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Community noise agreements, monitoring, and control for concerts on Boston's Rose Kennedy Greenway

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The Rose Kennedy Greenway is a mile-long series of public parks, gardens, and plazas located in downtown Boston, Massachusetts. The Greenway, which sits on land that was formerly an elevated highway and reclaimed as part of the "Big Dig", regularly hosts a variety of festivals, performances, and artwork for the enjoyment of the public. However, the parks are located in densely populated neighborhoods and there have been complaints about noise from some events. In preparation for a musical concert on Earth Day 2010, the Greenway hired Parsons Brinckerhoff (PB) to provide acoustical support services. PB completed an ambient noise survey of the concert area, made recommendations to limit community noise from the event, and monitored noise levels for compliance during the concert. PB also coordinated with the Boston Environmental Department to allow for a temporary exceedance of Boston's noise code limits during the concert. PB later completed a full ambient noise survey of the parks and developed a computer model to aid the Greenway in evaluating noise issues for future events. In addition to describing these activities, the unique challenges of long-term noise monitoring in urban areas will be discussed.

1 INTRODUCTION

The Rose Kennedy Greenway is the jewel in the crown of the Nation's most ambitious and complex public works projects in history, the Central Artery/Tunnel Project (The Big Dig) in Boston, Massachusetts. The Big Dig took over two decades to plan, design, construct and finish, with substantial completion occurring in 2005. The project built the new Williams Tunnel to Logan Airport, connected I-90 directly to the airport, improved access to East Boston via Route 1, depressed the previously-elevated I-93 mainline traffic into new tunnels under downtown Boston, built the new Zakim cable-stay bridge over the Charles River, and built the Rose Kennedy Greenway in downtown Boston in hopes of reconnecting all Bostonians with each other and with their historic waterfront. To that end, the Big Dig project was a complete success.

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The Greenway covers some fifteen acres and consists of a series of uniquely designed parks throughout the corridor. There are parks of specific cultural significance in Boston's Chinatown district, Downtown business district, Wharf/waterfront district, and North End district, each with design input from local stakeholders. In an ongoing effort to promote more use and enjoyment of the Greenway, its managers decided to offer free outdoor public concerts at several venue locations. However, being in such close proximity to nearby residences and businesses, there was concern that a loud music event might disturb the neighbors and run afoul of the City of Boston's noise code.

Consequently, the Greenway contacted Parsons Brinckerhoff (PB) for assistance due to the fact that PB had managed the noise control program for the Big Dig project and as a result was uniquely familiar with the effects of noise on communities adjacent to the Greenway.

2 ACOUSTICAL SUPPORT FOR EARTH DAY CONCERT EVENT

The concert on Earth Day 2010 featured performances by the musical acts *Citizen Cope* and *They Might Be Giants*. The concert was held from 12 – 3 PM on the downtown Greenway parcel near Rowes Wharf, which is bounded by India Street and Milk Street, and drew an audience of four to five thousand people. This area of the Greenway is shown in Figure 1.

Several prior events held on the Greenway had led to noise complaints from the community and negative attention from the local press. In particular, noise from an outdoor film screening and a lunchtime concert drew criticism from residents. These events were held on different sections of the Greenway and complaints came from several residents in different neighborhoods. The events were also fairly modest in size compared to the more ambitious concert the Greenway was planning for Earth Day 2010. As a result, the Greenway asked PB to advise them so that the Earth Day concert could be fully enjoyed by the audience while causing minimal disruption to the community. This involved several different tasks, which are described below.

2.1 Ambient noise monitoring

Ambient noise monitoring was completed in order to (1) document existing noise levels at noise-sensitive sites in the area, and (2) characterize typical audience area noise levels that could disrupt enjoyment of the music. The noise monitors employed were Larson Davis Model 720s which meet ANSI Standard S1.4 for Type II accuracy. Three noise-sensitive residential buildings around the concert area were identified, the locations of which are also shown in Figure 1 as sites R-1, R-2 and R-3. The Greenway had received noise complaints from residents at one of these buildings in the past. At each of these three sites, a long-term noise monitor was deployed for one week to collect ambient noise data. A noise monitor was also deployed near the center of the parcel to measure noise levels in the audience area (Site A-1).

