Ocean Concrete LLC, Concrete Batch Plant
Old Dixie Highway
Indian River County, Florida

Preliminary Baseline Sound Level Study Report

Prepared for:

Ocean Concrete L.L.C.
P.O. Box 338
Jensen Beach, Florida

Prepared by:

Grove Scientific & Engineering Company
Mr. Dart Morales, principal scientist
6140 Edgewater Drive, Suite F
Orlando, Florida 32810

Project # 218000
November 2007

www.grovescientific.com

GROVE
SCIENTIFIC & ENGINEERING

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

LIST OF TABLES

LIST OF FIGURES

APPENDICES

SECTION 1
INTRODUCTION

1.0 Introduction

Grove Scientific and Engineering Company (GSE) was contracted by Ocean Concrete, LLC to preform a preliminary ambient sound level study to evaluate the potential impact of sound emanating from a proposed Ocean Concrete, LLC concrete batch plant. This property to be developed is found at 11085 Old Dixie Highway, Sebastian, Florida 32958. Mr. Dart Morales, principal scientist of GSE conducted the sound level study and prepared this report.

Mr. Morales received his Bachelor of Science in Biological Science from Florida Institute of Technology in 1979. Since then he has specialized in the field of multimedia environmental science. He has approximately 20 years of community noise and industrial hygiene sound level measurement experience. Mr. Morales is certified by the Florida Department of Transportation and Orange County, Florida to conduct noise impact studies. Sample projects include predictive impact studies for WCPX Channel Six, employee and community sound exposures for Florida Hospital, authorship of the Brevard County Noise Ordinance, and warranty testing for the Stock Island Municipal Power Plant General Electric Turbine. Mr. Morales consults for five concrete manufacturers on environmental issues specifically related to this industry.

1.1 Purpose of the Study

The purpose of this study was to develop baseline, preconstruction estimates of potential sound levels at the property line. The estimated sound levels were in turn to be used to determine if the compliance limits of Title IX Land Development Code, Chapter 974. Noise and Vibration Control, Section 974.05, of the Indian River County Code of Ordinances would be met.

1.2 Technical Approach

An on-site simulation of a concrete mixer mixing a batch of concrete was performed at the site. Measurements were made at various distances. The results were used to prepare a graph of sound intensity versus distance from the source. The resulting slope was used to map predictive sound levels over a site plan of the proposed facility.

SECTION TWO
SITE DESCRIPTION

2.0 Existing Site Conditions

Grove Scientific and Engineering (GSE) first visited the site on April 10, 2007. Mr. Dart Morales, senior scientist for GSE met with Mr. George Maib of Ocean Concrete, LLC and Mr. Todd Smith, Professional Engineer, the site development engineer. The site is an undeveloped, right triangle-shaped parcel. The hypotenuse (east side) is bounded by the Florida East Coast Railway, and Old Dixie Highway, the remaining sides (west and south) are undeveloped land. Access is from Old Dixie Highway at the north point. Zoning is agricultural/residential along all of the west perimeter and for approximately half the southern perimeter. The remaining zoning is a combination of commercial and industrial. Street location maps are provided in Appendix A. An aerial view is provided in Figure One, below.

Ambient conditions on the sample day were calm, cool, and dry. Ground level winds were calm and variable (less than 3 mph) primarily from the north. The temperature was approximately 78 degrees Fahrenheit. The sky was mostly clear with occasional scattered clouds.

Figure One
Ocean Concrete Aerial

2.1 Current Site Sound Field

The current community sound field can be described as 'suburban'. While the actual property and most of its surroundings are undeveloped, the property receives audible impacts from Old Dixie Highway traffic, U.S. Highway 1 traffic, railway traffic, and local air traffic. We did not do ambient monitoring but our experience with similar landscapes in the area, and data from the farthest measurement collected on that day suggest daytime ambient levels are around the 52 to 55 dBA range. Rail traffic is the most extreme recurring sound impact. Locomotive passage can raise levels into the ninety-plus range at a couple of a hundred feet. The passing railcars can produce levels in the high sixties at the same distance.

2.2 Typical Concrete Batch Plant Sound Fields

Concrete batch plant sounds consist mainly of a continuous blend of electric motors, running conveyor belts, occasional actuator impacts, and the 'swoosh' of materials falling into hoppers during a batch cycle. Plants containing fugitive dust collectors also add fan noise during the batch cycle. Other sounds associated with a concrete plant operation include; the front-end loader to move the materials, the swoosh of material entering the loading hopper, and the concrete mixer trucks revving their engines at the batch shack, slump rack, and washout pit.

During the batching process the drum on a mixer truck is filled with measured amounts of water and sand, limerock, and cement are dropped into the drum. While batching the trucks are stationary, however, their engines are revved to provide power to rapidly circulate the mixer drum. Revving the motor while stationary causes the engine coolant fans to start running to prevent the engine from overheating. This revving also occurs at the slump racks and the washout pits.

Modern plants with shielding and operated in good condition are not loud beyond a several yards of distance. Most of the many sounds emanated from the actual plant and hoppers are not very powerful. There may be individual exceptions, but the most powerful noise produced at a batch plant is usually the revved stationary diesel engine of a mixer vehicle. By understanding and controlling the worst case condition, the remaining issues are usually within acceptable parameters. This is why we prepare a sound decay curve from an actual mixer simulating batching/slumping/washout activity. Using a site plan we can note where these stations are located, calculate impact at key points. From there we determine if mitigation may be required.

SECTION THREE
PREDICTIVE SOUND LEVEL METHODOLOGY

3.0 Predictive Sound Level Measurement Methodology

The decay of a point source of sound propagated in a free field follows an inverse square function. In the real world, the inverse square law is always an idealization because it assumes exactly equal sound propagation in all directions. Nevertheless, the inverse square law is the logical first estimate to predict the sound level at a distant point in an open area. Another method is to measure the source of emanated sound over several distances and plot this value to find a slope for an actual source and location. For this study we collected field data using an actual mixer vehicle revved up to simulate batching /slumping activity. Measurements were collected at doubled distances until we reached ten times the original distance.

Sound level measurements were collected with an ANSI/MSI compliant Metrosonics dB 308 dosimeter fitted with an omnidirectional microphone equipped with an open cell foam wind muff. A calibration was performed using a Metrosonics model CL304 ANSI compliant, 102 decibel calibrator. The meter was mounted on a camera tripod to elevate the microphone to a height of five feet above ground level. The meter was programmed to collect averaged sound levels (Lav) in decibels with an A- weighted filter network (a.k.a.. dBA) set to slow response, no cut offs, and at a 3 dBA exchange rate. The detector samples eight per second in the slow response mode The meter was programmed to average data at ten (10) second intervals. Because the event recorded was continuous, only a minute or so of recording was necessary to achieve an accurate representation.

The results of the sound level measurements were used to generate a distance attenuation curve. Because decibels are a logarithmic value, when they are plotted on semi-log paper they yield a "curve" depicted as a straight line equal to the slope of t he function. The resulting predictions of the "best fit" curve correlated well with the inverse square rule and with theoretical charts such as those found in *Transit Noise and Vibration Impact, U.S. Department of Transportation, April 1995.* The sound level meter data graphs and the attenuation curve plot are copied in Appendix B. Table One below tabulates the observations versus the theoretical plot.

