGE COST/SITE BENEFITED	COMMENTS
							Impacted	Not Impacted	Total				
ASL-CD1	Ground-Mounted	7096+35 To 7115+20	22	1,875	102	6.0 (8.3)	15	0	15	6.0 (8.3)	$1,237,500	$82,500	Not Recommended. Cost exceeds FDOT's Reasonable Cost Criteria.
ASL-CD2	Ground-Mounted	7096+35 To 7102+95	22	805	102	6.2 (8.5)	15	0	15	6.2 (8.5)	$933,300	$62,220	Not Recommended. Cost exceeds FDOT's Reasonable Cost Criteria.
	Structure-Mounted (WBCD)	7100+95 To 7117+70	8	1,675									
ASL-CD3	Ground-Mounted	7096+35 To 7104+95	22	1,005	102	6.2 (8.5)	15	0	15	6.2 (8.5)	$1,119,000	$74,600	Not Recommended. Cost exceeds FDOT's Reasonable Cost Criteria.
	Shoulder-Mounted (WBGU)	4947+80 To 4958+65	14	1,085									
ASL-CD4	Ground-Mounted	7094+90 To 7104+95	22	1,005	102	6.2 (8.5)	15	0	15	6.2 (8.5)	$1,425,000	$95,000	Not Recommended. Cost exceeds FDOT's Reasonable Cost Criteria.
	Structure-Mounted (WBCD)	7102+95 To 7115+70	8	1,275									
	Shoulder-Mounted (WBGU)	4947+80 To 4958+65	14	1,085									
ASL-CD5	Ground-Mounted	7094+90 To 7115+20	22	2,015	102	6.0 (8.5)	21	0	21	6.0 (8.5)	$1,729,500	$82,357	Not Recommended. Cost exceeds FDOT's Reasonable Cost Criteria.
	Structure-Mounted (WBCD)	7102+95 To 7119+60	8	1,665									

Adding a structure-mounted noise barrier segment along the WBCD or a shoulder-mounted noise barrier along the westbound mainline near these apartments was not predicted to benefit any additional sites.

Based on the results of this Design Phase noise barrier analysis using the latest project design plans, a noise barrier for the Altis Sand Lakes Apartments is no longer recommended for further consideration. It was not possible to provide reasonable noise abatement performance at a cost within the FDOT's noise barrier cost criteria due to the elevation of the westbound lanes. Changes to the height or length of the noise barrier, or providing additional noise barrier segments along the westbound lanes, did not provide a feasible and/or reasonable noise abatement option.

6.0 CONCLUSIONS AND RECOMMENDATIONS

This Design Phase noise barrier analysis has been conducted for Segment 1 of the FDOT's I-4 Beyond the Ultimate project which extends from west of C.R. 532 at the Polk/Osceola County Line to west of S.R. 828 Beachline Expressway. This analysis specifically addresses noise barriers recommended for three NSAs from a 2016 PD&E Phase noise analysis, as follows:

- NSA B – Tuscana Resort Orlando;
- NSA P – Marriott Vacation Club Harbour Lake, Residence Inn at SeaWorld, Axis West Luxury Apartments and Integra Cove Apartments; and,
- NSA Q – Altis Sand Lake Apartments

Based on the most recent project design plans, traffic noise levels are now predicted to approach or exceed the FHWA NAC at 227 apartment patios and balconies. Traffic noise levels are also predicted to exceed the FHWA NAC of 67 dB(A) at the playground at the Altis Sand Lake Apartments.

One (1) of the three noise barriers recommended during the 2016 PD&E are now recommended for construction (see ***Appendix B*** for the proposed alignments of these noise barriers). A summary of the recommended noise barrier is shown in **Table 6.1**.

Table 6.1 Summary of Recommended Noise Barriers

SITE LOCATION	NOISE BARRIER DESIGN CONCEPT	TYPE	LIMITS (Station)	HEIGHT/ LENGTH (feet)	NUMBER OF IMPACTED RECEPTOR SITES	NUMBER OF BENEFITED RECEPTOR SITES	AVERAGE (MAXIMUM) NOISE REDUCTION [dB(A)]	COST [Overall/Per Benefited Site] (@ $30 per square foot)
Axis West Luxury Apartments/ Integra Cove Apartments (NSA P)	AWIC-CD3	Ground-Mounted (Ramp B_CFP)	252+60 To 264+00	22/1,140	126	36	9.0 (11.4)	$1,082,400/ $30,067
		Shoulder-Mounted (Ramp B_CFP)	263+00 To 267+65	22/500				

This noise barrier concept meets all of the FDOT's feasibility requirements. In order to satisfy FDOT's reasonableness requirements, the FDOT will conduct a survey of the property owners and occupants (i.e., renters, leaseholders, etc.; where applicable) of the sites predicted to be benefited by this noise barrier. The results of this survey will be reported in a future NSRA.