The dominant noise source throughout the concert area was traffic on Atlantic Avenue and Surface Road, so the noise levels at all of the monitoring sites were generally expected to be similar. However, PB and the Greenway felt that from a community involvement perspective it would be beneficial to have an individual monitor and corresponding noise data for each of the noise sensitive buildings. In this manner, a complainant does not have to be convinced that the noise measured down the street is truly "representative" of the noise they hear at their property.

The results of the ambient noise monitoring are shown below in Figure 2. As can be seen, noise levels at all four sites generally follow the same daily trends, indicating that all sites share the same primary noise source (i.e. traffic). The hourly noise levels at the two louder sites, which were located closer to roadways, ranged from 64 to 73 dBA Leq. Hourly noise levels at

the two quieter sites ranged from 59 to 70 dBA Leq. Table 1 shows the average ambient noise level at each site during the hours of the concert.

2.2 Regulatory approach

Boston Municipal Code (Chapter 16, Section 26) sets noise limits within the City of Boston. The Boston noise code limits noise levels, when measured at the property line in residential/industrial areas, to 65 dBA during the day (7 AM – 6 PM) and 55 dBA at all other times. However, as can be seen in Figure 2 and Table 1, typical daytime noise levels in the concert area were already louder than the 65 dBA limit.

PB contacted the City of Boston Environmental Department (BED), who has authority to enforce the noise code, to explain the situation and share the results of the ambient noise monitoring survey. BED concluded that in such circumstances where the ambient noise level already exceeds the Boston noise code, it would be acceptable to temporarily exceed those limits provided it was done in moderation with respect to the abutting community.

PB then suggested a 15 decibel signal-to-noise ratio as a limit at the rear of the concert area during the event. This limit was intended to allow the music to be sufficiently loud for the audience to hear and enjoy it over the traffic noise, while protecting the community from unnecessarily loud noise levels. Because the average noise level in the audience area was 68 dBA Leq, this approach limited the average music level over the 3-hour concert to 83 dBA Leq at the rear of the audience area. PB also assured BED that an acoustical technician would be on site to monitor the noise levels during the event and respond should they receive any noise complaints. BED agreed that this was a reasonable and fair approach to the situation and gave their approval.

There are several reasons why PB decided that the 15 decibel signal-to-noise ratio would be the best noise criteria limit for this situation. First, it did not limit the natural dynamic range that listeners expect from a musical concert. Because the criteria limit used the average noise level (Leq) over the duration of the concert, the music levels could be louder or quieter at times while still complying with the criteria. Second, from a practical perspective, PB did not expect it to be possible to get the sound system contractor to limit the maximum sound level during the event. It was decided that the average sound level criteria approach would be best to facilitate cooperation with the sound contractor because there was no absolute limit being imposed on them. Third, basing the noise limit on the average ambient noise level in the area was thought to be a well reasoned approach that would stand up well to potential scrutiny. And last, by specifying the noise criteria at the rear of the audience area, it assured that the music would be loud enough to enjoy for nearly everyone who attended.

2.3 Community noise control

In order to control community noise from the concert event, PB first made some general recommendations on appropriate loudspeakers during the planning of the event. Loudspeakers with directivity characteristics that would focus sound on the audience area were recommended as a way to minimize excessive sound being projected towards the community.

Next, immediately prior to the concert, PB arranged for the sound system contractor to run a pink noise test source through the system in order to calibrate the output level of the sound system. During this test, the contractor agreed to run the sound system at the highest level they planned to use during the concert. PB had a noise monitor set up in the rear of the concert area and was able to directly communicate with the contractor to set the system at the appropriate

level. It was decided that as long as the noise level during the testing was at 80 dBA or less, the 3-hour average noise level throughout the concert would likely be in compliance with the agreed limit of 83 dBA Leq. PB assumed that the level of the music would certainly be louder at some points during the concert but also knew there would be quieter periods, between songs and during band changes for example. Given these factors, a "buffer" of 3 decibels below the desired noise limit was judged to be appropriate for the sound system calibration.