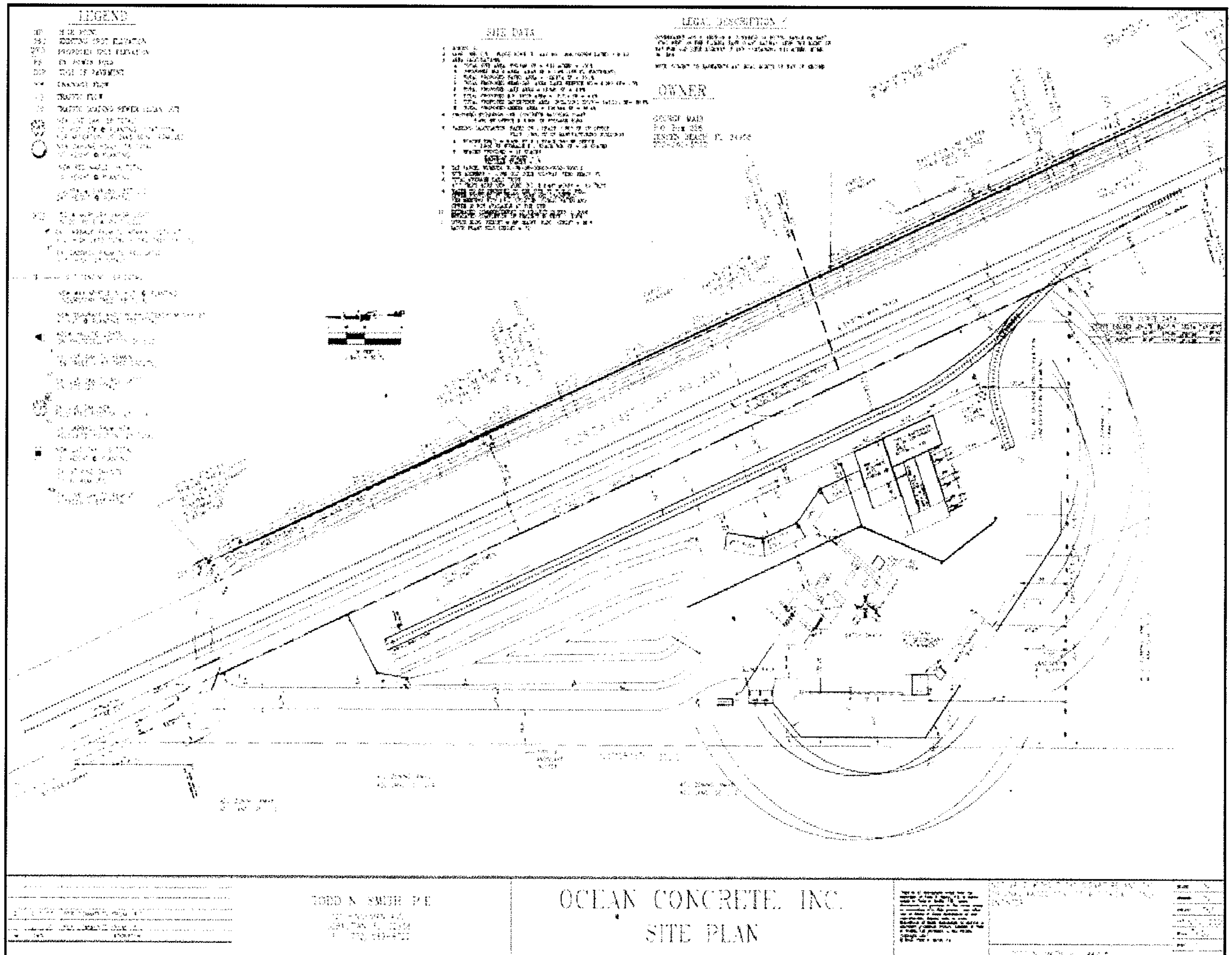
Table One
Sound Level versus Distance for a Batching Mixer

Distance From Batching Mixer Vehicle	Inverse Square Rule (Lav dBA)	Measured Decay (Lav dBA)
20 feet from the front	84	83.8
40 feet from the front	78	79.2
80 feet from the front	72	73.0
160 feet from the front	66	66.4
220 feet from the front	60	61.0
50 feet from the side	72	71.9
100 feet from the side	66	not measured
200 feet from the side	60	not measured
50 feet from behind	66	66.2
100 feet from behind	60	not measured
200 feet from behind	54	not measured

In order to determine uncontrolled property line compliant with the 60 dBA Ln_{50} Indian River County Daytime Maximum Permissible Daytime Sound Level for adjacent incompatible zoning (RM-6 residential zoning to the west and part of the south.) scaled arcs extending from the front of mixer vehicles at their work stations were plotted on a facility site plan. Green arcs represent the projected 60dBA Ln_{50} distance and red arcs for the 65 dBA line. Figure Two displays the facility site plan with arcs overlaid.

Figure Two indicates that approximately five hundred feet (out of approximately sixteen hundred total feet) of property line adjacent to the non-compatible residential zoning lies within the green 60 dBA arc. The red 65 dBA arc crosses approximately two hundred fifty feet of the property line within the green arc. The property line outside of the green arc is considered to be at low risk of significantly exceeding the 60 dBA . Areas inside the red arc are considered to be at high risk of exceeding 65 dBA Ln_{50}. Ocean Concrete desires to be a good neighbor and protect the adjacent non-compatible land use from non-compliant sound. Therefore, some form of sound mitigation will be needed to protect these segments of the property line interface from non-compliant sound.

Figure Two
Site Plan with Estimated Compliance Arcs



SECTION FOUR
PROPOSED MITIGATION STRATEGY

4.0 Design Features Proposed for Sound Mitigation

Numerous techniques are available to mitigate sounds from concrete batch plants, some are operational, some administrative, and are designed into the equipment. Since many of these are developed to address a specific need, an unanticipated problem, or are otherwise highly site specific, they will not all be discussed in this report. This report addresses structural designs which mitigate broad areas of otherwise difficult to control sound. There is simply not much technology available at this time to quiet a concrete mixer vehicle.

Major sound control design features of this site plan include; strategic site layout, an enclosed slump station, dense landscape buffers, and reflective sound barrier walls. The design site plan was prepared with a slump station enclosed by a solid cube enclosure on four sides (three walls and a roof) and wing walls directing sound away from the non-compatible property line

4.1 Strategic Layout

Where possible, the location of buildings and work stations were selected to reduce impacts to the residential zoning adjoining the west side. The site features a railway raw material supply station. Railcars can deliver more material per trip than trucks or tankers. Rail delivery significantly reduces the need for trunk and tanker delivery which in turn reduces surface road traffic throughout the entire community. It also reduces overall site generated sound because tankers must rev their engines to pressurize the tanker. The railway hopper is along a highway, in a compatible zoning area. The washout area, material storage bins, load hopper, and concrete blower station (pressurizes the rail tanker) are all located as far from the non-compatible zoning as practical. The plant entrance is at the north apex of the triangular plot, this northen area is utilized only for entry/egress and stormwater management (pond).

4.2 Sound Barriers

When source control options are limited ,sound barriers are an effective way to mitigate property line sound emanation. Because there is little that can be done to reduce mixer vehicle sound, and because mixer vehicles on-station are the most objectionable sound source, structural mitigation of some sort will be required. The site plan includes the use of reflective sound barrier walls to mitigate property lines located inside the 60 dBA which abut a non-compatible land use.

