Ohio Turnpike Commission

Noise Mitigation Study
Pilot Program Summary Report

Contract No. 71-08-02

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Background

In accordance with the requirements of Am. Sub. H.B. 67 of the 127th General Assembly, TranSystems was selected to perform a study of noise impact mitigation measures to be used along the Ohio Turnpike. As part of this study, alternatives to the traditional concrete noise barrier walls were evaluated and recommended for implementation through a pilot program. The study, Project Number 71-08-02, examined the viability of alternative noise abatement measures to reduce the existing noise levels along the Turnpike.

Seven innovative noise mitigation measures including quiet pavement technology, modified top noise barrier walls, noise insulation and land use planning, noise absorption treatments and natural barriers were evaluated for use along the Turnpike. Following the evaluation, two noise mitigation measures were selected for implementation as part of a pilot program: 1) construction of an absorptive concrete noise barrier wall using an innovative T-top treatment and, 2) construction of median-mounted noise absorptive acoustic panels on the existing concrete median.

A total of 67 noise sensitive areas (NSA) were identified along the length of the Ohio Turnpike, most being located in the vicinity of Toledo and in the suburbs south of Cleveland. An NSA is described as an area of residential structures, schools, hospitals, or similar land use where increased traffic noise levels could interfere with the use of exterior space. All of the 67 NSAs were considered for the pilot program but those exhibiting certain criteria were determined as optimal locations for the program. The criteria included a level location with a view of the turnpike, locations having no secondary noise sources, a tight grouping of receptors and a compact location less than 800 feet in length. Following consideration, it was determined that NSA 39 would be used for the T-Top noise barrier wall pilot program and NSA 47 would be used for the median-mounted acoustic panel pilot program. The relative locations of NSA 39 and NSA 47 are shown on Figure 1.

Introduction

This Pilot Program Summary will detail the levels of noise reduction provided by the two mitigation measures that were implemented along the Ohio Turnpike. NSA 39 is located near mile marker 158 on the south side of the turnpike just west of the Sprague Road overpass in Berea, Ohio. NSA 39 was used to test the effectiveness of the T-Top concrete noise barrier wall. The first step in each of the Pilot Programs was to determine the existing or pre-construction noise levels at several locations within each NSA through field monitoring. The second step of the pilot program at NSA 39 monitored noise levels at the same pre-construction locations following the construction of the noise barrier wall without the T-top. The third step at NSA 39 monitored the same receptor locations once the T-top had been placed on top of the noise wall. The third step was used to determine the final post-construction noise level and the additional level of noise reduction the "T" contributed to the noise wall.

NSA 47 is located near mile marker 164 on the south side of the turnpike just west of West 130th Street in Strongsville, Ohio. NSA 47 was used to evaluate the effectiveness of the noise absorptive panels placed on the existing concrete median. Similar to NSA 39 pre-construction noise levels were monitored at four locations prior to the installation of the acoustic panels. Post-construction noise monitoring at NSA 47 consisted of measuring the noise levels at the same pre-construction locations to determine the level of

noise reduction provided by the acoustic panels. The final step in the Pilot Program Summary compared the post-construction noise levels of the two innovative measures to a traditional concrete noise barrier wall using the FHWA Traffic Noise Model (TNM).

“T”-TOP NOISE BARRIER WALL PILOT PROGRAM

"T"-TOP NOISE BARRIER WALL PILOT PROGRAM

Pilot Program Objective

The objective of the "T"-Top Pilot Program was to determine the level of noise reduction that could be obtained by modifying the top edge of a traditional concrete noise barrier wall. In theory, the effectiveness of a traditional noise barrier wall of a given height may be increased by bringing the diffracting edge of the barrier closer to the source of noise. This increases the length of the noise energy path between source and receptor thereby resulting in additional noise attenuation. Placing a horizontal panel on top of a traditional noise barrier wall moves the diffracting edge closer to traffic. Furthermore, increasing the number of diffracting edges on the top surface of a noise barrier wall will also improve noise attenuation. Research on modified top noise barriers in Japan and Europe projected that a "T"-profile top edge noise barrier wall could reduce noise levels in a residential area behind a noise barrier by 1.0 to 1.5 decibels (dBA), when compared with a conventional vertical barrier of the same height. This 1.0 to 1.5 dB reduction would equate to a reduction in height of a traditional noise barrier wall by two to three feet, with a potential average reduced height of 2.5 feet, while achieving the same level of noise reduction. To test the above research, the pilot program used an eight-foot high noise barrier wall with a "T" panel extending one foot over the top of the barrier on the side facing traffic and 15 ½ " over the top of the barrier on the residential side of the wall. The difference is a result of placing 3 ½ " of absorbent material on the side of the barrier facing traffic to prevent noise from reflecting off the barrier and potentially effecting residents on the opposite side of the turnpike. A photograph of the completed "T"-top noise wall in shown in the photo below. The goal of the "T"-top pilot program was to achieve the same level of noise attenuation with the eight-foot high "T" wall that could be obtained with a traditional 10.5' high noise barrier.

Noise Modeling

For all three scenarios, noise levels were modeled at the same representative locations using the FHWA TNM Version 2.5 using traffic volumes counted during the field measurement periods. The purpose of noise modeling for the pre-construction scenario is to calibrate the noise model to simulate site specific conditions. Terrain lines, elevations, building rows and vegetation zones can be edited in the model so that measured levels and modeled levels can be accurately compared. The purpose of noise modeling for the post-construction noise barrier wall is similar to the pre-construction scenario except this time a traditional noise barrier is entered into the model. The purpose of the noise modeling for the post-"T" installation is to estimate, by noise modeling, what height of noise barrier wall would need to be constructed to match the noise reduction contributed by the "T"-top.

Modeling technology is not available to predict the level of noise reduction that could be expected with a "modified top noise barrier wall. For the pilot program, noise levels were both field monitored and modeled (using the FHWA TNM) at eight receptor sites under three scenarios: 1) the existing condition with no noise wall; 2) with a traditional eight-foot high noise barrier wall, and; 3) monitoring the eight-foot high "T" wall compared to a modeled 10.5-foot high noise barrier wall.

Field Measured Noise Levels

For all three scenarios, noise measurements were recorded at eight representative sites which are shown on Figure 2. The measurement sites were situated at residential dwellings where frequent outdoor use would occur (deck, swimming pool). Receiver 1 was located at a residential dwelling near the eastern end of the noise barrier wall. This location was selected to evaluate typical levels of noise reduction for dwellings located near the end of the barrier and only partially protected by the noise barrier wall. The noise barrier wall would have to extend approximately 100' further east to provide full coverage to receiver 1. Receivers 2, 3 and 4 are considered front row receptors located near the middle of the noise barrier wall. These sites were located to evaluate the typical levels of noise reduction where dwelling units are completely protected by the noise barrier. The maximum level of noise reduction would be expected to occur at receivers 2, 3 and 4. Receiver 5 is located at the west end of the noise barrier wall and only partially protected by the noise barrier. Receiver 6 is located in a park near the west end of the noise barrier wall in an area unprotected by the noise barrier wall. Receiver 6 was located as a control site in an area unaffected by the noise barrier wall. Even though field measurements were collected around the same time of day and around the same day of the week, it was expected that traffic volumes, vehicle mix and other ambient noise sources would vary from day to day as field measurements were taken. These changing variables were out of the study control. Noise measurements were taken at this location as a baseline to compare how the receivers were affected by inconsistencies in the traffic. Receiver 8 is considered representative of second row dwelling units shielded from traffic noise by the front row receptors. Receiver 7 is considered representative of third row dwelling units shielded from traffic noise by the first and second row of dwelling units.

Noise levels were monitored during the worst hour condition when truck volumes are at their highest and vehicle speeds are the greatest, typically when traffic is free-flowing. Noise measurements were performed in accordance with the FHWA Report Number FHWA-PD-96-046, *Measurement of Highway Related Noise* (May, 1996). Measurements were taken at representative receptor sites for twenty (20) minute intervals. The noise meter was tripod mounted with the microphone at a distance of approximately 4.9 feet above ground level and angled toward the dominate noise source. A foam windscreen was used for all noise measurements. Noise measurements were recorded with a Quest 2900 Type 2 Data Logging SLM. The

noise meter continuously measures and records the ambient noise level and integrates these values into a L_{eq} for the duration of the reading.

A concern during the noise monitoring periods was to record the field measurements under similar conditions to best insure that the traffic volume and the vehicle mix would be similar. Similar traffic volume and vehicle mix would help insure an accurate presentation of the effectiveness of the mitigation measure and not have results skewed by wide ranging volume or dissimilar vehicle mix. All field measurements were taken on Tuesday or Thursday between the hours of 8:15 AM and 1:15 PM. During each of the noise monitoring intervals, simultaneous data including traffic volume, speed, and vehicle composition were collected. Traffic volumes were counted on Thursday May 28, 2009 prior to construction, on Tuesday September 1, 2009 following the construction of the noise barrier wall and on Thursday October 8, 2009 following the installation of the "T"-top. The traffic volumes for all three intervals are shown on Table 1. In general, traffic volume during all measurement intervals were quite similar ranging no more than 20% between the highest and lowest automobile and truck volumes. Considering the fact that noise is measured on a logarithmic scale, the difference in traffic volume should be of no consequence to the resulting noise levels.

Existing Condition - Pre-Construction Noise Measurements

Noise measurements were taken at seven locations during the hours of 9:00AM to 1:00PM on Thursday May 28, 2009. A printout of the pre-construction noise measurements for the "T"-top noise wall is provided in Appendix B and summarized in Table 2.

Table 2.
"T"-Top Noise Wall
Pre-Construction Noise Measurements May 28, 2009

Receiver	Time	Field Measured Levels dBA	Modeled Level dBA	Difference in modeled level over measured level dB
1	9:12-9:32 AM	63.3	64.5	1.2
2	9:41-10:01 AM	67.6	69.6	2.0
3	10:26-10:46 AM	71.3	72.2	0.9
4 and 5	11:01-11:21 AM	74.1	73.6	0.5
6	11:29-11:49 AM	68.0	69.3	1.3
7	11:57-12:17 PM	56.4	59.8	3.4
8	12:24-12:44 PM	59.8	60.4	0.6

During the pre-construction noise measurement period, simultaneous data including traffic volume, speed, and vehicle composition were collected. Traffic volume counted on May 28, 2009 is shown in Table 1. Traffic data were input into TNM V2.5 to calibrate the measured noise level with the modeled noise level at each representative site. Table 1 presents the TNM modeled noise levels based on the observed traffic data. The table also presents a comparison of the measured levels to the modeled levels at each representative receptor site. All of the pre-construction noise measurement sites (except receiver 7) are within ±3 dB of the TNM predicted noise levels. This indicates an accurate representation of field measured noise levels when compared to the site-specific modeled conditions.

Table 1.
"T"-Top Noise Barrier Wall Pilot Program
Traffic Volume Summary

	Pre-Construction			With Noise Barrier Wall Only			With Noise Barrier Wall and "T" Top		
	May 28, 2009 – 9:15 – 10:15 AM			September 1, 2009-8:04 - 9:04 AM			October 8, 2009 - 7:59-8:59 AM		
	EB	WB	Total	EB	WB	Total	EB	WB	Total
Automobile	864	726	1,590	901	710	1,611	1034	784	1818
Medium Trucks	52	22	74	62	28	80	42	26	68
Heavy Trucks	324	336	660	382	384	766	365	377	742
Motorcycles	0	2	2	2	3	5	1	1	2
	May 28, 2009 – 10:30-11:30 AM			September 1, 2009 - 1:05-2:05 PM			October 8, 2009 - 1:35-2:35 PM		
	EB	WB	Total	EB	WB	Total	EB	WB	Total
Automobile	757	719	1,476	766	822	1588	789	871	1660
Medium Trucks	31	36	67	46	42	88	35	38	73
Heavy Trucks	303	315	618	337	356	693	347	315	662
Motorcycles	1	6	7	2	0	2	0	4	4

Post-Construction Noise Measurement - With Noise Barrier Wall Only

Noise measurements were taken at eight locations between the hours of 8:15 AM to 11:45 AM on Tuesday September 1, 2009. A printout of the post-construction noise measurements with the noise barrier wall only is provided in Appendix B and summarized in Table 3.

Table 3.
"T"-Top Noise Wall Noise Measurements
Noise Barrier Only - September 1, 2009

Receiver	Time	Field Measured Noise Levels	Modeled Noise Levels	Difference in modeled levels over measured levels dB
1	9:15-9:36 AM	62.2	63.5	1.3
2	9:42-10:02 AM	64.8	65.9	1.1
3	10:17-10:37 AM	66.1	67.6	1.5
4	10:45-11:05 AM	68.9	69.0	0.1
5	11:09-11:24 AM	73.7	72.8	0.9
6	11:27-11:42 AM	69.5	69.0	0.5
7	11:46-12:06 PM	53.9	59.8	5.9
8	12:23-12:43 PM	56.7	59.5	2.8

Again, during the noise measurement period, simultaneous data including traffic volume, speed, and vehicle composition were collected. Traffic volume counted on September 1, 2009 is shown in Table 1. Traffic data were input into TNM V2.5 to calibrate the measured noise level with the modeled noise level at each representative site. Table 3 also presents the TNM modeled noise levels based on the observed traffic data. The table compares the measured levels to the modeled levels at each representative receptor site. All of the post barrier installation noise measurement sites (except receiver 7) are within ±3 dB of the TNM predicted noise levels. This indicates an accurate representation of field measured noise levels when compared to the site-specific modeled conditions. For some unknown reason, the modeled and measured noise levels at Receiver 7 are different in both the pre-construction and post-construction scenarios. The model may be measuring a reflection that is not accurately represented from field conditions. In cases where one location is not in agreement it is assumed that the field measured level is correct.