It was determined that the only noise sensitive area of frequent exterior use at the Tuscana Orlando Resort (NSA B) was the resort's pool. The design year traffic noise level at the pool is predicted to be 52.2 dB(A) with the project, which does not approach or exceed the applicable FHWA NAC [72 dB(A)]. Therefore, noise abatement is not considered necessary since noise impacts are not predicted to occur here.

The remaining noise barrier that was recommended during the 2016 PD&E, for NSA Q -Altis Sand Lake Apartments, is no longer recommended for further consideration. The roadway design for the I-4 corridor west of Central Florida Parkway includes a westbound flyover, WBCD, westbound general-use lanes and westbound express lanes that are all at varying elevations well above-grade. Due to the elevations of these roadways, a ground-mounted noise barrier was ineffective for most of the impacted patios and balconies. Adding shoulder and structure-mounted noise barrier segments to the elevated roadways did not benefit enough additional sites to provide a cost reasonable noise barrier for these apartments. Based on the results of this Design Phase noise analyses, there are no apparent solutions available to mitigate the noise impacts at the Altis Sand Lake Apartments. A noise barrier is not recommended for further consideration or construction for this location, and traffic noise impacts at these apartments are considered to be an unavoidable consequence of the project.

7.0 CONSTRUCTION NOISE

During construction of the project, there is the potential for noise impacts to be substantially greater than those resulting from normal traffic operations due to the heavy equipment typically used to build roadways. In addition, construction activities may also result in increased vibration levels. The project area includes sites that should be considered sensitive to noise and vibration associated with construction activities. Construction noise and vibration impacts to these sites will be minimized by adherence to the controls listed in the latest edition of the FDOT's *Standard Specifications for Road and Bridge Construction*.

According to Section 335.02 of the Florida Statutes, the FDOT is exempt from compliance with local ordinances. However, it is the FDOT's policy to follow the requirements of local ordinances to the extent that is considered reasonable. Also, the contractor will be instructed to coordinate with the project engineer and the District Five Noise Specialist should unanticipated noise or vibration issues arise during project construction.

8.0 REFERENCES

Florida Department of Transportation, "*Project Development and Environment Manual, Part 2, Chapter 18-Highway Traffic Noise"*, June 14 2017.

23 CFR Part 772, "*Procedures for Abatement of Highway Traffic Noise and Construction Noise*", Federal Register, Vol. 75, No. 133, Tuesday, July 13, 2010; pages 39834-39839.

Federal Highway Administration Report FHWA-HEP-10-025, "*Highway Traffic Noise: Analysis and Abatement Guidance*", June 2010 (revised December, 2010); 76 pages.

Florida Statute 335.17, "*State highway construction; means of noise abatement*". 1989; 1 page.

Florida Department of Transportation Policy, "*Noise Abatement*". Topic 000-360-005-f; Effective September 20, 2007; 1 page.

Federal Highway Administration Report Number FHWA-PD-96-046, "*Measurement of Highway-Related Noise*". Cynthia S.Y. Lee and Gregg Fleming; May, 1996; 206 pages.

Florida Department of Transportation, "*Standard Specifications for Road and Bridge Construction*". July 2018; 1213 pages.

Federal Highway Administration Report FHWA-HEP-06-015, "*FHWA Highway Construction Noise Handbook: Final Report*". August 2006; 185 pages.