4.2.1 Theory and assumptions

For most conditions, the minimum insertion loss for a line-of sight reflective barrier wall is approximately 5 dBA, a practical maximum is 15 decibels. A reflective sound barrier system between the 65 dBA arc and the sound source should result in a 60 dBA or lower value at the property line beyond the 65 dBA arc.

The performance of a sound barrier was evaluated by drawing transects from the key source locations to the property line and calculating the corresponding property line predictive value. Certain assumptions were necessary for the calculations:

a) The obvious first assumption are that the elevation of the source and receiver will be below the wall elevation. The barrier's efficacy is based on breaking the line-of- sight propagation. The effect is quite dramatic. The efficacy drops if either height differential diminishes, or improves as it increases. We assumed a minimum five (5) foot height differential for both source and receiver. By using a height differential we can account for grade differences rather than specifying a single barrier height (i.e. a four foot concrete wall on a four foot above-grade earthen berm grade is equal to an eight foot wall at level grade).

b) We did not include additional insertion losses or reflection paths (equivalent to free field propagation over a hard surface) . In practice, there will be reflective surfaces and absorptive surfaces involved.

c) We assumed the slump rack station, being enclosed on three sides and a roof, would radiate most its energy away from the western property line. In addition, the slump rack building will act as a sound barrier wall of greater than five foot height differential. The same assumption holds for the eighty foot long maintenance building.

d) We did not adjust for off-axis sound level decay as the angle to the mixer vehicle deviates from forward emanation, in-line with the engine compartment.

4.2.2 Estimated Barrier Insertion Loss

Six transects were designated and analyzed as key descriptors of the barrier placement dynamics. These transects were analyzed according to formulas presented in page 6-24 of *Transit Noise and Vibration Impact, U.S. Department of Transportation, April 1995*. The transects are described below. Each transects analyzes potential sound emanations from a revved mixer vehicle. A mixer vehicle either backs up (rear loader) or pulls up (front loader) to the plant and revs its motor to provide for rapid rotation of the mixer drum. The maximum sound is generated from the engine compartment forward. Sound generated from a direction 90 degrees from the front of the compartment drops by approximately six decibels. Sound generation in a direction 180 degrees from the front of the compartment drops by approximately twelve decibels. Table Two tabulates the transect analysis results. The calculation work sheet is copied in Appendix C.

Transect One (T-1) is the first free-field, line-of- sight propagation line to the mixing plant. There is sufficient distance that a barrier is not anticipate. The property line intersection point is outside the green arc.

Transect Two (T-2) represents the line of maximum propagation from a batching source in the primary batching position to a non-compatible property line. The transect property line intersection point is inside the green arc and marginally outside the red arc.

Transect Three (T-3) represents the shortest propagation distance from a batching source to a non-compatible property line. The transect property line intersection point is inside the green arc and the red arcs. It is at the approximate center of the 65 dBA arcs from the primary. It is also equivalent to the shortest propagation distance to from a batching source to a non-compatible property line.

Transect Four (T-4) represents the line of maximum propagation from a batching source located at the secondary batching position into a non-compatible property line. The line representing the shortest propagation distance to from a batching source at the secondary batching position to a non-compatible property line is equivalent in geometry to transect three. The transect property line intersection point is outside the green arc and the red arc.

Transect Five (T-5) is the shortest propagation distance from a mixer vehicle washing out its mixer drum and the non-compatible property line. The transect property line intersection point is inside the green arc and the red arc.

Transect six (T-6) is the shortest propagation distance from a vehicle washing out its mixer drum and the end of the south sound barrier wall. The property line at this transect is a compatible use. However, for better protection of the residential zoning to the southwest, the sound barrier wall extends approximately seventy five feet east past the end of the non-compatible zoning line.

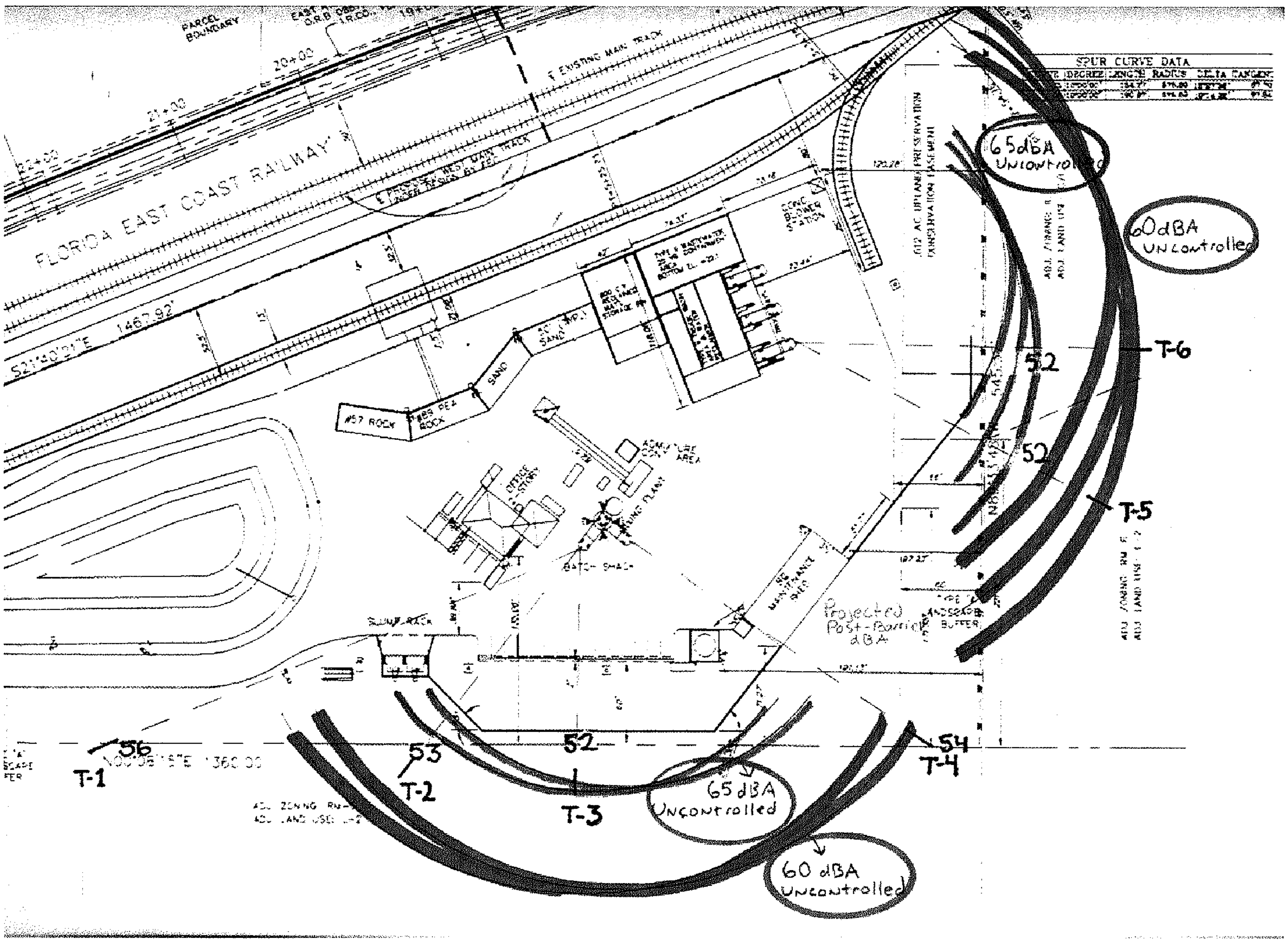
Table Two
Transect Analysis Summary

Transect Number	Inside Distance (feet)	Outside Distance (feet)	Pre-mitigation Estimated Lav dBA	Estimated Barrier Attenuation (dBA)	Post - mitigation Estimated Lav dBA
T-1	n/a	370	56	n/a	56
T-2	180	38	62	9	53
T-3	132	10	66	14	52
T-4	130	130	60	6	54
T-5	154	24	63	11	52
T-6	128	10	66	14	52

The transects and their post mitigation value are plotted on Figure Three - Transect Layout and Values.