Post-Construction Noise Measurement - Noise Barrier Wall with "T"-Top

Noise measurements were taken at eight locations between the hours of 9:14 AM to 1:18 PM on Thursday October 8, 2009. This round of noise measurements recorded the level of noise reduction added by the installation of the "T"-top on top of the noise barrier wall. A printout of the post-construction noise measurements with the "T"-top installed on the noise wall is provided in Appendix B and summarized in Table 4. The "T"-top added an additional noise reduction of approximately 1.2 dB to those dwelling units located adjacent to the noise barrier wall. The representative receptor located in the second row of dwelling units received an additional 0.3 dB in noise reduction and the representative receptor located in the third row received an additional noise reduction of 0.2 dB.

Table 4. "T"-Top Noise Wall Noise Measurements Post "T" Installation – October 8, 2009						
Rec.	Time	Field Measured Noise Levels		Noise Reduction Contributed by "T"	Simulated Noise Wall at an Average Height of 10.25'	Comparison of simulated 10.25' wall to 8' "T"-wall
		Barrier Only	Barrier and "T"			
1	9:14-9:30 AM	62.2	61.7	0.5	61.7	0.0
2	9:41-10:01 AM	64.8	63.6	1.2	63.4	0.2
3	10:12-10:32 AM	66.1	65.0	1.1	64.7	0.3
4	10:48-11:08 AM	68.9	67.7	1.2	67.0	0.7
5	11:09-10:29 AM	73.7	73.8	+0.1	72.7	1.1
6	11:32-11:52 AM	69.5	69.7	0.2	68.9	0.8
7	12:01-12:21 PM	53.9	53.7	0.2	59.3	N/A
8	12:58-1:18 PM	56.7	56.4	0.3	58.7	2.3

The objective of the "T"-Top noise barrier wall pilot program was to test the theory that by modifying the top of a standard wall with a "T" shape could provide an additional 1.0 to 1.5 dB noise reduction. The program demonstrated that the objective range of noise reduction could be attained near the center of the noise barrier wall where noise reductions are generally greatest. The level of noise reduction for receivers near the wall ends and in the second and third row or receivers could not be achieved. As also shown in Table 4, the simulated noise reduction for a noise barrier wall height at 10.25' is similar to the levels of noise reduction provided by the eight-foot high noise barrier wall with the "T". Therefore the "T"-Top noise barrier wall does equate to a reduction in height of a traditional noise barrier wall by an average of approximately 2.25 feet. The field measured and modeled levels at receiver 7 have not compared similarly throughout the study and are considered not applicable for results comparison. Based on one location, receiver 8, it appears that the "T"-top noise wall provides a greater level of noise at the third row of receptors sites than the simulated noise barrier wall would provide.

Table 5 shows the overall performance of the "T"-top noise barrier wall. According to the ODOT noise policy and guidance, a substantial noise reduction is considered to be 5 dB or greater. The noise barrier provided receivers 3 and 4 a substantial noise reduction. Receivers 3 and 4 are representative of five residential dwelling units. ODOT policy further considers any dwelling unit that receives a 3 dB or greater noise reduction to be a benefitted receiver. As shown in Table 5, receivers 2 and 8 would experience a noise reduction of 3 dB or more. Receivers 2 and 8 are representative of six residential dwelling units. A total of eleven residential dwelling units are considered benefitted by the "T"-top noise barrier wall. At an average cost of \$29 ft^2, the "T"-top barrier cost \$284,737 or \$25,885 per benefitted receptor. To achieve the same level of noise reduction with a traditional concrete noise barrier wall, a 10.25' high wall at \$25 ft^2 would cost \$315,000 or approximately \$28,636 per benefitted receptor. The "T"-top noise barrier wall would translate into a cost savings of approximately \$25 per lineal foot.

Table 5. "T"-Top Noise Wall "T"-Top Noise Wall Summary					
Receiver	Pre-Construction Noise Levels	Noise Levels with Noise Barrier Only	Noise Levels with "T" Installed	Noise Reduction Contributed by "T"	Total Noise Reduction Provided by the "T"-top Noise Barrier
1	63.3	62.2	61.7	0.5	1.6
2	67.6	64.8	63.6	1.2	4.0
3	71.3	66.1	65.6	1.1	5.7
4	74.1	68.9	67.7	1.2	6.4
5	74.1	73.7	73.8	None	0.3
6	68.0	69.5	69.7	None	None
7	56.4	53.9	53.7	0.2	2.7
8	59.8	56.7	56.4	0.3	3.4

Summary

The objective of the "T"-Top noise barrier wall pilot program was to test the theory that by modifying the top of a standard noise barrier wall with a "T" shape top, a shorter "T"-top noise barrier wall could provide a similar level of noise reduction as a higher traditional noise barrier wall. Furthermore a reduction in noise barrier height would result in a less expensive noise abatement measure. The "T"-top provided an additional 1.2 dB noise reduction to centrally located receptors directly behind the barrier wall. The FHWA TNM was used to simulate a noise barrier wall that would provide the same level of noise reduction as the "T"-top and determined that a standard 10.25' high noise barrier would be necessary to provide the same level of noise reduction as the 8' high "T"-top noise barrier. The "T"-top wall would provide a cost savings of almost $30,000 dollars compared to a standard noise barrier wall. The "T"-top noise wall should be considered as a viable option for future use as a noise abatement measure based on the cost savings and similar levels of noise reduction as a traditional noise barrier wall.

MEDIAN-MOUNTED ACOUSTIC PANELS PILOT PROGRAM

MEDIAN-MOUNTED ACOUSTIC PANELS

Pilot Program Objective

The objective of the median-mounted acoustic panel pilot program was to determine the level of noise reduction that could be obtained by constructing noise absorbent acoustic panels on top of the existing concrete median. It was assumed that panels placed on the concrete median at a total height (median + panels) of 10'-4" would screen out almost all the noise energy generated by traffic in the westbound travel lanes. It was further assumed that the panels may also absorb some of the noise energy reflected off the concrete median and not be bounced back towards the receptors on the south side of the Turnpike. Noise is measured on a logarithmic scale and if the panels could screen out and absorb at least one half of the noise energy generated from the turnpike, noise levels could be reduced by a minimum 3dB. If obtained, this level of noise reduction would be perceptible by most persons. A photograph of the median-mounted acoustic panels, as viewed from the eastbound traffic lanes, is shown below.

Field Measured Noise Levels

An important concern during the noise monitoring periods was to take the field measurements on both days at similar times to best insure that the traffic volume and the vehicle mix would be similar. Similar traffic volume and vehicle mix would help insure an accurate presentation of the effectiveness of the mitigation measure and not have results skewed by wide ranging volume or dissimilar vehicle mix. Both field measurements were taken on a Wednesday between the hours of 9:15 AM and 11:30 AM. During each of the noise measurement periods, simultaneous data including traffic volume, speed, and vehicle composition were collected. Traffic volumes were counted on Wednesday May 27, 2009 prior to construction. Traffic volumes were counted on Wednesday October 21, 2009 following the installation of the acoustic panels. The traffic volumes are shown in Table 6. In general, the traffic volume on both days were similar with automobile volume and medium truck volume being slightly lower during the second round of monitoring but this was countered with heavy truck volume being higher during the second round of monitoring. Considering the fact that noise is measured on a logarithmic scale the difference in traffic volume is almost of no consequence to the resulting noise levels.

Table 6. Median-Mounted Acoustic Panels Traffic Volume Summary							
	May 27, 2009 – 9:15-10:15 AM			October 21, 2009–10:30-11:30 AM			
	EB	WB	Total	EB	WB	Total	Difference
Automobile	796	868	1,664	633	690	1,323	-20%
Medium Trucks	50	51	101	33	45	78	-23%
Heavy Trucks	222	283	505	325	302	627	+24%
Motorcycles	1	0	1	3	0	3	- - -

Existing Condition - Pre-Construction Noise Measurements

Noise measurements were taken at four receivers during the hours of 9:00AM to 11:00AM on Wednesday May 27, 2009. The noise receiver locations are shown on Figure 2. Receiver 1 is considered a front row receptor located near the middle of the median-mounted acoustic panels. The site was located to evaluate the typical level of noise reduction where dwelling units are completely shielded by the acoustic panels. The maximum level of noise reduction would be expected to occur at receiver 1. Receiver 2 is also considered a front row receptor and is located very close (less than 100' south) to the eastbound lanes of the Turnpike. The receiver was located at this location to determine what level of noise reduction the acoustic panels would have on a location in close proximity to the travel lanes. Receiver 3 is considered representative of second row dwelling units shielded from traffic noise by the front row receptors. Receiver 4 is located near a residential dwelling near the west end of the acoustic panels in an area not shielded by the panels. Receiver 4 was located as a control site in an area unaffected by the acoustic panels. Even though field measurements were collected around the same time of day and the same day of the week, it was expected that traffic volumes, vehicle mix and other ambient noise sources would vary from day to day as field measurements were taken. These changing variables were out of the study control. Noise measurements were taken at this location as a baseline to compare how the receivers were affected by inconsistencies in the traffic. Noise levels recorded at NSA 47 prior to installation of the acoustic panels are summarized in Table 7.

Table 7. Median-Mounted Acoustic Panels Pre-Construction Noise Measurements May 27, 2009						
Receiver	Time	L_{min} dBA	L_{max} dBa	L_{eq} dBA	Modeled Level dBA	Difference in modeled level over measured level dB
1	9:15-9:35 AM	55.9	77.9	67.3	69.5	2.2
2	9:37-10:57 AM	55.3	83.7	71.4	71.7	0.3
3	10:00-10:20 AM	53.0	72.7	64.9	65.3	0.4
4	10:25-10:45 AM	52.1	70.3	59.7	60.5	0.8

Again, during the noise measurement period, simultaneous data including traffic volume, speed, and vehicle composition were collected. Traffic volume counted on September 1, 2009 is shown in Table 6. Traffic data were input into TNM V2.5 to calibrate the measured noise level with the modeled noise level at each representative site. Table 6 also presents the TNM modeled noise levels based on the observed traffic data. The table compares the measured levels to the modeled levels at each representative receptor

site. All of the measurement sites are within ±3 dB of the TNM predicted noise levels. This indicates an accurate representation of field measured noise levels when compared to the site-specific modeled conditions.

Post-Construction Noise Measurements

Noise measurements were taken at four locations between the hours of 11:41 AM to 12:51 PM on Wednesday October 21, 2009. The measured noise levels are summarized in Table 8.

Table 8.
Median-Mounted Acoustic Panels
Post-Construction Noise Measurements October 21, 2009

Receiver	Time	L_{min} dBA	L_{max} dBA	L_{eq} dBA	Pre-Construction Noise Level dBA	Decrease in Noise Level dB
1	11:41-12:01 PM	52.3	77.9	65.1	67.3	2.2
2	12:06-12:26 PM	52.9	83.3	71.0	71.4	0.4
3	12:55-1:15	53.0	72.7	62.9	64.9	2.0
4	12:31-12:51 PM	51.6	69.2	58.8	59.7	0.9

The objective of the median-mounted acoustic panels pilot program was to determine the level of noise reduction that could be obtained by constructing noise absorbent acoustic panels on top of the existing concrete median. It was expected that a minimum 3dB noise reduction could be attained by the acoustic panels. The program demonstrated that the range of noise reduction could not be attained at any of the receiver sites. As shown in Table 8, the maximum level of noise reduction achieved by the panels was around 2.2 dB at the receiver site near the middle of the acoustic panels. The receiver site representative of the second row of receivers achieved a similar noise reduction of 2.0 dB.

Noise Modeling

For all three scenarios, noise levels were modeled at the same representative locations using the FHWA TNM Version 2.5 using traffic volumes counted during the field measurement periods. The purpose of noise modeling for the pre-construction scenario is to calibrate the noise model to simulate site specific conditions. Terrain lines, elevations, building rows and vegetation zones can be edited in the model so that measured levels and modeled levels can be accurately compared.

To evaluate the future viability of the median-mounted acoustic panel as a potential mitigation method, the level of noise reduction and cost the pilot program were compared to noise reduction ability and average cost of a traditional concrete noise barrier wall. The total cost of the acoustic panel pilot program was $166,409. TNM was used to compare the cost of a traditional concrete noise barrier wall to the acoustic panel program, by simulating a traditional concrete noise barrier placed along the turnpike right-of-way line. At a cost of approximately $25 ft^2, a noise barrier consisting of 6,656 ft^2 could be constructed at total cost of $166,400 – approximately the same cost of the acoustic panel program. A traditional concrete noise barrier wall along the south right of way line was simulated at a length of 665 feet and average height of 10 feet. A noise barrier wall in this configuration would provide a noise reduction ranging from 1 to 8 dB with two dwelling units receiving a noise reduction of greater than 3 dB. Results of the measured noise reduction provided by the acoustic panels are shown in Table 9. Also shown in the table is the expected noise reduction that would be provided by a traditional noise barrier wall at a similar cost.