Appendix A – TNM Traffic Data

Traffic Data Used in TNM Model NSA B†				
Roadway Segment	Build Alternative (2040)			
	Number of Lanes	Peak-Hour	LOS C	TNM Data
I-4				
I-4 General Use Lanes Only (All Trucks In Outside 2 GU Lanes) Eastbound Western Project Terminus to CR 532/Champions Gate Blvd On-Ramp PM Peak DDHV	3	4,900	4,580	4,580
I-4 General Use and Auxiliary Lanes Only (All Trucks In Outside 2 GU Lanes) Eastbound CR 532/Champions Gate Blvd On-Ramp to Eastern Project Terminus PM Peak DDHV	3	6,150	4,580	4,580
I-4 General Use Lanes Only (All Trucks In Outside 2 GU Lanes) Westbound Eastern Project Terminus to CR 532/Champions Gate Blvd Off-Ramp PM Peak DDHV	3	6,968	4,580	4,580
I-4 General Use and Auxiliary Lanes Only (All Trucks In Outside 2 GU Lanes) Westbound CR 532/Champions Gate Blvd Off-Ramp to Western Project Terminus PM Peak DDHV	4	5,418	5,580	5,418
I-4 Express Lanes Only Eastbound Southern Project Terminus to Northern Project Terminus PM Peak DDHV	2	1,800	3,320	1,800
I-4 Express Lanes Only Westbound Northern Project Terminus to Southern Project Terminus PM Peak DDHV	2	1,709	3,320	1,709
Ramps				
CR 532/Champions Gate Blvd On-Ramp CR 532/Champions Gate Blvd to EB I-4 On-Ramp PM Peak DDHV	1	1,250	N/A	1,250
CR 532/Champions Gate Blvd Off-Ramp WB I-4 to CR 532/Champions Gate Blvd Off-Ramp PM Peak DDHV	1	1,550	N/A	1,550

Notes:
† = Peak-Hour Demand traffic data taken from the project's approved 2017 SAMR
* = Level of Service C service volume from 2012 FDOT Generalized LOS tables
TNM By-Lane Data is either AM Peak-Hour Volume or Level of Service C Capacity, whichever is less.
PHD = Peak-Hour Demand
LOS C = Level-of-Service C

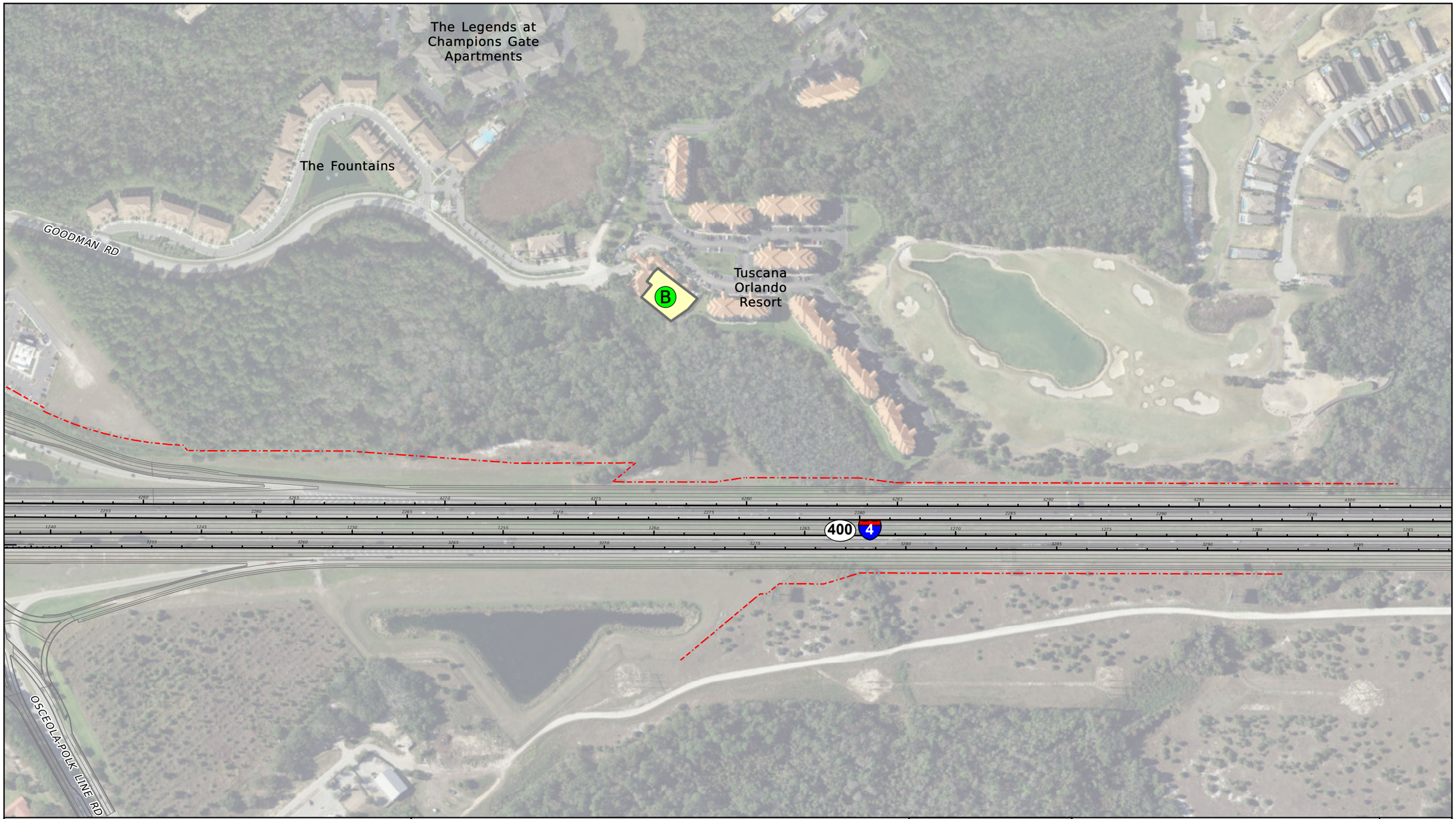
Traffic Data Used in TNM Model NSA P and Q†