Figure Three

Transect Layout and Values



SECTION FIVE
CONCLUSION

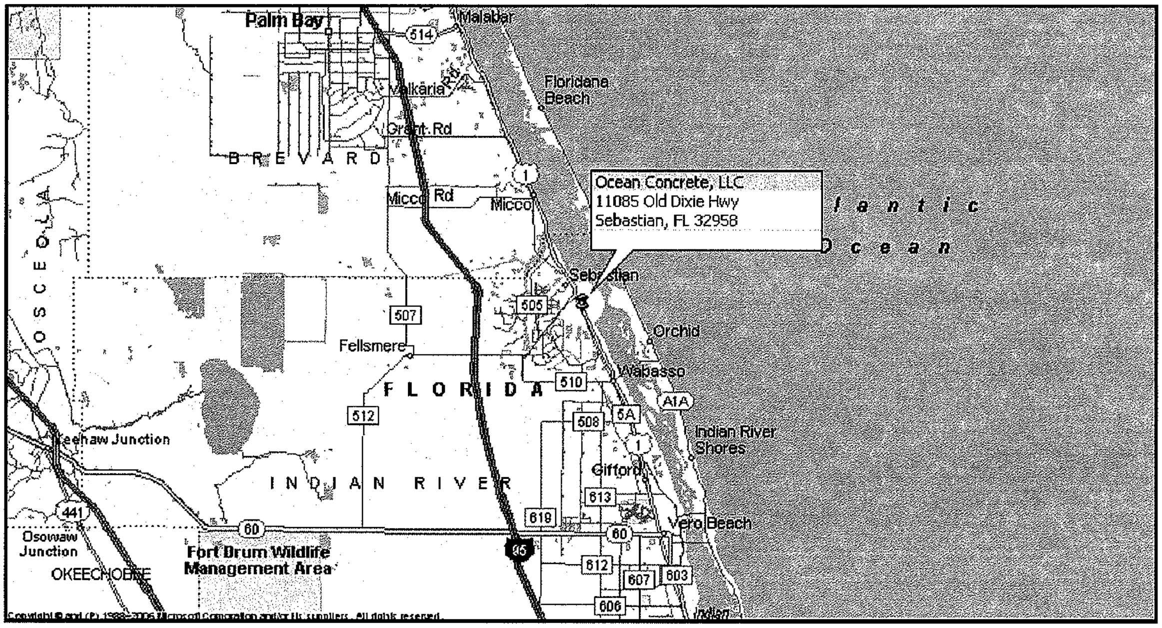
5.0 Conclusion

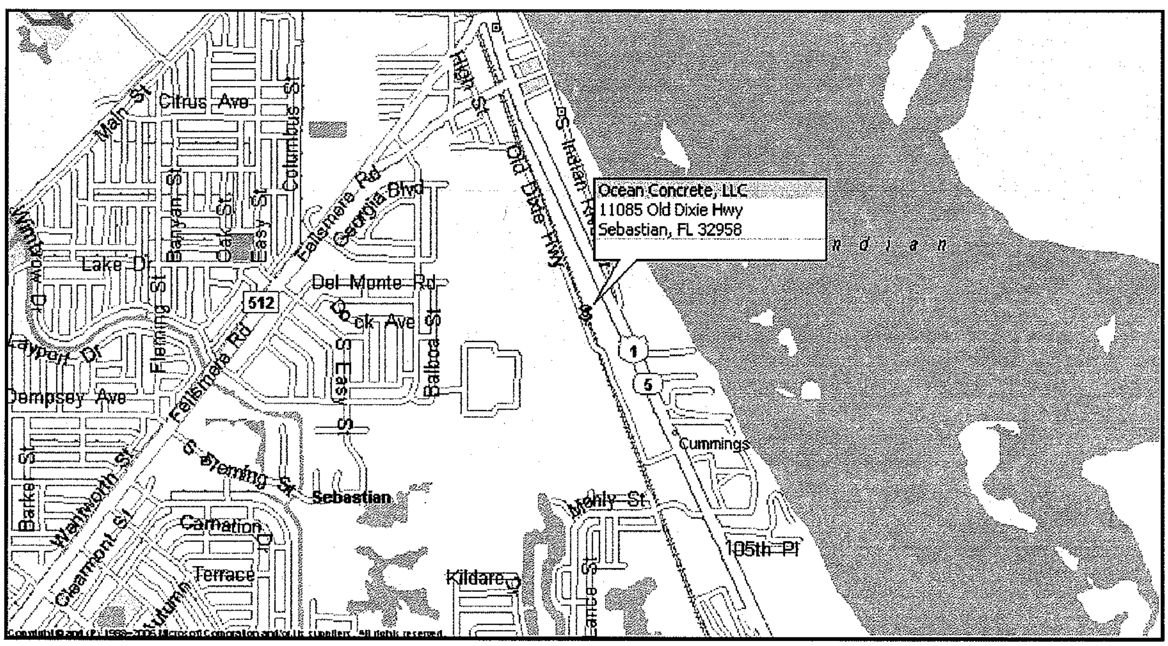
Based upon our measurements, observations, and calculations the proposed Ocean Concrete, LLC concrete batching facility will probably require mitigation in order not exceed the compliance limits of Title IX Land Development Code, Chapter 974. Noise and Vibration Control, Section 974.05, of the Indian River County Code of Ordinances. Ocean Concrete, LLC has proposed to include within the facility site plan, provision for erection of sound reflective barriers to control noise at key locations.

Our calculations support a sound reflective barrier providing a five foot height differential between the source-wall-receptor pathway as providing sufficient attenuation to protect the non-compatible land use property line at the 60dBA L_{n50} property line daytime maximum limit from Chapter 974. Noise and Vibration Control of the Indian River County Code of Ordinances.