Table 9. Median-Mounted Acoustic Panels Noise Summary					
Receiver	Pre-Construction Noise Level	Measured Noise Level with Acoustic Panels	Decrease in Noise Level with Acoustic Panels	Noise Reduction with Simulated Traditional Concrete Noise Barrier Wall	Decrease in Noise Level with Concrete Noise Barrier Wall
1	67.3	65.1	2.2	65.6	1.7
2	71.4	71.0	0.4	62.7	8.7
3	64.9	62.9	2.0	61.9	3.0
4	59.7	58.8	0.9	58.7	1.0

Summary

The objective of the median-mounted acoustic panel pilot program was to test the theory that by blocking noise created by one directional flow of traffic (in this case the westbound traffic lanes) noise levels would drop by 3 dB at receptors located on the south side of the turnpike. Additional noise reduction could also occur by absorbing some reflected noise off the concrete median. As shown in Table 9, the maximum level of noise reduction provided by the acoustic panels was 2.2 dB and below the anticipated 3dB noise reduction. A minimum 3 dB noise reduction would be necessary to be perceptible by most persons. Based on the ODOT Noise Policy, the 2.2 dB level of noise reduction is not considered a substantial noise reduction and the median-mounted acoustic panels would not be considered a feasible noise abatement measure. TNM was used to simulate a noise barrier wall that could be constructed at the same relative cost as the acoustic panels to determine which abatement measure would provide the highest level of noise reduction at the same cost. As shown in Table 9, a 10' high noise barrier wall at a length of 573 feet would provide an 8.7 dB noise reduction at receiver 2. According to ODOT Noise Policy the noise barrier wall could provide a substantial noise reduction and would be considered a feasible noise abatement measure. One additional receiver site would experience a 3 dB noise reduction and would also be considered a benefitted receptor site.

The pilot program demonstrates that a traditional concrete noise barrier wall would provide a much greater level of noise reduction than the median-mounted acoustic panels at the same relative cost. Therefore, median-mounted acoustic panels would probably not be considered as a viable, cost effective option for noise abatement at other locations along the Ohio Turnpike.

FINAL PROJECT SUMMARY

The Ohio Turnpike Commission Noise Mitigation Study was undertaken to investigate and evaluate innovative noise abatement measures that could be used along the turnpike while maintaining compliance with both the FHWA and the ODOT traffic noise analysis and abatement policy and guidance documents. Two innovative abatement measures, a "T"-top noise barrier wall and median-mounted acoustic panels were constructed, monitored and evaluated at noise sensitive areas 39 and 47 respectively. The standard noise abatement measure used throughout Ohio and the United States is the concrete noise barrier wall. The overall noise reduction capabilities and costs of the innovative noise abatement measures were compared to the noise reduction capability and average cost of a traditional concrete noise barrier wall to determine whether the innovative measures may be a cost-effective and viable for future use along the turnpike.

The "T"-top pilot program determined that an eight-foot high "T"-top noise barrier wall could provide the same level of noise reduction as a 10.25-foot high traditional concrete noise barrier wall. For cost comparison, the actual construction cost of \$29 ft^2 for the "T"-top wall was compared to the average cost, per ODOT, for a traditional noise barrier wall of \$25 ft^2. Though the "T"-top wall costs more per square foot, the pilot program determined that the overall cost of the "T"-top noise barrier wall (\$284,737) would be less than the cost of a traditional noise barrier wall (\$315,000). A "T"-top noise wall can provide the same level of noise reduction as a traditional wall at a slightly lower cost than the traditional noise barrier wall. Depending on site-specific conditions, a "T"-top noise wall could be a cost effective and viable option for future noise mitigation.

The median-mounted acoustic panels were not able to provide a level of noise reduction (3 dB) that would be perceptible to most people. When comparing the total cost of the median-mounted acoustic panels (\$166,409) to the total cost of a traditional concrete noise barrier wall (\$166,400) the concrete noise barrier wall provides a much higher level of noise reduction at the same cost. Further use of median-mounted acoustic panels does not appear to be a cost-effective or viable option for future noise mitigation.

APPENDIX A
FIGURES

Figure 1
Pilot Program Locations

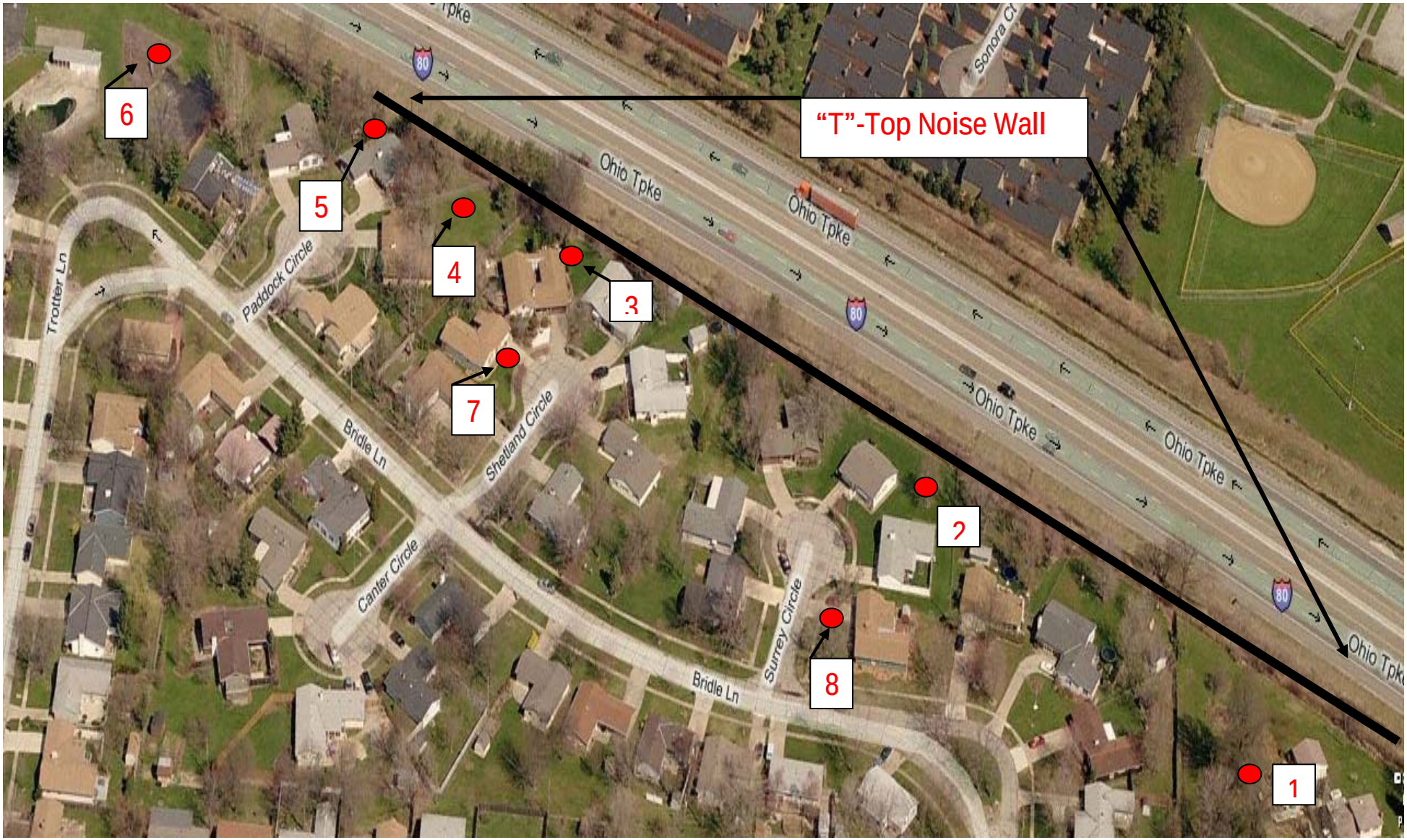

Figure 2
"T"-Top Noise Barrier Wall
Noise Receptor Locations

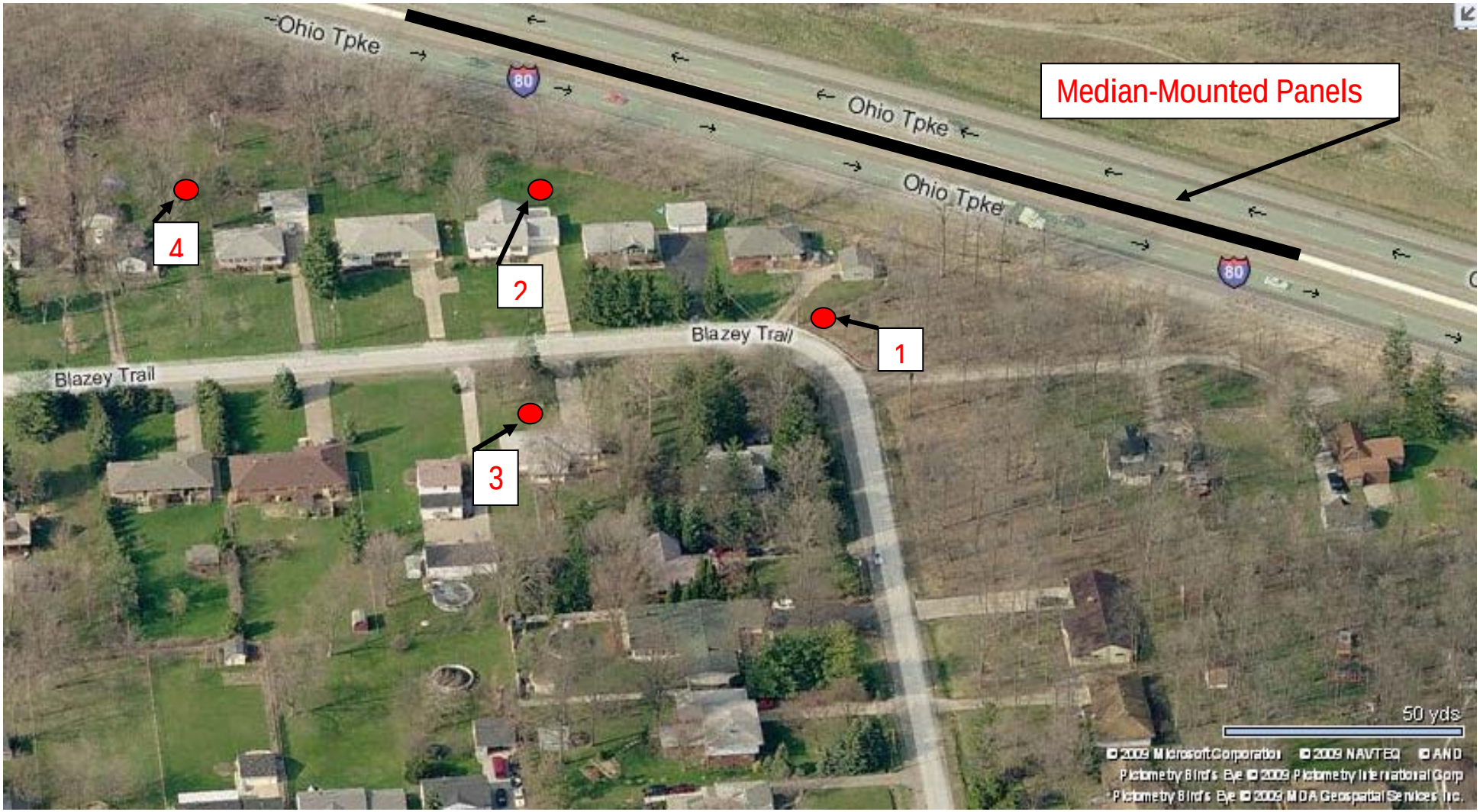

Figure 3
Median-Mounted Acoustic Panels
Noise Receptor Locations

APPENDIX B
FIELD MEASURED NOISE LEVELS
"T"-TOP NOISE BARRIER WALL

Pre-Construction Noise Monitoring

QuestSuite Professional-10.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commission		
Work Area:	NSA 39 "T"-Top Noise Barrier Wall Pilot Program		
Description:	Pre Construction Noise Monitoring		
Comments:	**Location 1**		

Group 1 Test 2

Test Started:	5/28/2009 8:45:46 AM
Test Ended:	5/28/2009 9:07:26 AM
Run Time:	00:21:39

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	88.2 dB, 5/28/2009 8:49:09AM						
Max Level:	66.9 dB, 5/28/2009 8:49:08AM						
Min Level:	51.6 dB, 5/28/2009 9:52:49AM						
Overload:	0.00%						
LEQ:	63.3 dB	SEL(3):	92.8 dB	TWA:	48.3 dB	TAKM5:	76.3 dB
LDN:	63.3 dB	CNEL:	63.3 dB	Pa2Sec:	0.8		
L5:	67.0 dB	L10:	64.0 dB	L50:	57.3 dB	L90:	51.6 dB

Comments:

QuestSuite Professional-10.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commission		
Work Area:	NSA 39 "T"-Top Noise Barrier Wall Pilot Program		
Description:	Pre Construction Noise Monitoring		
Comments:	**Location 2**		