2.4 Earth Day concert

Several hours before the concert began, Larson Davis 720 noise monitors were placed at two of the three community receptor sites. Also, a CEL Instruments Model 593 noise spectrum analyzer, which meets ANSI Standard S1.4 for Type I accuracy, was set up in the rear of the audience area to use for sound system level calibration before the concert and compliance measurements throughout. Figure 3 shows the ambient noise levels measured during the event in the rear of the audience area and at the two community receptor locations. As expected, noise levels in the rear of the audience area while the bands were playing were several decibels higher than the "maximum level" for which the system was calibrated. However, over the 3-hour concert the Leq was 84 dBA, which was only slightly above the agreed upon limit of 83 dBA. And most importantly, the concert was enjoyed by all and there were no known complaints of noise from the community.

The managers of the Greenway were particularly pleased with these results. They received extensive positive feedback from concert-goers and other city officials congratulating them on a successful concert. These results gave the Greenway managers the confidence and assurance they needed in order to plan more public events in the future.

3 MONITORING AND COMPUTER MODELING FOR FUTURE EVENTS

PB later completed an ambient noise survey of the full Greenway corridor for use in future event planning. Similar to the Earth Day monitoring, Larson Davis 720 long-term noise monitors were deployed both in the potential audience areas of parcels where events may occur and at the nearest noise-sensitive community receptors. In addition, short-term noise measurements were taken with the CEL 593 at each audience area site during mid-day hours to collect octave-band spectral levels. In total, long-term noise monitoring was completed for eight potential audience area sites and eight community receptor sites in close proximity to potential Greenway performance areas. Based on the measured noise levels, PB was also able to make recommendations as to which park parcels, from an acoustical perspective, may be better suited to host performances and events.

The Cadna-A® program was then used to create a three-dimensional acoustic model of the Greenway corridor. The model started with a GoogleEarth® base map and then any building structures flanking the parks that may influence sound propagation were added. To test and calibrate the model, the Earth Day concert event was simulated. Directional loudspeaker sources were added into the model at the stage area and noise level calculation points were placed at the three monitoring locations. Knowing the relative differences in measured noise levels at the three sites during the event, PB was able to confirm that the model was performing properly. Examples of the Cadna-A model are shown in Figures 4 and 5.

In the future, the ambient noise data and Cadna-A model can be used to assess noise impacts or compliance with the Boston noise code for a wide variety of events that may be planned or held on the Greenway.

4 CHALLENGES OF NOISE MONITORING IN URBAN AREAS

The Greenway parks are in downtown Boston and experience frequent pedestrian traffic, so finding a secure place to deploy the noise monitors for a week at a time was a constant challenge. The obvious concern was that pedestrians would tamper with or steal the noise monitors if they were easily noticed and accessible. From past experience, PB has found that the "stealth" approach, where noise monitors are hidden from view as best possible and placed out of reach, often works best in these situations. Beyond practical concerns, residential noise-sensitive receptors are usually several floors above street level in urban areas as well, so noise levels measured 10 - 15 feet above ground are often more representative of the noise levels to which people are actually exposed.

For long-term noise monitoring, PB uses ANSI S1.4 Type 2 environmental noise monitors housed in small, weatherproof Pelican cases. The cases are equipped with AA battery packs that can power the monitors for a full week of measurements, and have a cable attached for hanging the monitors out of reach in trees or on utility poles. The microphone is detached from the nose cone, extended out of the case through a small hole, and then covered with a windscreen secured to the case with rubber bands. When hung upside-down, the Pelican case essentially acts as a rain hood for the microphone. The system only weighs a few pounds and can easily be placed on an elevated perch by using a telescoping pole.

Several locations where the noise monitors were deployed on the Greenway can be seen in the pictures below. Typically, the monitors were hidden out of reach in leafy trees. However, some of the more unique and creative locations involved placing a monitor on a third-floor residential balcony (with the property owner's permission), inside of the perforated enclosure of a public art sculpture, and in the middle of a bamboo planting in the Chinatown park.

5 CONCLUSIONS

The Rose Kennedy Greenway is the jewel in the crown that marked the completion of the Big Dig in Boston. It opened with much fanfare and great expectations to reunify Bostonians with each other and with their historic waterfront. PB served as expert acoustical consultants to the Greenway in preparation for the 2010 Earth Day concert. Ambient noise levels were measured throughout the entire Greenway corridor, occasionally under challenging conditions, and a base acoustical model was developed in Cadna-A to assist with the planning of future music events.