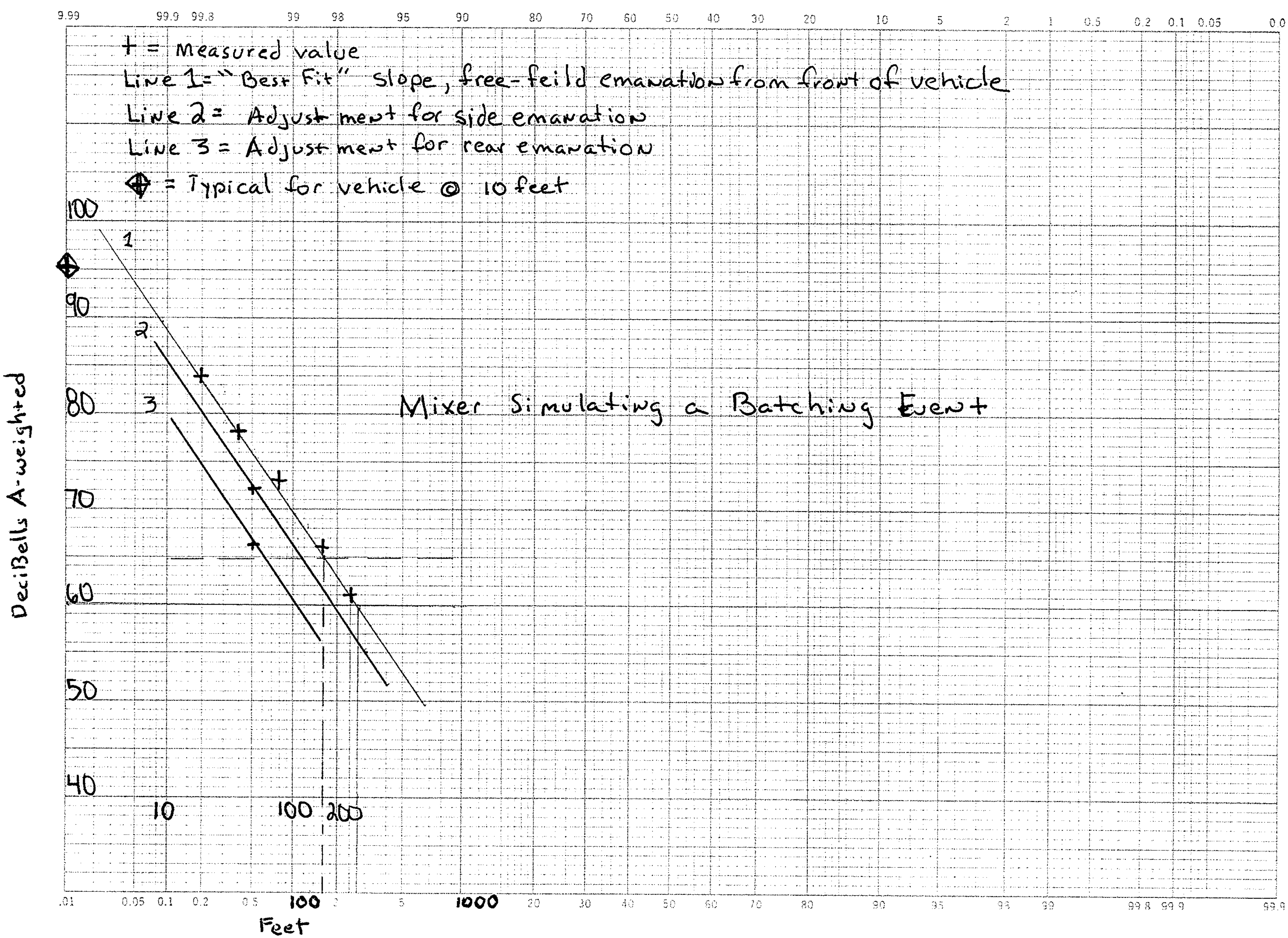
Appendix A
Street Location Maps

11085 Old Dixie Highway, Sebastian, Florida 32958

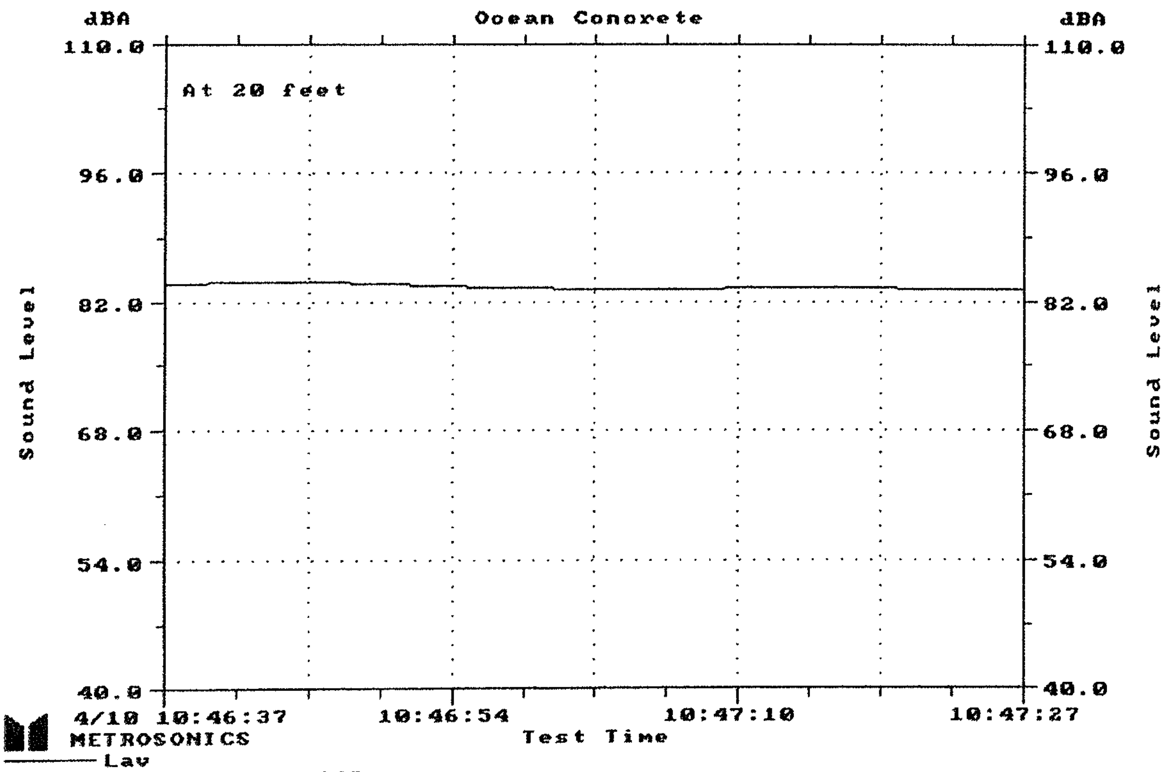




Appendix B
Attenuation Plot and Sound Level Meter Graphs

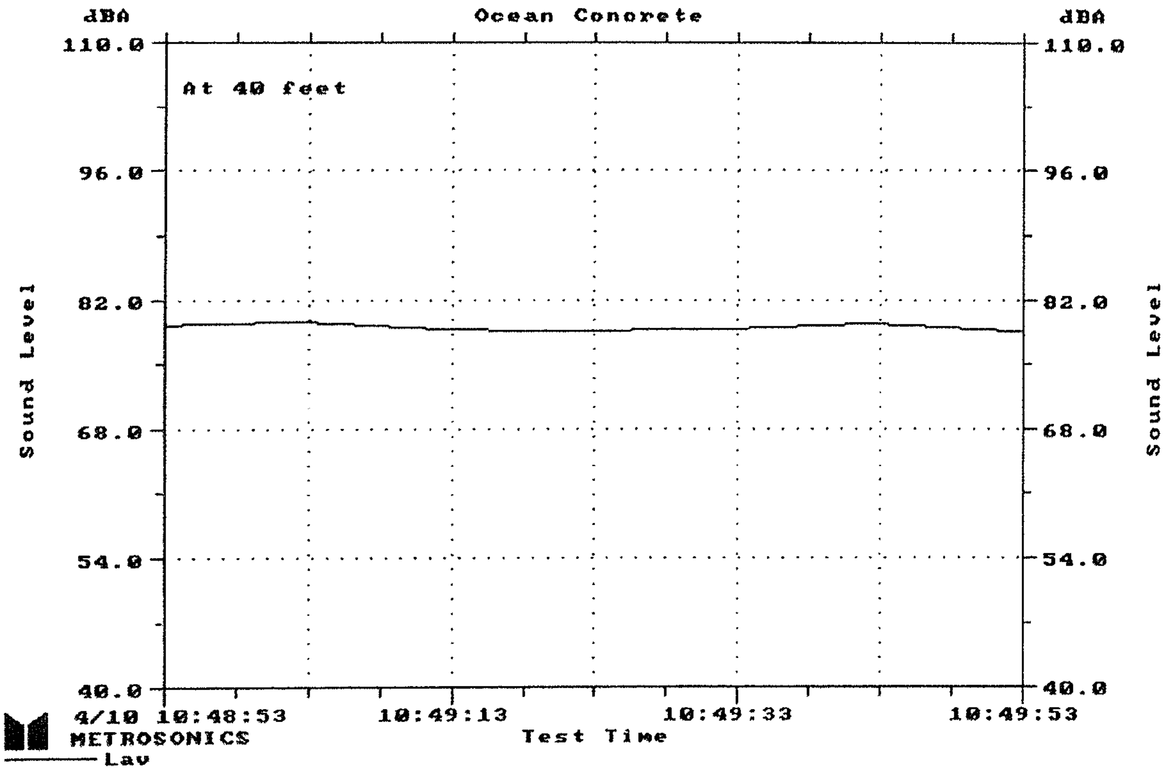

+ = Measured value
Line 1 = "Best Fit" slope, free-feild emanation from front of vehicle
Line 2 = Adjustment for side emanation
Line 3 = Adjustment for rear emanation
⊕ = Typical for vehicle @ 10 feet
Mixer Simulating a Batching Event
DeciBells A-weighted
Feet
100
90
80
70
60
50
40
10
100
200
1000
1
2
3

Filename.........bin71
Logger...........db-308   SN 2914
Test Location.....Ocean Concrete