Group 1 Test 2

Test Started:	5/28/2009 9:12:46 AM
Test Ended:	5/28/2009 9:32:56 AM
Run Time:	00:20:10

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	98.9 dB, 5/28/2009 9:13:09AM						
Max Level:	76.6 dB, 5/28/2009 9:16:51AM						
Min Level:	51.6 dB, 5/28/2009 9:32:49AM						
Overload:	0.00%						
LEQ:	67.6 dB	SEL(3):	98.3 dB	TWA:	53.9 dB	TAKM5:	71.9 dB
LDN:	67.6 dB	CNEL:	67.6 dB	Pa2Sec:	2.7		
L5:	72.3 dB	L10:	70.3 dB	L50:	64.8 dB	L90:	60.4 dB

Comments:

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2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commission		
Work Area:	NSA 39 "T"-Top Noise Barrier Wall Pilot Program		
Description:	Pre Construction Noise Monitoring		
Comments:	**Location 3**		

Group 1 Test 3

Test Started:	5/28/2009 9:41:06 AM
Test Ended:	5/28/2009 9:59:00 AM
Run Time:	00:17:54

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	102.8 dB, 5/28/2009 9:50:29AM						
Max Level:	84.9 dB, 5/28/2009 9:52:37AM						
Min Level:	51.6 dB, 5/28/2009 9:42:11AM						
Overload:	0.00%						
LEQ:	71.3 dB	SEL(3):	102.0 dB	TWA:	57.5 dB	TAKM5:	75.9 dB
LDN:	71.3 dB	CNEL:	71.3 dB	Pa2Sec:	6.3		
L5:	72.3 dB	L10:	75.9 dB	L50:	67.9 dB	L90:	61.0 dB

Comments:

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2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commission		
Work Area:	NSA 39 "T"-Top Noise Barrier Wall Pilot Program		
Description:	Pre Construction Noise Monitoring		
Comments:	**Locations 4 and 5**		

Group 1 Test 4

Test Started:	5/28/2009 9:41:06 AM
Test Ended:	5/28/2009 10:01:10 AM
Run Time:	0:20:04

Measuring Parameters

Range:	60 - 120 dB	Weighting: A		Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	103.4 dB, 5/28/2009 9:57:26AM						
Max Level:	86.5 dB, 5/28/2009 9:47:01AM						
Min Level:	54.0 dB, 5/28/2009 9:53:17AM						
Overload:	0.00%						
LEQ:	74.1 dB	SEL(3):	104.8 dB	TWA:	60.4 dB	TAKM5:	78.1 dB
LDN:	74.1 dB	CNEL:	74.1 dB	Pa2Sec:	12.2		
L5:	80.2 dB	L10:	78.8 dB	L50:	70.6dB	L90:	62.7 dB

Comments:

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2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commission		
Work Area:	NSA 39 "T"-Top Noise Barrier Wall Pilot Program		
Description:	Pre Construction Noise Monitoring		
Comments:	**Location 6**		

Group 1 Test 5

Test Started:	5/28/2009 10:03:19 AM
Test Ended:	5/28/2009 10:23:23 AM
Run Time:	0:20:04

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	100.0 dB, 5/28/2009 10:14:19AM						
Max Level:	78.6 dB, 5/28/2009 10:21:41AM						
Min Level:	51.8 dB, 5/28/2009 10:18:02AM						
Overload:	0.00%						
LEQ:	68.0 dB	SEL(3):	98.7 dB	TWA:	54.2 dB	TAKM5:	71.4 dB
LDN:	68.0 dB	CNEL:	68.0 dB	Pa2Sec:	2.9		
L5:	73.1 dB	L10:	72.2 dB	L50:	65.4 dB	L90:	58.9 dB

Comments:

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2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commission		
Work Area:	NSA 39 "T"-Top Noise Barrier Wall Pilot Program		
Description:	Pre Construction Noise Monitoring		
Comments:	**Location 7**		

Group 1 Test 6

Test Started:	5/28/2009 10:28:07 AM
Test Ended:	5/28/2009 10:48:08 AM
Run Time:	00:20:01

Measuring Parameters

Range:	60 - 120 dB	Weighting: A		Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	89.7 dB, 5/28/2009 10:47:05AM						
Max Level:	66.8 dB, 5/28/2009 10:36:07AM						
Min Level:	51.6 dB, 5/28/2009 10:28:09AM						
Overload:	0.00%						
LEQ:	56.4 dB	SEL(3):	87.6 dB	TWA:	43.2 dB	TAKM5:	58.7 dB
LDN:	56.4 dB	CNEL:	56.4 dB	Pa2Sec:	0.2		
L5:	60.4 dB	L10:	59.4 dB	L50:	55.2 dB	L90:	51.6 dB

Comments:

QuestSuite Professional-10.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commission		
Work Area:	NSA 39 "T"-Top Noise Barrier Wall Pilot Program		
Description:	Pre Construction Noise Monitoring		
Comments:	**Location 8**		

Group 1 Test 7

Test Started:	5/28/2009 10:45:27 AM
Test Ended:	5/28/2009 11:05:28 AM
Run Time:	00:20:01

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	94.9 dB, 5/28/2009 10:50:41AM						
Max Level:	69.9 dB, 5/28/2009 10:50:41AM						
Min Level:	51.6 dB, 5/28/2009 10:46:40AM						
Overload:	0.00%						
LEQ:	59.8 dB	SEL(3):	89.6 dB	TWA:	45.1 dB	TAKM5:	62.6 dB
LDN:	59.8 dB	CNEL:	59.8 dB	Pa2Sec:	0.4		
L5:	64.4 dB	L10:	63.2 dB	L50:	58.3 dB	L90:	53.1 dB

Comments:

Post-Construction Noise Monitoring
Noise Barrier Wall Only

QuestSuite Professional-10.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039

Name: CMCox

Company: TranSystems for the Ohio Turnpike Commission

Work Area: NSA 39 "T"-Top Noise Barrier Wall Pilot Program
Description: Post Barrier Wall Installation

Comments: **Location 1**

Group 1 Test 1

Test Started: 9/1/2009 8:15:50 AM
Test Ended: 9/1/2009 8:36:00 AM
Run Time: 00:20:10

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level: 93.0 dB, 9/1/2009 8:30:16AM

Max Level: 73.7 dB, 9/1/2009 8:27:58AM
Min Level: 51.6 dB, 9/1/2009 8:27:19AM
Overload: 0.00%

LEQ:	62.2 dB	SEL(3):	92.9 dB	TWA:	48.5 dB	TAKM5:	65.0 dB
LDN:	62.2 dB	CNEL:	62.2 dB	Pa2Sec:	0.8		
L5:	66.6 dB	L10:	65.5 dB	L50:	60.9 dB	L90:	55.9 dB

Comments:

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2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commission		
Work Area:	NSA 39 "T"-Top Noise Barrier Wall Pilot Program		
Description:	Post Barrier Wall Installation		
Comments:	**Location 2**		

Group 1 Test 2

Test Started:	9/1/2009 8:42:21 AM
Test Ended:	9/1/2009 9:02:31 AM
Run Time:	00:20:10

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	96.8 dB, 9/1/2009 9:13:22AM						
Max Level:	79.7 dB, 9/1/2009 9:13:21AM						
Min Level:	51.6 dB, 9/1/2009 8:47:27AM						
Overload:	0.00%						
LEQ:	64.8 dB	SEL(3):	96.5 dB	TWA:	52.1 dB	TAKM5:	69.3 dB
LDN:	64.8 dB	CNEL:	64.8 dB	Pa2Sec:	1.6		
L5:	70.7 dB	L10:	69.5 dB	L50:	63.7 dB	L90:	58.0 dB

Comments:

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2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039

Name: CMCox

Company: TranSystems for the Ohio Turnpike Commission

Work Area: NSA 39 "T"-Top Noise Barrier Wall Pilot Program
Description: Post Barrier Wall Installation

Comments: **Location 3**

Group 1 Test 3

Test Started: 9/1/2009 9:17:03 AM
Test Ended: 9/1/2009 9:37:07 AM
Run Time: 0:20:04

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level: 94.9 dB, 9/1/2009 9:19:30AM

Max Level: 77.1 dB, 9/1/2009 9:19:41AM
Min Level: 52.6 dB, 9/1/2009 9:20:57AM
Overload: 0.00%

LEQ:	66.1 dB	SEL(3):	96.3 dB	TWA:	51.8 dB	TAKM5:	70.0 dB
LDN:	66.1 dB	CNEL:	66.1 dB	Pa2Sec:	1.7		
L5:	71.4 dB	L10:	70.3 dB	L50:	65.3 dB	L90:	59.9 dB

Comments:

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2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039

Name: CMCox

Company: TranSystems for the Ohio Turnpike Commission

Work Area: NSA 39 "T"-Top Noise Barrier Wall Pilot Program
Description: Post Barrier Wall Installation

Comments: **Location 4**

Group 1 Test 4

Test Started: 9/1/2009 9:45:59 AM
Test Ended: 9/1/2009 10:05:00 AM
Run Time: 00:20:01

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level: 100.3 dB, 9/1/2009 9:43:01AM

Max Level: 78.0 dB, 9/1/2009 9:55:36AM
Min Level: 53.2 dB, 9/1/2009 10:00:43AM
Overload: 0.00%

LEQ:	68.9 dB	SEL(3):	96.6 dB	TWA:	52.2 dB	TAKM5:	69.6 dB
LDN:	68.9 dB	CNEL:	68.9 dB	Pa2Sec:	1.8		
L5:	72.4 dB	L10:	69.8 dB	L50:	63.7 dB	L90:	58.7 dB

Comments:

QuestSuite Professional-10.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039

Name: CMCox

Company: TranSystems for the Ohio Turnpike Commission

Work Area: NSA 39 "T"-Top Noise Barrier Wall Pilot Program
Description: Post Barrier Wall Installation

Comments: **Location 5**

Group 1 Test 5

Test Started: 9/1/2009 10:09:29 AM
Test Ended: 9/1/2009 10:24:38 AM
Run Time: 00:15:08

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level: 103.4 dB, 9/1/2009 10:16:45AM

Max Level: 83.9 dB, 9/1/2009 10:14:31AM
Min Level: 54.3 dB, 9/1/2009 10:14:21AM
Overload: 0.00%

LEQ:	73.7 dB	SEL(3):	101.2 dB	TWA:	56.8 dB	TAKM5:	76.7 dB
LDN:	73.7 dB	CNEL:	73.7 dB	Pa2Sec:	5.3		
L5:	78.3 dB	L10:	76.6 dB	L50:	67.5 dB	L90:	61.3 dB

Comments:

QuestSuite Professional-10.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039

Name: CMCox

Company: TranSystems for the Ohio Turnpike Commission

Work Area: NSA 39 "T"-Top Noise Barrier Wall Pilot Program
Description: Post Barrier Wall Installation

Comments: **Location 6**
Park
Control Location-This Location Unaffected by the Noise Barrier

Group 1 Test 6

Test Started: 9/1/2009 10:27:56 AM
Test Ended: 9/1/2009 10:42:57 AM
Run Time: 00:15:01

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level: 103.2 dB, 9/1/2009 10:30:17AM

Max Level: 77.6 dB, 9/1/2009 10:33:51AM
Min Level: 54.9 dB, 9/1/2009 10:31:22AM
Overload: 0.00%

LEQ:	69.5 dB	SEL(3):	97.0 dB	TWA:	52.5 dB	TAKM5:	70.4 dB
LDN:	69.5 dB	CNEL:	69.5 dB	Pa2Sec:	2.0		
L5:	73.1 dB	L10:	72.2 dB	L50:	65.6 dB	L90:	60.7 dB

Comments:

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2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039

Name:	CMCox
Company:	TranSystems for the Ohio Turnpike Commission
Work Area:	NSA 39 "T"-Top Noise Barrier Wall Pilot Program
Description:	Post Barrier Wall Installation
Comments:	**Location 7**

Group 1 Test 7

Test Started:	9/1/2009 10:46:12 AM
Test Ended:	9/1/2009 11:06:13 AM
Run Time:	00:20:01

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	88.9 dB, 9/1/2009 10:50:58AM						
Max Level:	71.1 dB, 9/1/2009 10:50:57AM						
Min Level:	53.3 dB, 9/1/2009 11:05:09AM						
Overload:	0.00%						
LEQ:	53.9 dB	SEL(3):	87.1 dB	TWA:	41.2 dB	TAKM5:	58.5 dB
LDN:	53.9 dB	CNEL:	53.9 dB	Pa2Sec:	0.1		
L5:	57.5 dB	L10:	56.4 dB	L50:	52.9 dB	L90:	51.6 dB

Comments:

QuestSuite Professional-10.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039

Name: CMCox

Company: TranSystems for the Ohio Turnpike Commission

Work Area: NSA 39 "T"-Top Noise Barrier Wall Pilot Program
Description: Post Barrier Wall Installation

Comments: **Location 8**

Group 1 Test 8

Test Started: 9/1/2009 11:23:07 AM
Test Ended: 9/1/2009 11:43:07 AM
Run Time: 00:20:00

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level: 92.9 dB, 9/1/2009 11:37:02AM

Max Level: 66.5 dB, 9/1/2009 11:43:04AM
Min Level: 52.0 dB, 9/1/2009 11:39:04AM
Overload: 0.00%