PB brokered an agreement between the Greenway and the City of Boston to allow the concert to be performed at an acceptable loudness level. PB recommended a 15 decibel signal-to-noise ratio, which resulted in a limit of 83 dBA Leq at the rear of the audience area. The Earth Day concert was performed successfully to everyone's satisfaction, and the Greenway received glowing accolades from concert-goers and other city officials.

6 ACKNOWLEDGEMENTS

PB would like to thank the Rose Kennedy Greenway Conservancy and the Boston Environmental Department for all their help and cooperation.

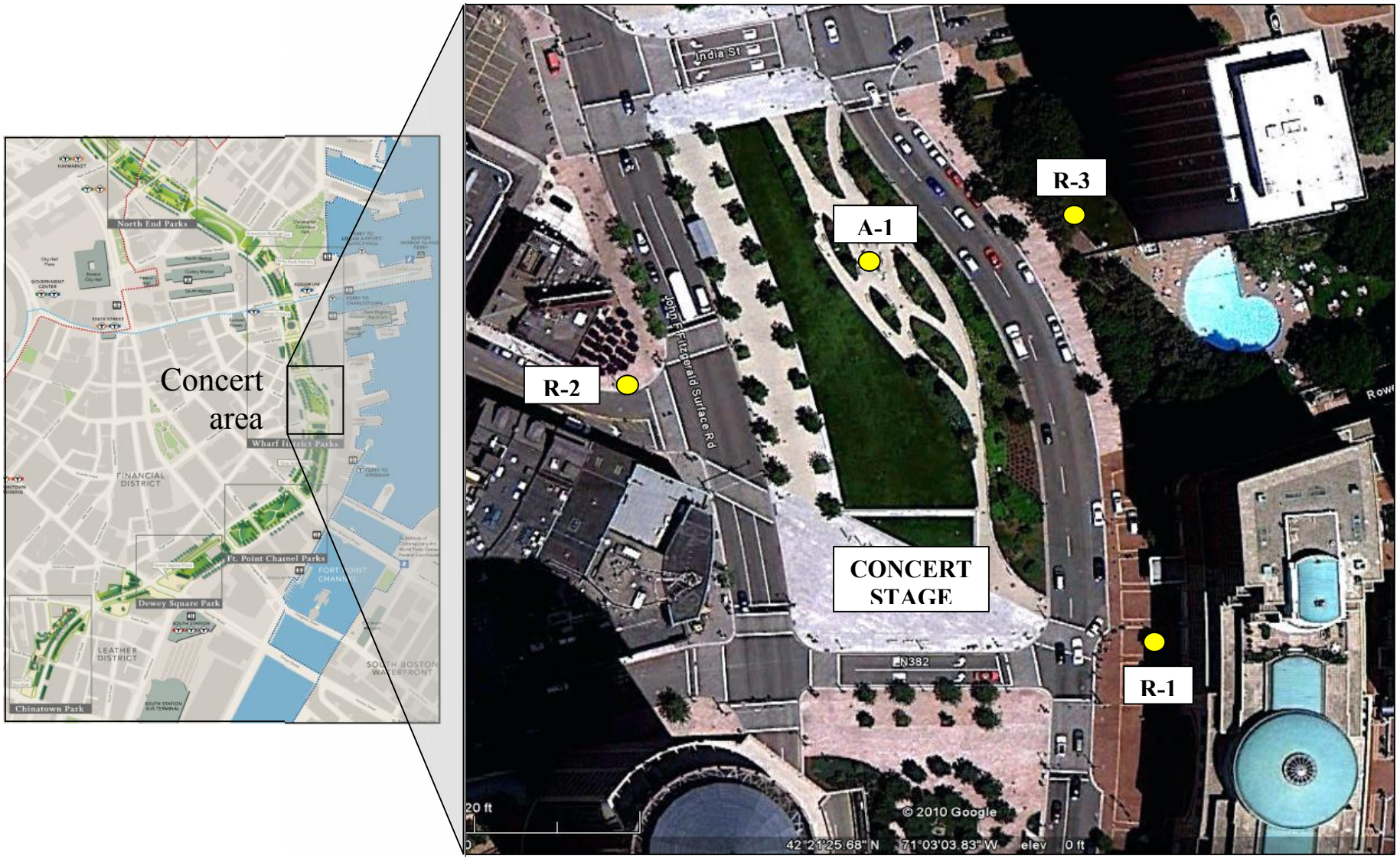


Fig. 1 – Rose Kennedy Greenway layout and noise monitoring sites for the Earth Day concert