Employee Name.....April 10, 2007
Employee Number...
Department........
Comment Field 1...Simulated batching
Comment Field 2...
Numeric Code #1...   #2...   #3...   #4...   #5...



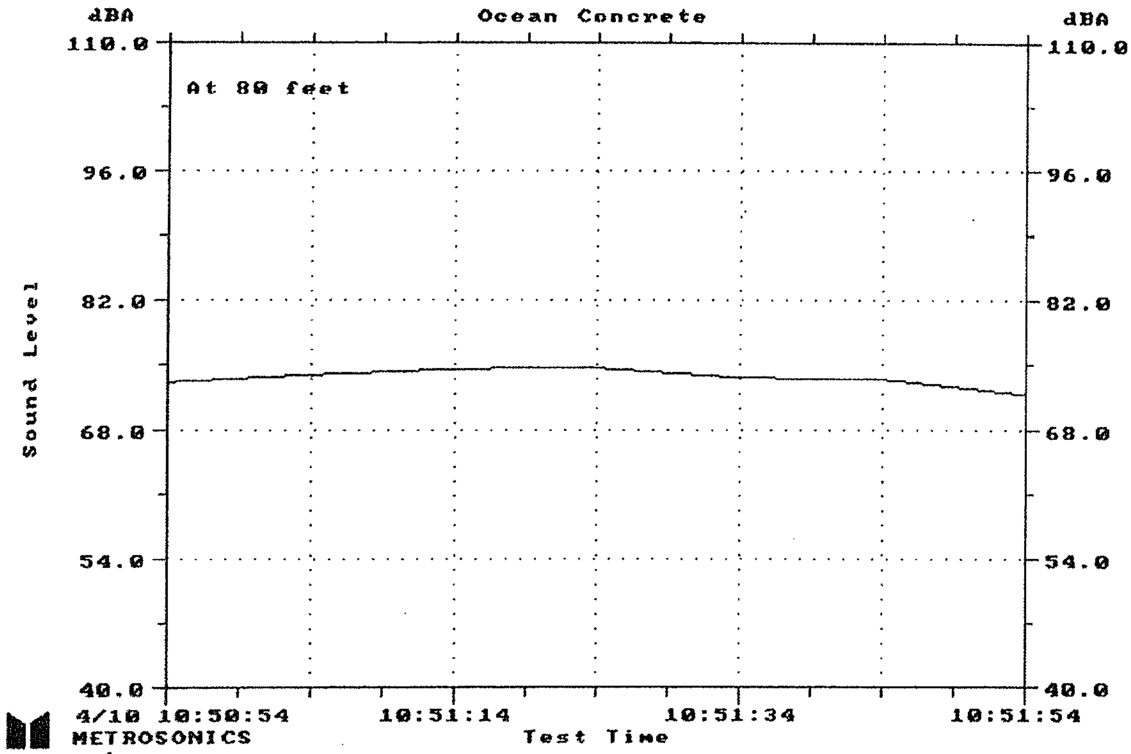
OVERALL: Lav= 83.8dB
SCAN LINE: 4/10/07 10:46:37   Lav=   84.0dB

Filename.........bin71
Logger...........db-308   SN 2914
Test Location.....Ocean Concrete
Employee Name.....April 10, 2007
Employee Number...
Department........
Comment Field 1...Simulated batching
Comment Field 2...
Numeric Code #1...   #2...   #3...   #4...   #5...



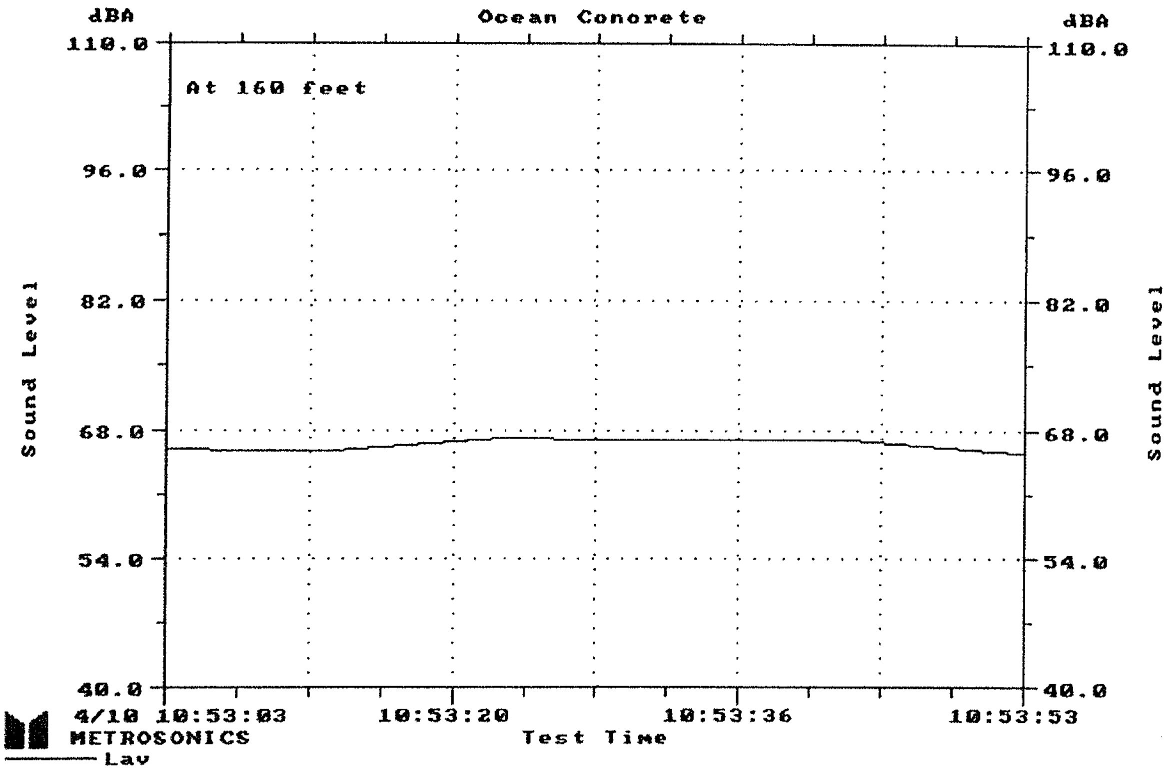
OVERALL: Lav= 79.0dB
SCAN LINE: 4/10/07 10:48:53 Lav= 79.2dB