Roadway Segment	Build Alternative (2040)			
	Number of Lanes	Peak-Hour	LOS C	TNM Data
I-4				
I-4 General Use Lanes Only (All Trucks In Outside 2 GU Lanes) Eastbound West of Daryl Carter Pkwy On-Ramp	3	4,853	4,580	4,580
I-4 General Use Lanes Only (Aux Lane is Separate, all Trucks In Outside 2 GU Lanes)) Eastbound Daryl Carter Pkwy On-Ramp to Eastern Project Terminus PM Peak DDHV	3	4,853	4,580	4,580
I-4 General Use Lanes Only (All Trucks In Outside 2 GU Lanes) Westbound Eastern Project Terminus to Ramp A_CFP PM Peak DDHV	3	3,539	4,580	3,539
I-4 General Use Lanes Only (All Trucks In Outside 2 GU Lanes) Westbound Ramp A_CFP to Ramp C_CFP PM Peak DDHV	3	4,285	4,580	4,285
I-4 General Use Lanes Only (All Trucks In Outside 2 GU Lanes) Westbound Ramp C_CFP to West of Daryl Carter Pkwy PM Peak DDHV	3	5,692	4,580	4,580
I-4 Express Lanes Only Eastbound Western Project Terminus to Eastern Project Terminus PM Peak DDHV	2	2,084	3,320	2,084
I-4 Express Lanes Only Westbound Eastern Project Terminus to West of Daryl Carter Pkwy PM Peak DDHV	2	2,198	3,320	2,198
WBCD Westbound Eastern Project Terminus to Daryl Carter Pkwy Off-Ramp PM Peak DDHV	2	3,539	3,020	3,020
WBCD Westbound Daryl Carter Pkwy Off-Ramp to West of Daryl Carter Pkwy PM Peak DDHV	2	2,069	3,020	2,069
I-4 Aux Lane Eastbound Daryl Carter Pkwy On-Ramp to Eastern Project Terminus PM Peak DDHV	1	1,383	1,000	1,000
Central Florida Pkwy				
Central Florida Pkwy Eastbound Turkey Lake Rd to Ramp A_CFP PM Peak DDHV	3	1,469	3,087	1,469
Central Florida Pkwy Eastbound Ramp A_CFP to RP_C (Seg 2) PM Peak DDHV	2	1,463	2,006	1,463
Central Florida Pkwy Eastbound RP_C (Seg 2) to Ramp B_CFP PM Peak DDHV	2	888	2,006	888
Central Florida Pkwy Eastbound South of Ramp B_CFP PM Peak DDHV	3	2,096	3,087	2,096
Central Florida Pkwy Westbound South of Ramp C_CFP PM Peak DDHV	3	2,308	3,087	2,308
Central Florida Pkwy Westbound Ramp C_CFP to RP_C (Seg 2) PM Peak DDHV	3	901	3,087	901
Central Florida Pkwy Westbound RP_C (Seg 2) to RP_D (Seg 2) PM Peak DDHV	3	1,117	3,087	1,117
Central Florida Pkwy Westbound RP_D (Seg 2) to Turkey Lake Rd PM Peak DDHV	3	1,722	3,087	1,722
Palm Parkway/Turkey Lake Road				
Palm Parkway Northbound South of Central Florida Pkwy PM Peak DDHV	2	1,629	2,006	1,629
Palm Parkway Southbound South of Central Florida Pkwy PM Peak DDHV	2	1,055	2,006	1,055
Turkey Lake Road Northbound North of Central Florida Pkwy PM Peak DDHV	2	1,997	2,006	1,997
Turkey Lake Road Southbound North of Central Florida Pkwy PM Peak DDHV	2	1,170	2,006	1,170