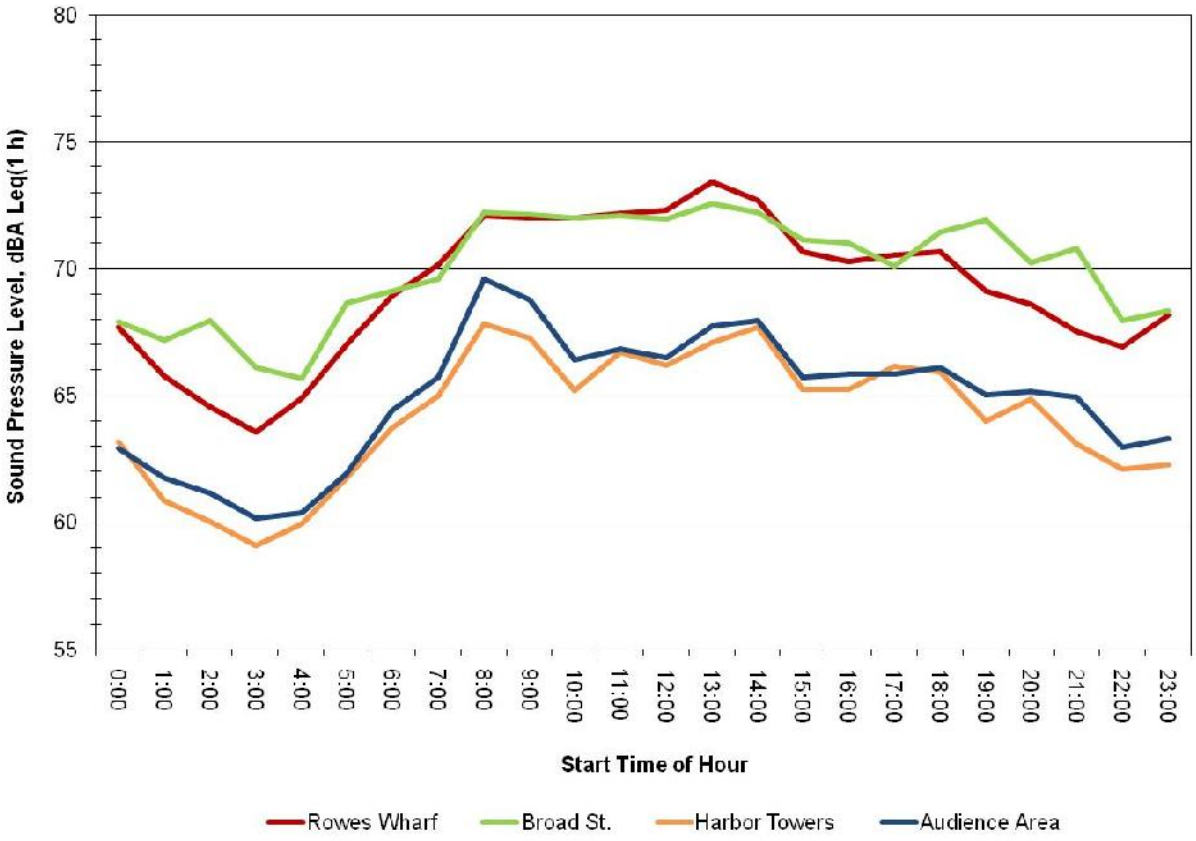


Fig. 2 – Typical 24-hour ambient noise levels for Earth Day concert area

Table 1 – Average ambient noise levels during concert hours

Monitoring Site	Average Ambient Noise Level 12 – 3 PM, dBA Leq(1 h)
Audience Area (A-1)	68 dBA
Rowes Wharf (R-1)	73 dBA
Broad Street (R-2)	72 dBA
Harbor Towers (R-3)	67 dBA