Filename..........bin71
Logger...........db-308   SN 2914
Test Location.....Ocean Concrete
Employee Name.....April 10, 2007
Employee Number...
Department........
Comment Field 1...Simulated batching
Comment Field 2...
Numeric Code #1...   #2...   #3...   #4...   #5...



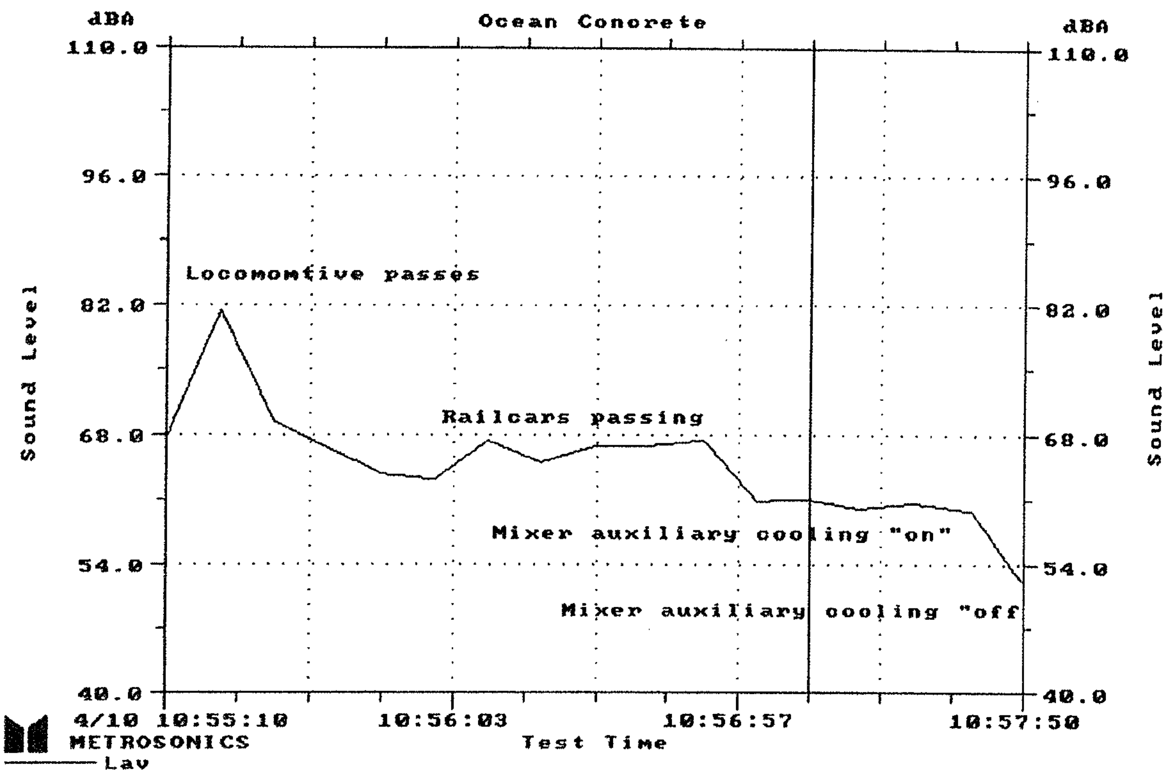
——— Lav
OVERALL: Lav= 73.8dB
SCAN LINE: 4/10/07 10:50:54   Lav=   73.1dB

Filename.........bin71
Logger...........db-308   SN 2914
Test Location.....Ocean Concrete
Employee Name.....April 10, 2007
Employee Number...
Department........
Comment Field 1...Simulated batching
Comment Field 2...
Numeric Code #1...   #2...   #3...   #4...   #5...



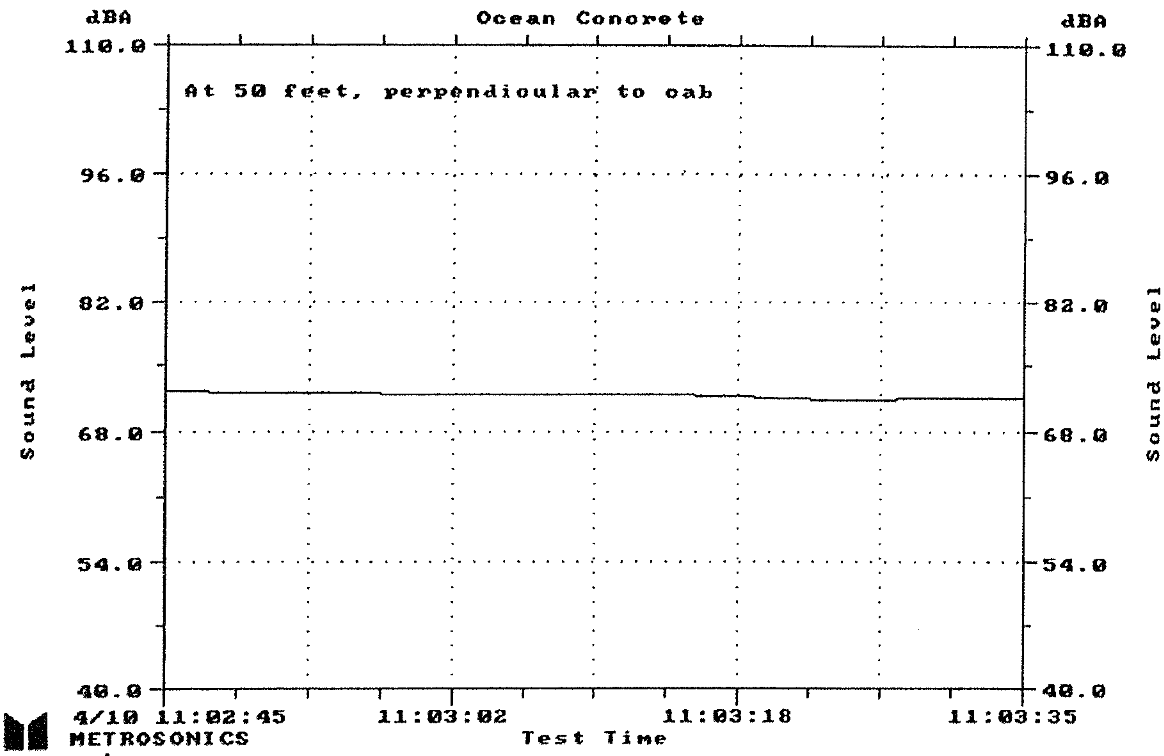
OVERALL: Lav= 66.4dB
SCAN LINE: 4/10/07 10:53:03 Lav= 65.9dB

Filename..........bin71
Logger............db-308 SN 2914
Test Location.....Ocean Concrete
Employee Name.....April 10, 2007
Employee Number...
Department........
Comment Field 1...Simulated batching
Comment Field 2...
Numeric Code #1... #2... #3... #4... #5...