Traffic Data Used in TNM Model NSA P and Q†				
Roadway Segment	Build Alternative (2040)			
	Number of Lanes	Peak-Hour	LOS C	TNM Data
Westwood Boulevard				
Westwood Boulevard Northbound South of Central Florida Pkwy PM Peak DDHV	2	1,038	2,006	1,038
Westwood Boulevard Southbound South of Central Florida Pkwy PM Peak DDHV	2	696	2,006	696
Westwood Boulevard Northbound North of Central Florida Pkwy PM Peak DDHV	2	812	2,006	812
Westwood Boulevard Southbound North of Central Florida Pkwy PM Peak DDHV	2	922	2,006	922
Ramps				
Ramp C_DCP NB Daryl Carter Pkwy to EB I-4 On-Ramp PM Peak DDHV	2	1,383	N/A	1,383
Ramp B_CFP EB I-4 to SB/NB Central Florida Pkwy Off-Ramp PM Peak DDHV	2	2,174	N/A	2,174
Ramp A_CFP SB Centeral Florida Pkwy to WB I-4 On-Ramp PM Peak DDHV	1	746	N/A	746
Ramp C_CFP NB Centeral Florida Pkwy to WB I-4 On-Ramp PM Peak DDHV	1	1,407	N/A	1,407

Notes:
† = Peak-Hour Demand traffic data taken from the project's approved 2017 SAMR
* = Level of Service C service volume from 2012 FDOT Generalized LOS tables
TNM By-Lane Data is either AM Peak-Hour Volume or Level of Service C Capacity, whichever is less.
PHD = Peak-Hour Demand
LOS C = Level-of-Service C

Appendix B – Noise Analysis Maps



	SOURCES:
0 150 300 600 Feet	AERIAL SOURCE: ESRI DATA SOURCE: FGDL

LEGEND

- Limits of Noise Sensitive Area
- Preferred Alternative
- Right of Way
- Noise Sensitive Area

FDOT

SR 400 (I-4)
DESIGN-PHASE NOISE BARRIER ANALYSIS

Noise Sensitive Area B

SHEET NO.
1 OF 2

PALM PKWY

TURKEY LAKE RD

Q

Sand Lake
Altis Apartments

400

4

Begin Noise Barrier AWIC-CD3(b)
Sta. 263+00 (Ramp B_CFP)
Height = 22 Feet
Length = 500 Feet

End Noise Barrier AWIC-CD3(b)
Sta. 267+65 (Ramp B_CFP)

Begin Noise Barrier AWIC-CD3(a)
Sta. 252+60 (Ramp B_CFP)
Height = 22 Feet
Length = 1,140 Feet

End Noise Barrier AWIC-CD3(a)
Sta. 264+00 (Ramp B_CFP)

Sea Isle
Apartments

Axis West
Apartments

P

Residence Inn
by Marriott

Integra
Cove

WESTWOOD BLVD

Marriot Vacation Club
Harbour Lake

CENTRAL FLA PKWY

Hilton
Grand

Hampton Inn

WESTWOOD BLVD

MAP DATE: AUGUST 2018

SOURCES:

AERIAL SOURCE: ESRI
DATA SOURCE: FGDL

0 150 300 600 Feet

LEGEND

- *Not Recommended Noise Barrier*
- *Recommended Noise Barrier*
- *Preferred Alternative*
- *Right of Way*
- *Limits of Noise Sensitive Area*
- X *Noise Sensitive Area*

FDOT

SR 400 (I-4)
DESIGN-PHASE NOISE BARRIER ANALYSIS

Noise Sensitive Areas P and Q

SHEET NO.

2 OF 2