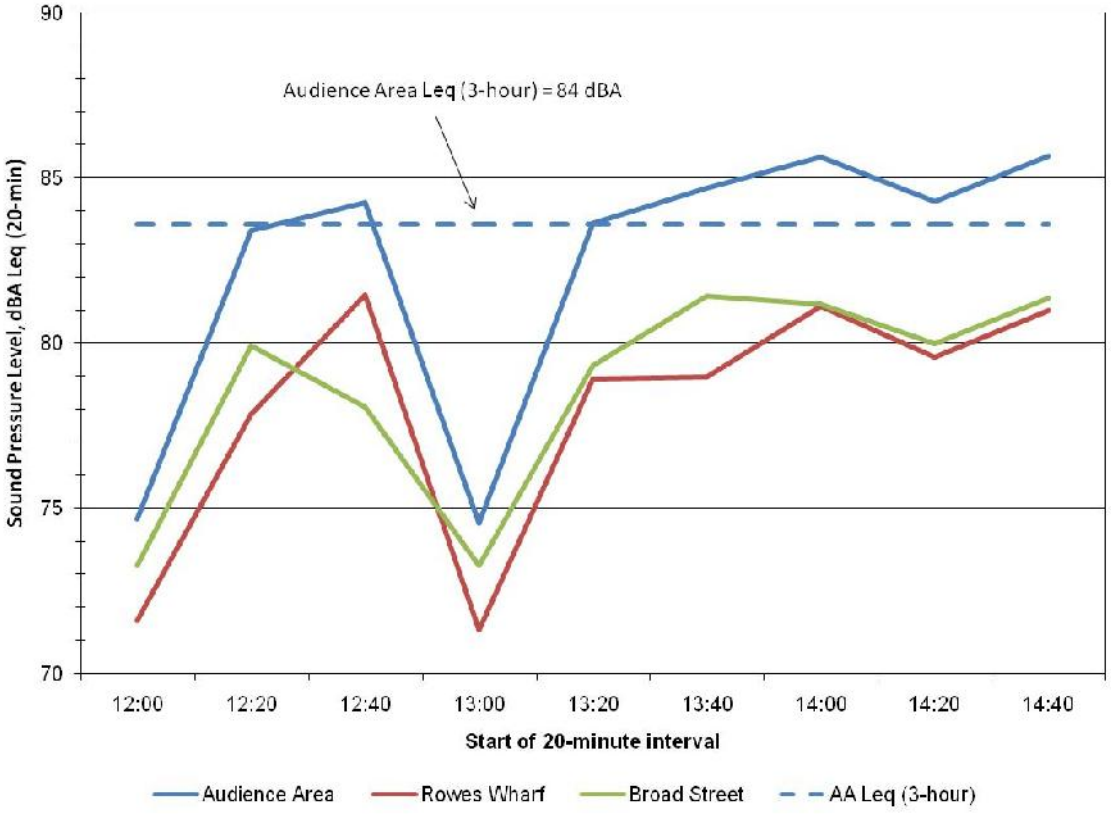


Fig. 3 - Music levels during Earth Day concert

Fig. 4 - Cadna-A model of the Greenway park corridor