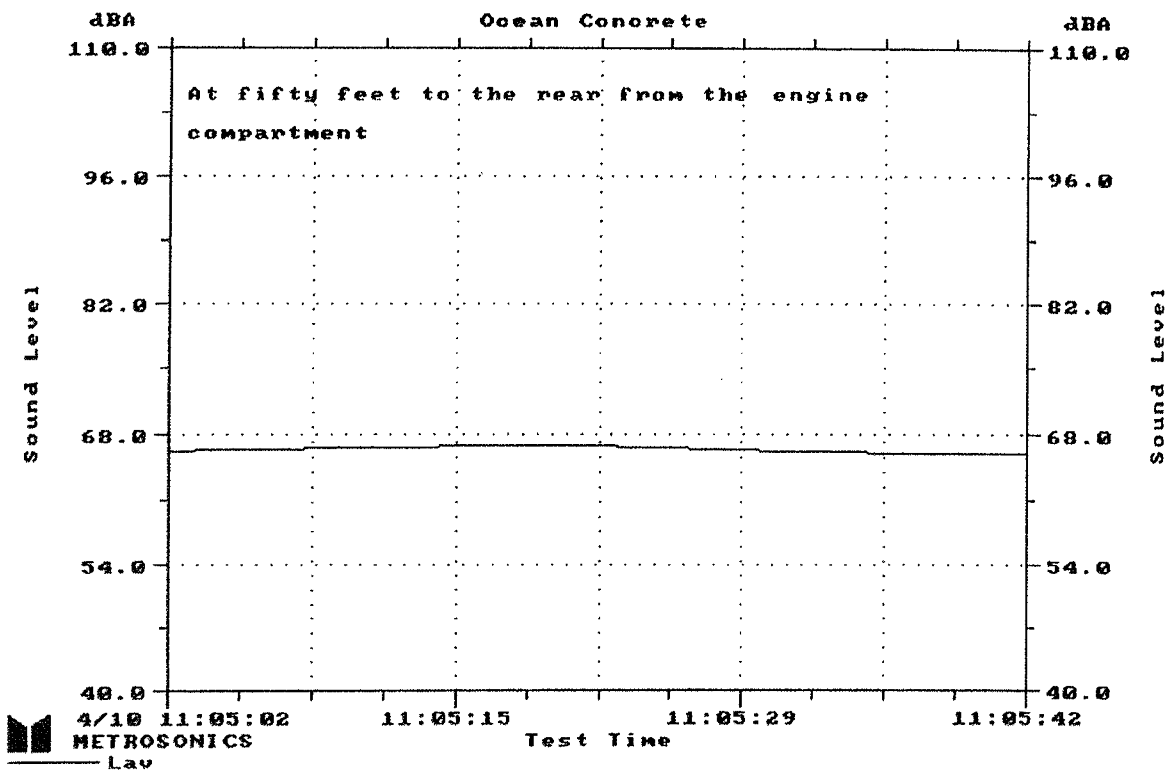
OVERALL: Lav= 70.6dB
SCAN LINE: 4/10/07 10:57:10 Lav= 61.0dB

Filename..........bin71
Logger............db-308 SN 2914
Test Location.....Ocean Concrete
Employee Name.....April 10, 2007
Employee Number...
Department........
Comment Field 1...Simulated batching
Comment Field 2...
Numeric Code #1... #2... #3... #4... #5...



—— Lav
OVERALL: Lav= 71.9dB
SCAN LINE: 4/10/07 11:02:45 Lav= 72.4dB

Filename..........bin71
Logger............db-308 SN 2914
Test Location.....Ocean Concrete
Employee Name.....April 10, 2007
Employee Number...
Department........
Comment Field 1...Simulated batching
Comment Field 2...
Numeric Code #1... #2... #3... #4... #5...



OVERALL: Lav= 66.4dB
SCAN LINE: 4/10/07 11:05:02 Lav= 66.2dB

Appendix C
Calculations Worksheet

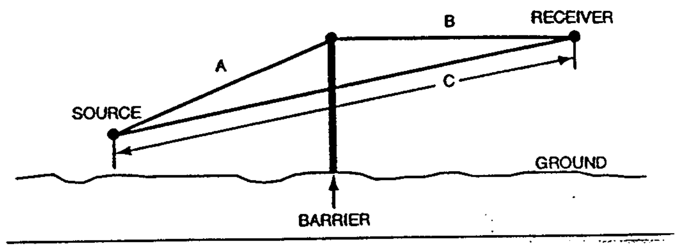
For all other barriers, and for protrusion of terrain above the line of sight:	$A_{barrier} = \min\left\{ 15 \text{ or } \left[20 \times \log\left(\frac{2.51\sqrt{P}}{\tanh[4.46\sqrt{P}]} \right) + 5 \right] \right\}$
Barrier Insertion Loss	$IL_{barrier} = A_{barrier} - 10(G_{NB} - G_B)\log\left(\frac{D}{50}\right)$
Net Attenuation	$A_{shielding} = \max\{IL_{barrier} \text{ or } A_{barrier} \text{ or } A_{trees}\}$

D = closest distance between the receiver and the source, in feet
P = path length difference, in feet (see figure below)
G_{NB} = Ground factor G computed *without barrier* (see Figure 6-5)
G_B = Ground factor G computed *with barrier* (see Figure 6-5)

† The term "tanh(variable)" stands for hyperbolic tangent, available on many scientific calculators. If "tanh" is not available, then compute E = exp(variable), and set tanh(variable) = (E - 1/E) / (E + 1/E), where exp(variable) is the "exponential" function, also written as e^x on calculator keypads.

BARRIER PARAMETER P

P= A+B-C



For T-2 P= 0.4 $\sqrt{\ }$ = 0.63
For T-3 P= 1.22 = 1.10
For T-4 P= 0.2 = 0.45
For T-5 P= 0.6 = 0.77
For T-6 P= 1.3 = 1.14

$$T\text{-}2 \quad A_{barrier} = 20 \times \log\left(\frac{2.51 \times 0.63}{\tanh(4.46 \times 0.63)}\right) + 5 = 20 \times \log\left(\frac{1.58}{\tanh 2.81}\right) + 5$$

$$20 \times \log\left(\frac{1.58}{0.99}\right) + 5 = 9$$

$$T\text{-}3 = 20 \times \log\left(\frac{2.761}{\tanh(4.9)}\right) + 5 = 20 \times \log(2.76) + 5 = 14$$

$$T\text{-}4 = 20 \times \log\left(\frac{1.13}{\tanh(2.0)}\right) + 5 = 20 \times \log(1.17) + 5 = 6$$

$$T\text{-}5 = 20 \times \log\left(\frac{1.93}{\tanh(3.43)}\right) + 5 = 20 \times \log(1.93) + 5 = 11$$

$$T\text{-}6 = 20 \times \log\left(\frac{2.86}{\tanh(5.08)}\right) + 5 = 20 \times \log(2.86) + 5 = 14$$

Calculations above assume a five foot height for emitter and receiver, and a five foot barrer height above emitter and receiver. Higher differentials improve attenuation and vice versa.