LEQ:	56.7 dB	SEL(3):	88.5 dB	TWA:	44.0 dB	TAKM5:	60.3 dB
LDN:	56.7 dB	CNEL:	56.7 dB	Pa2Sec:	0.3		
L5:	60.9 dB	L10:	60.3 dB	L50:	57.1 dB	L90:	54.1 dB

Comments:

Post-Construction Noise Monitoring
Noise Barrier Wall with “T”-Top

QuestSuite Professional-12.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commission		
Work Area:	NSA 39 "T"-Top Noise Barrier Wall Pilot Program		
Description:	Post "T"-Top Installation		
Comments:	**Location 1**		

Group 1 Test 1

Test Started:	10/8/2009 9:14:12 AM
Test Ended:	10/8/2009 9:30:43 AM
Run Time:	00:16:31

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	92.8 dB, 10/8/2009 9:26:04AM						
Max Level:	73.1 dB, 10/8/2009 9:20:04AM						
Min Level:	51.6 dB, 10/8/2009 9:23:35AM						
Overload:	0.00%						
LEQ:	61.7 dB	SEL(3):	92.4 dB	TWA:	48.0 dB	TAKM5:	65.1 dB
LDN:	61.7 dB	CNEL:	61.7 dB	Pa2Sec:	0.7		
L5:	66.5 dB	L10:	65.7 dB	L50:	61.4 dB	L90:	56.7 dB

Comments:

QuestSuite Professional-12.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commission		
Work Area:	NSA 39 "T"-Top Noise Barrier Wall Pilot Program		
Description:	Post "T"-Top Installation		
Comments:	**Location 2**		

Group 1 Test 2

Test Started:	10/8/2009 9:41:05 AM
Test Ended:	10/8/2009 10:01:06 AM
Run Time:	00:20:01

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	96.1 dB, 10/8/2009 9:45:27AM						
Max Level:	80.9 dB, 10/8/2009 9:45:25AM						
Min Level:	51.6 dB, 10/8/2009 9:44:55AM						
Overload:	0.00%						
LEQ:	63.6 dB	SEL(3):	96.5 dB	TWA:	52.1 dB	TAKM5:	69.3 dB
LDN:	63.6 dB	CNEL:	63.6 dB	Pa2Sec:	1.8		
L5:	70.0 dB	L10:	68.5 dB	L50:	63.7 dB	L90:	58.0 dB

Comments:

QuestSuite Professional-12.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commission		
Work Area:	NSA 39 "T"-Top Noise Barrier Wall Pilot Program		
Description:	Post "T"-Top Installation		
Comments:	**Location 3**		

Group 1 Test 3

Test Started:	10/8/2009 10:12:04 AM
Test Ended:	10/8/2009 10:32:14 AM
Run Time:	00:20:09

Measuring Parameters

Range:	60 - 120 dB	Weighting: A		Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	97.8 dB, 10/8/2009 10:12:18AM						
Max Level:	72.9 dB, 10/8/2009 10:12:17AM						
Min Level:	51.4 dB, 10/8/2009 10:24:11AM						
Overload:	0.00%						
LEQ:	65.0 dB	SEL(3):	95.7 dB	TWA:	51.1 dB	TAKM5:	67.0 dB
LDN:	65.0 dB	CNEL:	64.9 dB	Pa2Sec:	2.0		
L5:	69.2 dB	L10:	68.1 dB	L50:	63.8 dB	L90:	59.7 dB

Comments:

QuestSuite Professional-12.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commission		
Work Area:	NSA 39 "T"-Top Noise Barrier Wall Pilot Program		
Description:	Post "T"-Top Installation		
Comments:	**Location 4**		

Group 1 Test 4

Test Started:	10/8/2009 10:48:53 AM
Test Ended:	10/8/2009 11:08:54 AM
Run Time:	00:20:01

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	99.4 dB, 10/8/2009 11:04:13AM						
Max Level:	77.8 dB, 10/8/2009 10:57:01AM						
Min Level:	53.4 dB, 10/8/2009 10:52:01AM						
Overload:	0.00%						
LEQ:	67.7 dB	SEL(3):	98.8 dB	TWA:	65.2 dB	TAKM5:	70.7 dB
LDN:	67.7dB	CNEL:	67.7 dB	Pa2Sec:	2		
L5:	71.9 dB	L10:	70.7 dB	L50:	65.3 dB	L90:	60.6 dB

Comments:

QuestSuite Professional-12.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commission		
Work Area:	NSA 39 "T"-Top Noise Barrier Wall Pilot Program		
Description:	Post "T"-Top Installation		
Comments:	**Location 5**		

Group 1 Test 5

Test Started:	10/8/2009 11:09:28 AM
Test Ended:	10/8/2009 11:29:30 AM
Run Time:	00:20:02

Measuring Parameters

Range:	60 - 120 dB		Weighting:	A		Time Constant:	Fast
Threshold:	Off		Exchange Rate:		3 dB	Peak Weighting:	C

Summary

Peak Level:	98.7 dB, 10/8/2009 11:24:33AM						
Max Level:	85.4 dB, 10/8/2009 11:15:46AM						
Min Level:	57.2 dB, 10/8/2009 11:22:13AM						
Overload:	0.00%						
LEQ:	73.8 dB	SEL(3):	104.5 dB	TWA:	60.0dB	TAKM5:	78.9 dB
LDN:	73.8 dB	CNEL:	73.8 dB	Pa2Sec:	2.3		
L5:	80.1 dB	L10:	78.3 dB	L50:	70.0 dB	L90:	64.0 dB

Comments:

QuestSuite Professional-12.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commission		
Work Area:	NSA 39 "T"-Top Noise Barrier Wall Pilot Program		
Description:	Post "T"-Top Installation		
Comments:	**Location 6**		

Group 1 Test 6

Test Started:	10/8/2009 11:32:08 AM
Test Ended:	10/8/2009 11:52:09 AM
Run Time:	00:20:00

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	99.5 dB, 10/8/2009 11:48:36AM						
Max Level:	78.9 dB, 10/8/2009 11:45:10AM						
Min Level:	52.8 dB, 10/8/2009 11:44:12AM						
Overload:	0.00%						
LEQ:	69.7 dB	SEL(3):	100.5	TWA:	56.1 dB	TAKM5:	71.8 dB
LDN:	69.7 dB	CNEL:	69.7 dB	Pa2Sec:	3.6		
L5:	73.8 dB	L10:	71.5 dB	L50:	68.9 dB	L90:	66.4 dB

Comments:

QuestSuite Professional-12.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commission		
Work Area:	NSA 39 "T"-Top Noise Barrier Wall Pilot Program		
Description:	Post "T"-Top Installation		
Comments:	**Location 7**		

Group 1 Test 7

Test Started:	10/8/2009 12:01:06 PM
Test Ended:	10/8/2009 12:21:07 PM
Run Time:	00:20:01

Measuring Parameters

Range:	60 - 120 dB	Weighting: A		Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	95.3 dB, 10/8/2009 12:10:35AM						
Max Level:	72.3 dB, 10/8/2009 12:08:53PM						
Min Level:	49.6 dB, 10/8/2009 12:20:54PM						
Overload:	0.00%						
LEQ:	53.7 dB	SEL(3):	82.2 dB	TWA:	37.8 dB	TAKM5:	56.9 dB
LDN:	53.7 dB	CNEL:	53.7 dB	Pa2Sec:	0.3		
L5:	55.1 dB	L10:	53.6 dB	L50:	51.3 dB	L90:	50.0 dB

Comments:

QuestSuite Professional-12.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commission		
Work Area:	NSA 39 "T"-Top Noise Barrier Wall Pilot Program		
Description:	Post "T"-Top Installation		
Comments:	**Location 8**		

Group 1 Test 8

Test Started:	10/8/2009 12:58:21 PM
Test Ended:	10/8/2009 1:18:21 PM
Run Time:	00:20:00

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	100.5 dB, 10/8/2009 1:05:01PM						
Max Level:	72.9 dB, 10/8/2009 1:04:43PM						
Min Level:	51.9 dB, 10/8/2009 12:58:43PM						
Overload:	0.00%						
LEQ:	56.4 dB	SEL(3):	86.2 dB	TWA:	41.8 dB	TAKM5:	58.6 dB
LDN:	56.4 dB	CNEL:	56.4 dB	Pa2Sec:	0.4		
L5:	59.5 dB	L10:	58.4 dB	L50:	55.9 dB	L90:	54.2 dB

Comments:

APPENDIX C
FIELD MEASURED NOISE LEVELS
MEDIAN-MOUNTED ACOUSTIC PANELS

Pre-Construction Noise Monitoring

QuestSuite Professional-13.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commision		
Work Area:	NSA 47 Median-Mounted Acoustic Panels		
Description:	Pre-Construction Noise Measurement		
Comments:	**Location 1**		

Group 1 Test 1

Test Started:	5/27/2009 9:15:02 AM
Test Ended:	5/27/2009 9:35:03 AM
Run Time:	00:20:01

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	99.8 dB, 5/27/2009 9:29:00AM						
Max Level:	77.9 dB, 5/29/2009 9:31:38PM						
Min Level:	55.9 dB, 5/29/2009 9:20:49PM						
Overload:	0.00%						
LEQ:	67.3 dB	SEL(3):	97.9 dB	TWA:	53.5 dB	TAKM5:	70.7 dB
LDN:	67.3 dB	CNEL:	67.3 dB	Pa2Sec:	1.9		
L5:	72.5 dB	L10:	71.3 dB	L50:	65.0 dB	L90:	60.1 dB

Comments:

QuestSuite Professional-13.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commision		
Work Area:	NSA 47 Median-Mounted Acoustic Panels		
Description:	Pre-Construction Noise Measurement		
Comments:	**Location 2**		

Group 1 Test 2

Test Started:	5/27/2009 9:37:02 AM
Test Ended:	5/27/2009 9:57:03 AM
Run Time:	00:20:01

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	99.7 dB, 5/27/2009 9:52:00AM						
Max Level:	83.7 dB, 5/27/2009 9:52:38PM						
Min Level:	55.3 dB, 5/27/2009 9:53:49PM						
Overload:	0.00%						
LEQ:	71.4 dB	SEL(3):	102 dB	TWA:	57.6 dB	TAKM5:	74.5 dB
LDN:	71.4 dB	CNEL:	71.4 dB	Pa2Sec:	6.4		
L5:	76.9 dB	L10:	75.5 dB	L50:	68.8 dB	L90:	63.2 dB

Comments:

QuestSuite Professional-13.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commision		
Work Area:	NSA 47 Median-Mounted Acoustic Panels		
Description:	Pre-Construction Noise Measurement		
Comments:	**Location 3**		

Group 1 Test 3

Test Started:	5/27/2009 9:00:19 AM
Test Ended:	5/27/2009 10:20:20 AM
Run Time:	00:20:01

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	97.8 dB, 5/27/2009 9:03:00AM						
Max Level:	72.7 dB, 5/27/2009 9:16:38PM						
Min Level:	55.0 dB, 5/27/2009 9:11:49PM						
Overload:	0.00%						
LEQ:	64.9 dB	SEL(3):	95.6 dB	TWA:	51.1 Db	TAKM5:	67.0 dB
LDN:	64.9 dB	CNEL:	64.9 dB	Pa2Sec:	1.4		
L5:	69.0 dB	L10:	68.1 dB	L50:	63.8 dB	L90:	59.7 dB

Comments:

QuestSuite Professional-13.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commision		
Work Area:	NSA 47 Median-Mounted Acoustic Panels		
Description:	Pre-Construction Noise Measurement		
Comments:	**Location 4**		

Group 1 Test 4

Test Started:	5/27/2009 10:25:47 AM
Test Ended:	5/27/2009 10:45:48 AM
Run Time:	00:20:01

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	91.2 dB, 5/27/2009 10:36:00AM						
Max Level:	70.3 dB, 5/27/2009 10:42:38PM						
Min Level:	52.1 dB, 5/27/2009 10:44:49PM						
Overload:	0.00%						
LEQ:	59.7 dB	SEL(3):	90.3 dB	TWA:	45.9 dB	TAKM5:	61.7 dB
LDN:	59.7 dB	CNEL:	59.7 dB	Pa2Sec:	0.4		
L5:	63.2 dB	L10:	62.2 dB	L50:	58.8 dB	L90:	56.3 dB

Comments:

Post-Construction Noise Monitoring

QuestSuite Professional-13.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commision		
Work Area:	NSA 47 Median-Mounted Acoustic Panels		
Description:	Post-Construction Noise Measurement		
Comments:	**Location 1**		

Group 1 Test 1

Test Started:	10/21/2009 11:41:02 AM
Test Ended:	10/21/2009 12:01:03 PM
Run Time:	00:20:01

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	101.3 dB, 10/21/2009 11:49:00AM						
Max Level:	77.9 dB, 10/21/2009 11:59:38AM						
Min Level:	52.3 dB, 10/21/2009 11:43:49AM						
Overload:	0.00%						
LEQ:	65.1 dB	SEL(3):	95.8 dB	TWA:	52.0 dB	TAKM5:	70.0 dB
LDN:	65.1 dB	CNEL:	65.1 dB	Pa2Sec:	1.9		
L5:	70.6 dB	L10:	69.2 dB	L50:	62.1 dB	L90:	55.3 dB

Comments:

QuestSuite Professional-13.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commision		
Work Area:	NSA 47 Median-Mounted Acoustic Panels		
Description:	Post-Construction Noise Measurement		
Comments:	**Location 2**		

Group 1 Test 2

Test Started:	10/21/2009 12:06:44 PM
Test Ended:	10/21/2009 12:26:44 PM
Run Time:	00:20:00

Measuring Parameters

Range:	60 - 120 dB	Weighting: A		Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	100.5 dB, 10/21/2009 12:25:20PM						
Max Level:	83.3 dB, 10/21/2009 12:14:58PM						
Min Level:	52.9 dB, 10/21/2009 12:16:32PM						
Overload:	0.00%						
LEQ:	71.0 dB	SEL(3):	101.7 dB	TWA:	57.3 dB	TAKM5:	74.9 dB
LDN:	71.0 dB	CNEL:	71.0 dB	Pa2Sec:	6.0		
L5:	76.5 dB	L10:	75.4 dB	L50:	67.9 dB	L90:	61.0 dB

Comments:

QuestSuite Professional-13.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039
Name:	CMCox		
Company:	TranSystems for the Ohio Turnpike Commision		
Work Area:	NSA 47 Median-Mounted Acoustic Panels		
Description:	Post-Construction Noise Measurement		
Comments:	**Location 3**		

Group 1 Test 3

Test Started:	10/21/2009 12:55:02 PM
Test Ended:	10/21/2009 1:15:03 PM
Run Time:	00:20:01

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level:	101.3 dB, 10/21/2009 12:59:00PM						
Max Level:	77.9 dB, 10/21/2009 12:55:38PM						
Min Level:	52.3 dB, 10/21/2009 1:05:49PM						
Overload:	0.00%						
LEQ:	62.9 dB	SEL(3):	90.5 dB	TWA:	46.1 dB	TAKM5:	68.0 dB
LDN:	62.9 dB	CNEL:	62.9 dB	Pa2Sec:	1.9		
L5:	68.0 dB	L10:	62.9 dB	L50:	56.2 dB	L90:	54.7 dB

Comments:

QuestSuite Professional-13.sdat

2900 Integrating/Logging Sound Level Meter

FW Version:	02.4	Serial Number:	CDE060039

Name: CMCox

Company: TranSystems for the Ohio Turnpike Commision

Work Area: NSA 47 Median-Mounted Acoustic Panels
Description: Post-Construction Noise Measurement

Comments: **Location 4**

Group 1 Test 4

Test Started: 10/21/2009 12:31:01 PM
Test Ended: 10/21/2009 12:51:16 PM
Run Time: 00:20:14

Measuring Parameters

Range:	60 - 120 dB	Weighting:	A	Time Constant:	Fast
Threshold:	Off	Exchange Rate:	3 dB	Peak Weighting:	C

Summary

Peak Level: 96.7 dB, 10/21/2009 12:44:41PM

Max Level: 69.2 dB, 10/21/2009 12:31:08PM
Min Level: 51.6 dB, 10/21/2009 12:37:37PM
Overload: 0.00%

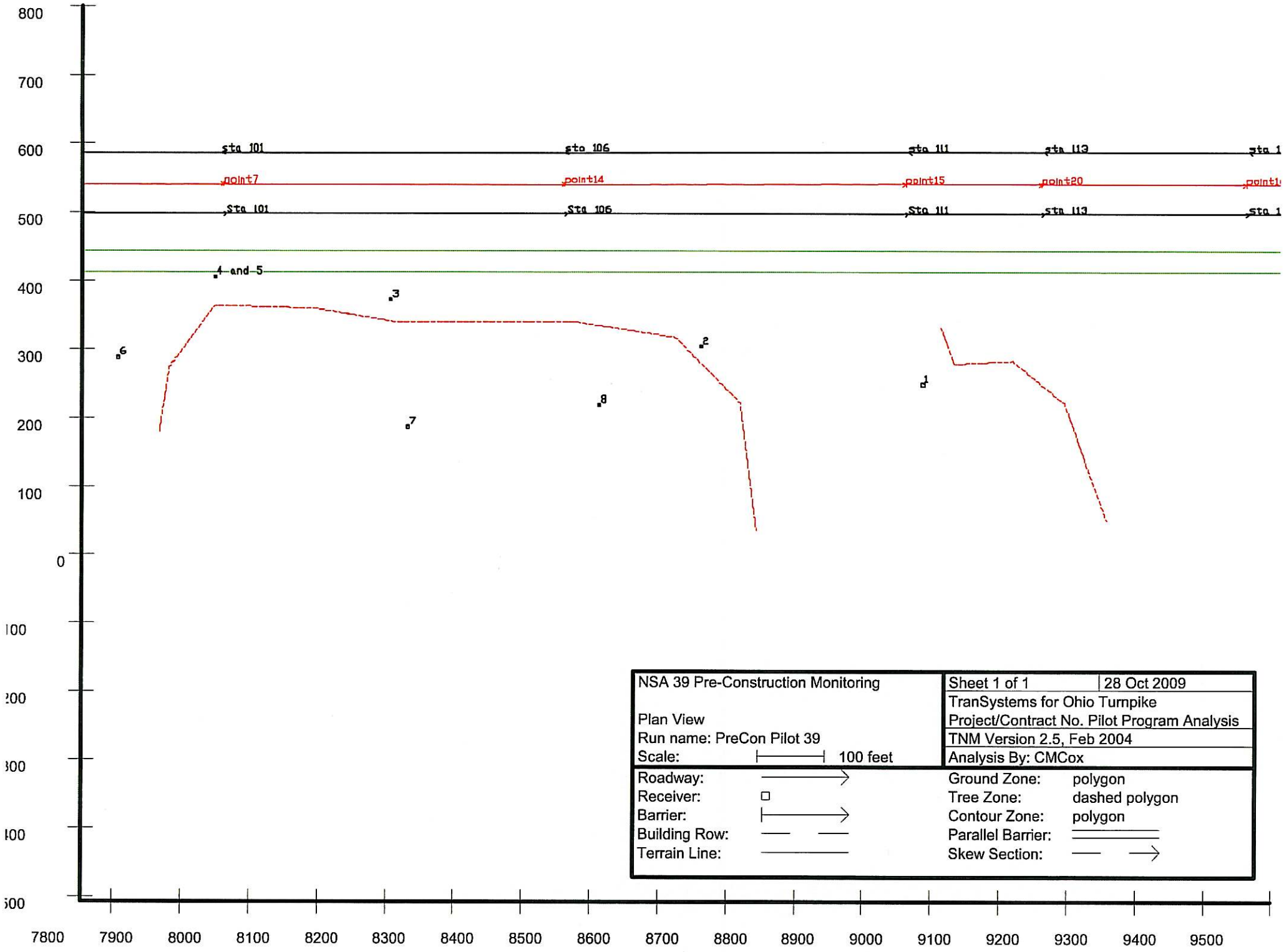
LEQ:	58.8 dB	SEL(3):	89.5 dB	TWA:	45.1 dB	TAKM5:	60.7 dB
LDN:	58.8 dB	CNEL:	58.8 dB	Pa2Sec:	0.4		
L5:	61.9 dB	L10:	60.9 dB	L50:	58.3 dB	L90:	54.9 dB

Comments:

APPENDIX D

TNM Model Results

"T"-Top Noise Barrier Wall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500
400
300
200
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sta 101
sta 106
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sta 113
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point14
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point20
Sta 101
Sta 106
Sta 111
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4 and 5
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7
7800
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8000
8100
8200
8300
8400
8500
8600
8700
8800
8900
9000
9100
9200
9300
9400
9500
NSA 39 Pre-Construction Monitoring
Plan View
Run name: PreCon Pilot 39
Scale: 100 feet
Sheet 1 of 1
28 Oct 2009
TranSystems for Ohio Turnpike
Project/Contract No. Pilot Program Analysis
TNM Version 2.5, Feb 2004
Analysis By: CMCox
Roadway:
Receiver:
Barrier:
Building Row:
Terrain Line:
Ground Zone: polygon
Tree Zone: dashed polygon
Contour Zone: polygon
Parallel Barrier:
Skew Section:

TranSystems for Ohio Turnpike
CMCox

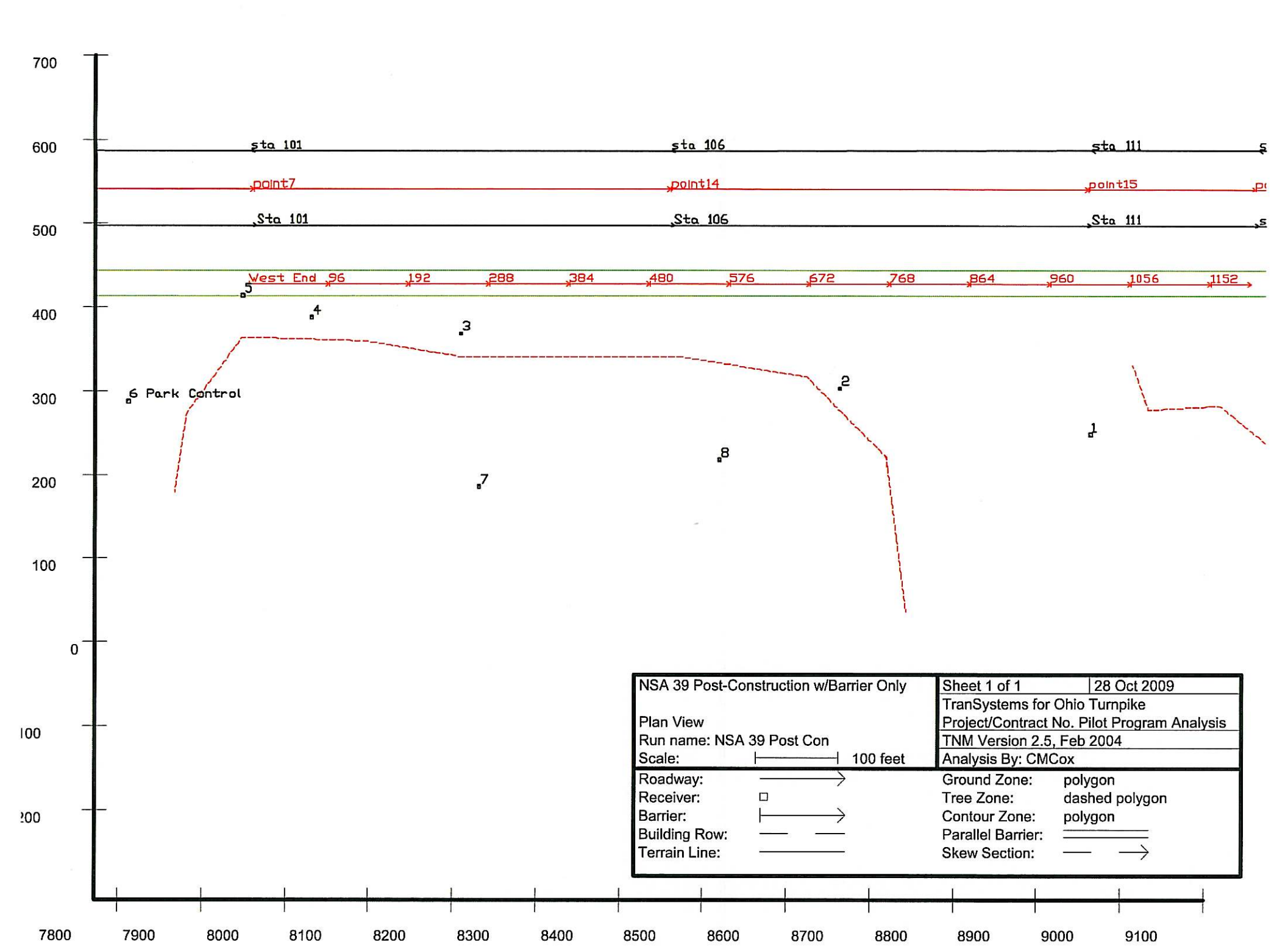
28 October 2009
TNM 2.5
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: Pilot Program Analysis
RUN: NSA 39 Pre-Construction Monitoring
BARRIER DESIGN: INPUT HEIGHTS
ATMOSPHERICS: 68 deg F, 50% RH

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Goal	Calculated minus Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
1	24	1	0.0	64.5	66	64.5	10	----	64.5	0.0	8	-8.0
2	25	1	0.0	69.6	66	69.6	10	Snd Lvl	69.6	0.0	8	-8.0
3	26	1	0.0	72.2	66	72.2	10	Snd Lvl	72.2	0.0	8	-8.0
4 and 5	27	1	0.0	73.6	66	73.6	10	Snd Lvl	73.6	0.0	8	-8.0
6	29	1	0.0	69.3	66	69.3	10	Snd Lvl	69.3	0.0	8	-8.0
7	30	1	0.0	59.8	66	59.8	10	----	59.8	0.0	8	-8.0
8	31	1	0.0	60.4	66	60.4	10	----	60.4	0.0	8	-8.0

Dwelling Units	# DUs	Noise Reduction Min	Avg	Max
		dB	dB	dB
All Selected	7	0.0	0.0	0.0
All Impacted	4	0.0	0.0	0.0
All that meet NR Goal	0	0.0	0.0	0.0


700
600
500
400
300
200
100
0
100
200
sta 101
sta 106
sta 111
point7
point14
point15
Sta 101
Sta 106
Sta 111
West End
96
192
288
384
480
576
672
768
864
960
1056
1152
1
2
3
4
5
6 Park Control
7
8
7800
7900
8000
8100
8200
8300
8400
8500
8600
8700
8800
8900
9000
9100
NSA 39 Post-Construction w/Barrier Only
Plan View
Run name: NSA 39 Post Con
Scale: 100 feet
Sheet 1 of 1
28 Oct 2009
TranSystems for Ohio Turnpike
Project/Contract No. Pilot Program Analysis
TNM Version 2.5, Feb 2004
Analysis By: CMCox
Roadway:
Receiver:
Barrier:
Building Row:
Terrain Line:
Ground Zone: polygon
Tree Zone: dashed polygon
Contour Zone: polygon
Parallel Barrier:
Skew Section:

TranSystems for Ohio Turnpike
CMCox

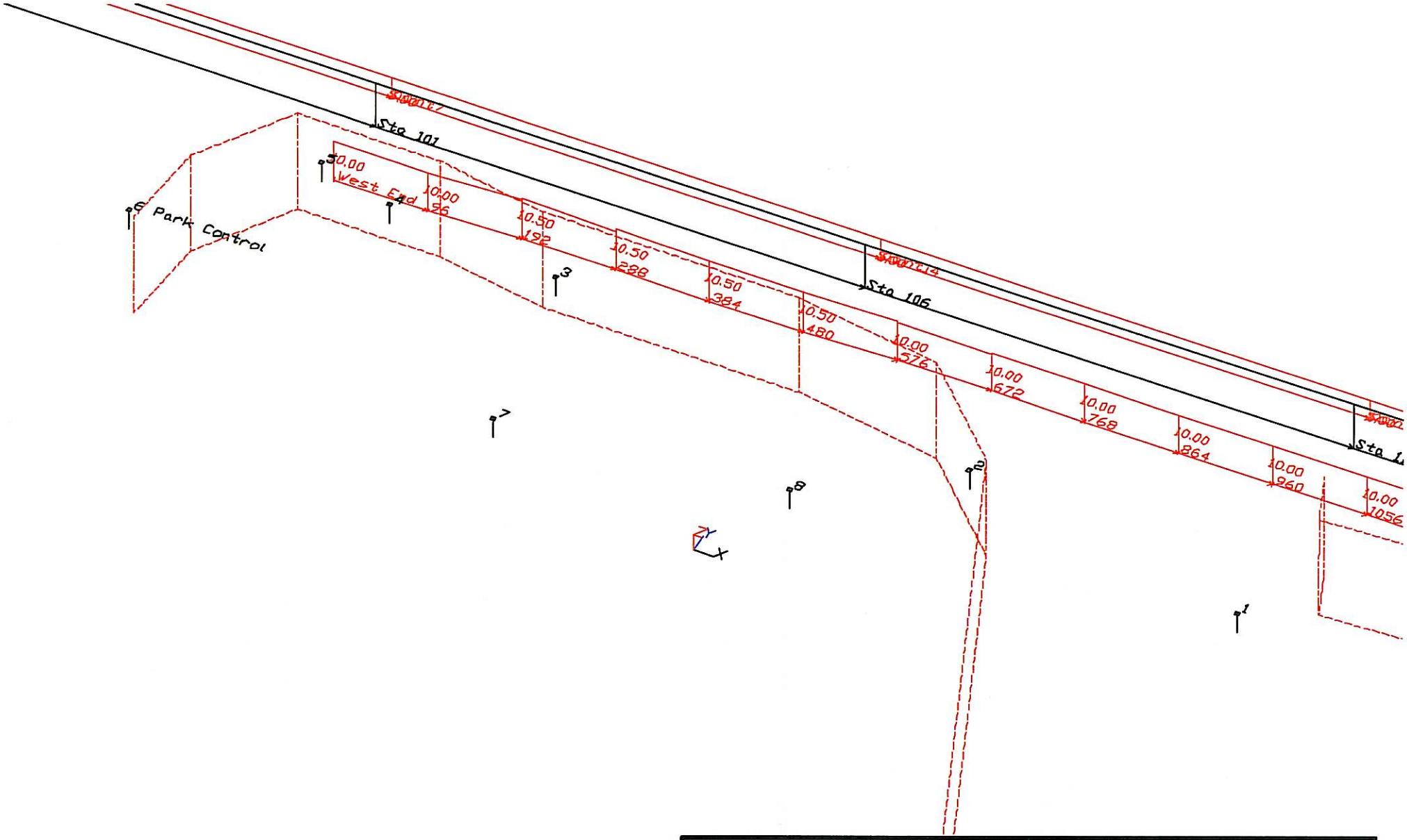
28 October 2009
TNM 2.5
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: Pilot Program Analysis
RUN: NSA 39 Post-Construction w/Barrier Only
BARRIER DESIGN: INPUT HEIGHTS
ATMOSPHERICS: 68 deg F, 50% RH

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier					With Barrier			
				LAeq1h		Increase over existing		Type Impact	Calculated LAeq1h	Noise Reduction		
				Calculated	Crit'n	Calculated	Crit'n Sub'l Inc			Calculated	Goal	Calculated minus Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
1	24	1	64.5	64.8	66	0.3	10	----	63.5	1.3	8	-6.7
2	25	1	69.6	69.7	66	0.1	10	Snd Lvl	65.9	3.8	8	-4.2
3	26	1	72.2	72.1	66	-0.1	10	Snd Lvl	67.6	4.5	8	-3.5
5	27	1	73.6	74.2	66	0.6	10	Snd Lvl	72.8	1.4	8	-6.6
6 Park Control	29	1	69.3	69.3	66	0.0	10	Snd Lvl	69.0	0.3	8	-7.7
7	30	1	59.8	59.6	66	-0.2	10	----	59.8	-0.2	8	-8.2
8	31	1	60.4	60.5	66	0.1	10	----	59.5	1.0	8	-7.0
4	34	1	73.6	72.9	66	-0.7	10	Snd Lvl	69.0	3.9	8	-4.1

Dwelling Units	# DUs	Noise Reduction		
		Min	Avg	Max
		dB	dB	dB
All Selected	8	-0.2	2.0	4.5
All Impacted	5	0.3	2.8	4.5
All that meet NR Goal	0	0.0	0.0	0.0



NSA 39 Post-Construction w/Barrier Only		Sheet 1 of 1	28 Oct 2009
		TranSystems for Ohio Turnpike	
Barrier View-10.14 feet		Project/Contract No. Pilot Program Analysis	
Run name: NSA 39 Post Con		TNM Version 2.5, Feb 2004	
Scale: <DNA - due to perspective>		Analysis By: CMCox	
Roadway:	——→	Ground Zone:	polygon
Receiver:	□	Tree Zone:	dashed polygon
Barrier:	⊢——→	Contour Zone:	polygon
Building Row:	— —	Parallel Barrier:	═══
Terrain Line:	———	Skew Section:	—→

TranSystems for Ohio Turnpike
CMCox

28 October 2009
TNM 2.5
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: Pilot Program Analysis
RUN: NSA 39 Post-Construction w/Barrier Only
BARRIER DESIGN: 10.14 feet
ATMOSPHERICS: 68 deg F, 50% RH

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	No Barrier LAeq1h Crit'n	Increase over existing Calculated	Increase over existing Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	With Barrier Noise Reduction Calculated	With Barrier Noise Reduction Goal	With Barrier Noise Reduction Calculated minus Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
1	24	1	64.5	64.8	66	0.3	10	----	61.7	3.1	8	-4.9
2	25	1	69.6	69.7	66	0.1	10	Snd Lvl	63.4	6.3	8	-1.7
3	26	1	72.2	72.1	66	-0.1	10	Snd Lvl	64.7	7.4	8	-0.6
5	27	1	73.6	74.2	66	0.6	10	Snd Lvl	72.7	1.5	8	-6.5
6 Park Control	29	1	69.3	69.3	66	0.0	10	Snd Lvl	68.9	0.4	8	-7.6
7	30	1	59.8	59.6	66	-0.2	10	----	59.5	0.1	8	-7.9
8	31	1	60.4	60.5	66	0.1	10	----	58.7	1.8	8	-6.2
4	34	1	73.6	72.9	66	-0.7	10	Snd Lvl	67.0	5.9	8	-2.1

Dwelling Units	# DUs	Noise Reduction Min	Noise Reduction Avg	Noise Reduction Max
		dB	dB	dB
All Selected	8	0.1	3.3	7.4
All Impacted	5	0.4	4.3	7.4
All that meet NR Goal	0	0.0	0.0	0.0

TranSystems for Ohio Turnpike 28 October 2009
CMCox TNM 2.5

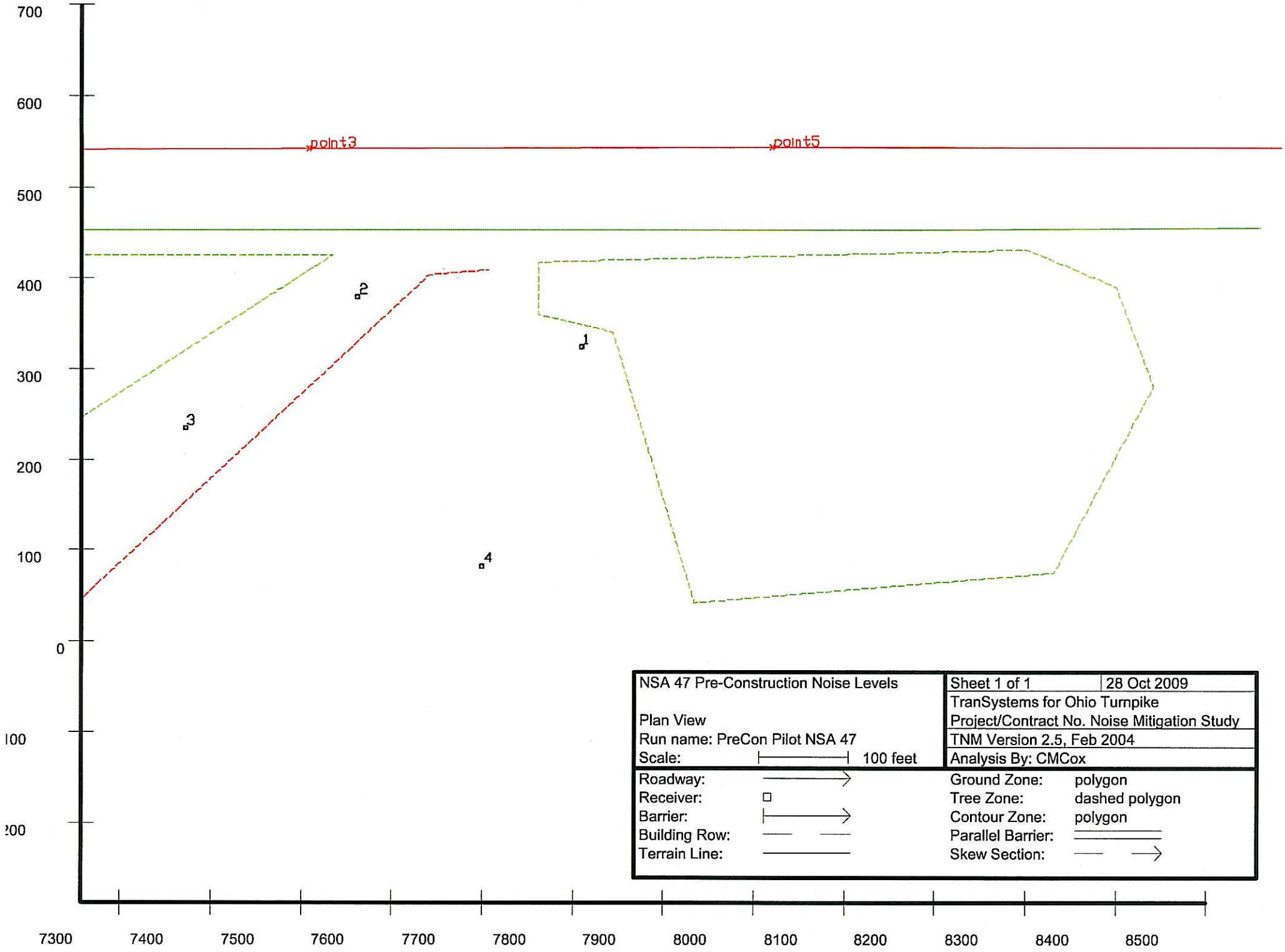
RESULTS: BARRIER DESCRIPTIONS
PROJECT/CONTRACT: Pilot Program Analysis
RUN: NSA 39 Post-Construction w/Barrier Only
BARRIER DESIGN: 10.14 feet

Barriers

Name	Type	Heights along Barrier			Length	If Wall	If Berm			Cost
		Min	Avg	Max		Area	Volume	Top Width	Run:Rise	
		ft	ft	ft	ft	sq ft	cu yd	ft	ft:ft	$
"T"-Top Barrier	W	9.50	10.14	10.50	1200	12170				0
Barrier1	W	5.00	5.00	5.00	4600	23001				0
									Total Cost:	0

APPENDIX E

TNM Model Results
Median-Mounted Acoustic Panels


700
600
500
400
300
200
100
0
100
200
point3
point5
R2
R1
R3
R4
7300
7400
7500
7600
7700
7800
7900
8000
8100
8200
8300
8400
8500
NSA 47 Pre-Construction Noise Levels
Plan View
Run name: PreCon Pilot NSA 47
Scale: 100 feet
Sheet 1 of 1
28 Oct 2009
TranSystems for Ohio Turnpike
Project/Contract No. Noise Mitigation Study
TNM Version 2.5, Feb 2004
Analysis By: CMCox
Roadway:
Receiver:
Barrier:
Building Row:
Terrain Line:
Ground Zone: polygon
Tree Zone: dashed polygon
Contour Zone: polygon
Parallel Barrier:
Skew Section:

TranSystems for Ohio Turnpike
CMCox

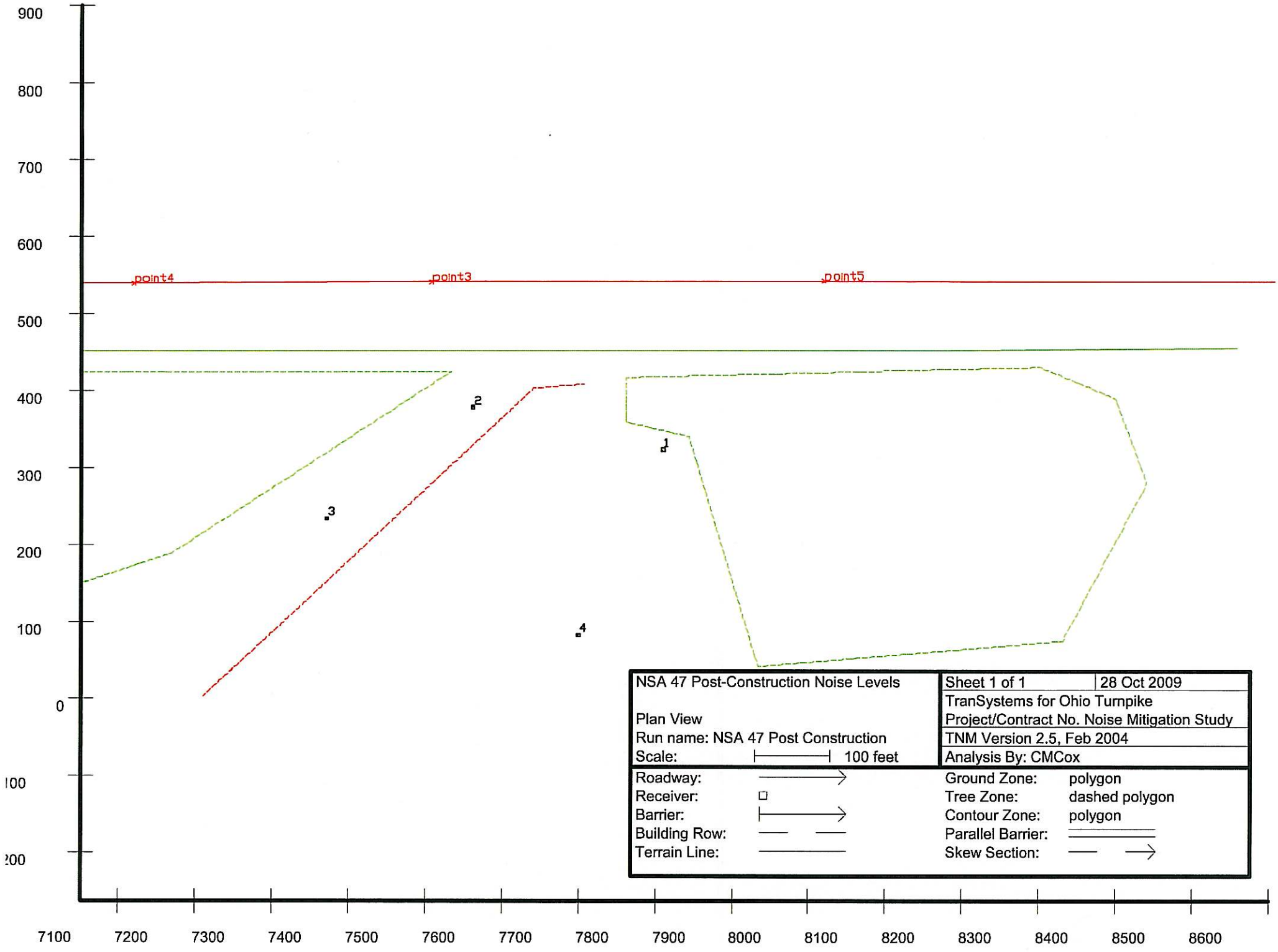
28 October 2009
TNM 2.5
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: Noise Mitigation Study
RUN: NSA 47 Pre-Construction Noise Levels
BARRIER DESIGN: INPUT HEIGHTS
ATMOSPHERICS: 68 deg F, 50% RH

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Goal	Calculated minus Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
1	24	1	0.0	69.5	66	69.5	10	Snd Lvl	69.5	0.0	8	-8.0
2	25	1	0.0	71.7	66	71.7	10	Snd Lvl	71.7	0.0	8	-8.0
3	26	1	0.0	65.3	66	65.3	10	---	65.3	0.0	8	-8.0
4	27	1	0.0	60.5	66	60.5	10	----	60.5	0.0	8	-8.0

Dwelling Units	# DUs	Noise Reduction Min	Avg	Max
		dB	dB	dB
All Selected	4	0.0	0.0	0.0
All Impacted	2	0.0	0.0	0.0
All that meet NR Goal	0	0.0	0.0	0.0


900
800
700
600
500
400
300
200
100
0
100
200
point4
point3
point5
1
2
3
4
7100
7200
7300
7400
7500
7600
7700
7800
7900
8000
8100
8200
8300
8400
8500
8600
NSA 47 Post-Construction Noise Levels
Plan View
Run name: NSA 47 Post Construction
Scale: 100 feet
Sheet 1 of 1
28 Oct 2009
TranSystems for Ohio Turnpike
Project/Contract No. Noise Mitigation Study
TNM Version 2.5, Feb 2004
Analysis By: CMCox
Roadway:
Receiver:
Barrier:
Building Row:
Terrain Line:
Ground Zone: polygon
Tree Zone: dashed polygon
Contour Zone: polygon
Parallel Barrier:
Skew Section:

TranSystems for Ohio Turnpike
CMCox

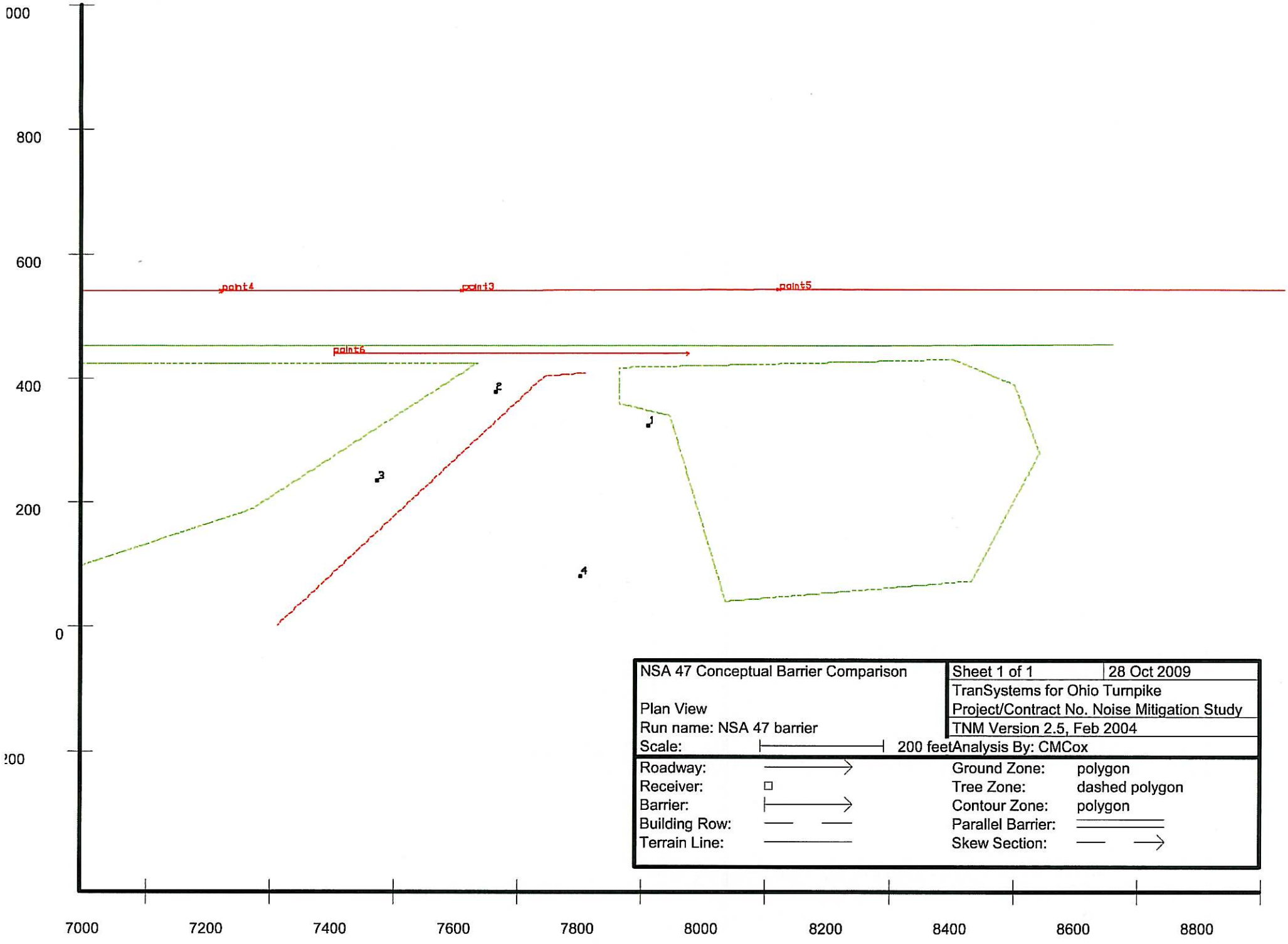
28 October 2009
TNM 2.5
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: Noise Mitigation Study
RUN: NSA 47 Post-Construction Noise Levels
BARRIER DESIGN: INPUT HEIGHTS
ATMOSPHERICS: 68 deg F, 50% RH

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	No Barrier LAeq1h Crit'n	Increase over existing Calculated	Increase over existing Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Noise Reduction Goal	Calculated minus Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
1	24	1	0.0	69.4	66	69.4	10	Snd Lvl	69.4	0.0	8	-8.0
2	25	1	0.0	71.5	66	71.5	10	Snd Lvl	71.5	0.0	8	-8.0
3	26	1	0.0	65.2	66	65.2	10	----	65.2	0.0	8	-8.0
4	27	1	0.0	60.5	66	60.5	10	----	60.5	0.0	8	-8.0

Dwelling Units	# DUs	Noise Reduction Min	Noise Reduction Avg	Noise Reduction Max
		dB	dB	dB
All Selected	4	0.0	0.0	0.0
All Impacted	2	0.0	0.0	0.0
All that meet NR Goal	0	0.0	0.0	0.0


000
800
600
400
200
0
200
point4
point3
point5
point6
2
1
3
4
7000
7200
7400
7600
7800
8000
8200
8400
8600
8800
NSA 47 Conceptual Barrier Comparison
Plan View
Run name: NSA 47 barrier
Scale: 200 feet
Sheet 1 of 1
28 Oct 2009
TranSystems for Ohio Turnpike
Project/Contract No. Noise Mitigation Study
TNM Version 2.5, Feb 2004
Analysis By: CMCox
Roadway:
Receiver:
Barrier:
Building Row:
Terrain Line:
Ground Zone: polygon
Tree Zone: dashed polygon
Contour Zone: polygon
Parallel Barrier:
Skew Section:

TranSystems for Ohio Turnpike
CMCox

28 October 2009
TNM 2.5
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: Noise Mitigation Study
RUN: NSA 47 Conceptual Barrier Comparison
BARRIER DESIGN: INPUT HEIGHTS
ATMOSPHERICS: 68 deg F, 50% RH

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Goal	Calculated minus Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
1	24	1	0.0	69.5	66	69.5	10	Snd Lvl	65.6	3.9	8	-4.1
2	25	1	0.0	71.7	66	71.7	10	Snd Lvl	62.7	9.0	8	1.0
3	26	1	0.0	65.3	66	65.3	10	----	61.9	3.4	8	-4.6
4	27	1	0.0	60.5	66	60.5	10	----	58.7	1.8	8	-6.2

Dwelling Units	# DUs	Noise Reduction Min	Avg	Max
		dB	dB	dB
All Selected	4	1.8	4.5	9.0
All Impacted	2	3.9	6.4	9.0
All that meet NR Goal	1	9.0	9.0	9.0

Ohio Turnpike Commission

TranSystems

Pilot Program Summary Report

Ohio Turnpike Commission

Contract No. 71-08-02

55 Public Square, Suite 1900

Cleveland, OH 44113-1901

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