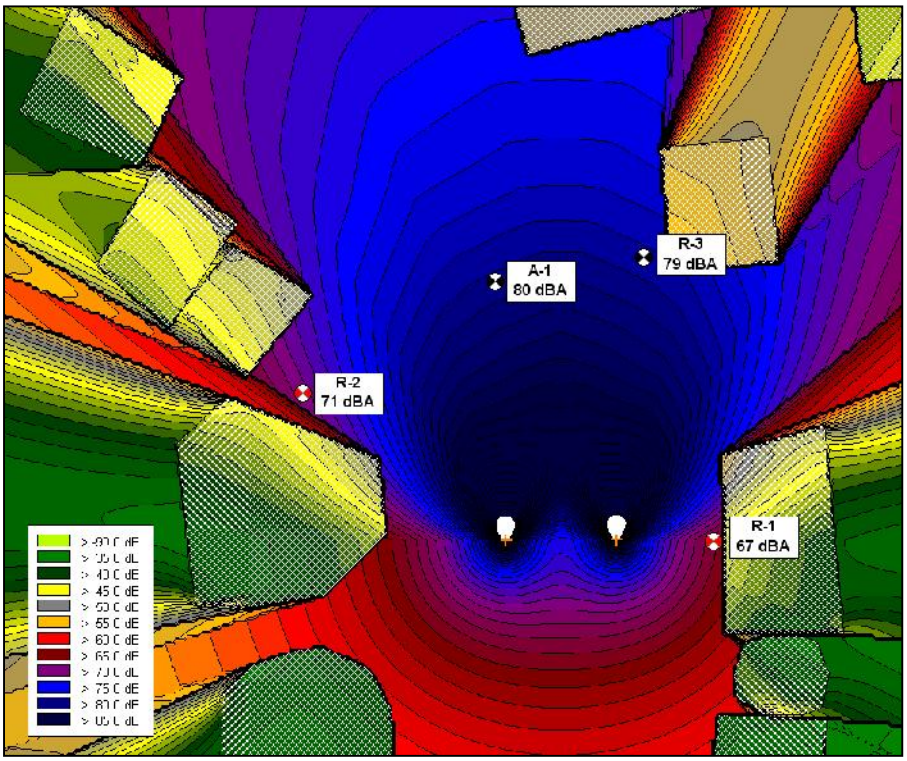
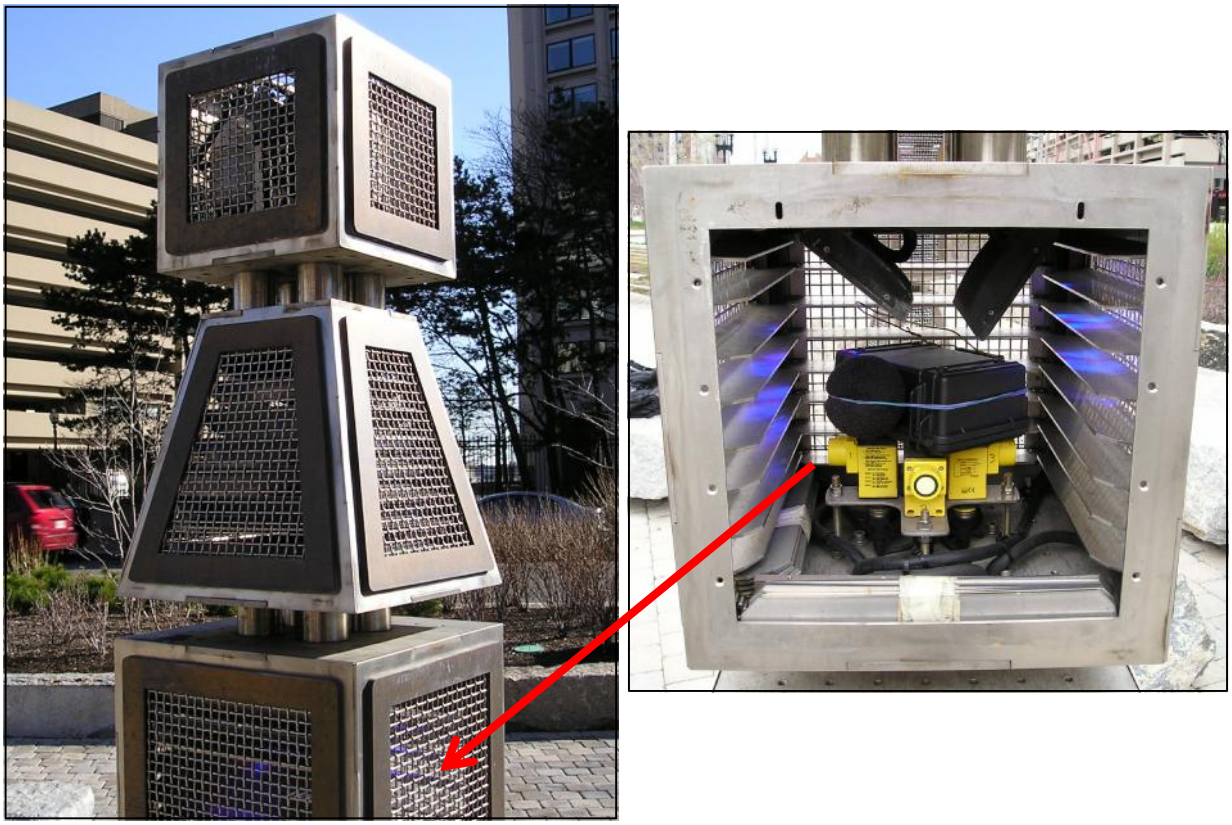
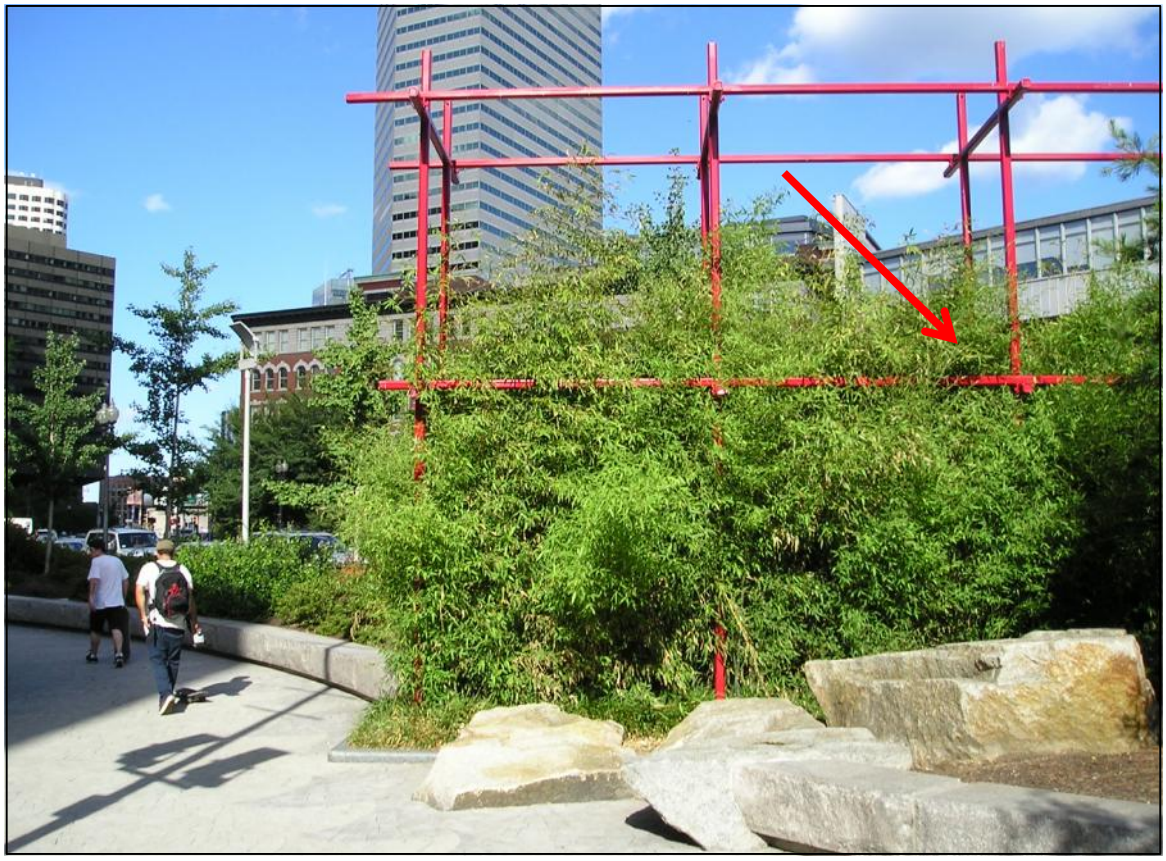


Fig. 5 – Cadna-A sound level contours from a simulation of the Earth Day concert



Photos 1 - 4 – Example placement of long-term noise monitors




CIRQUE DU SOLEIL

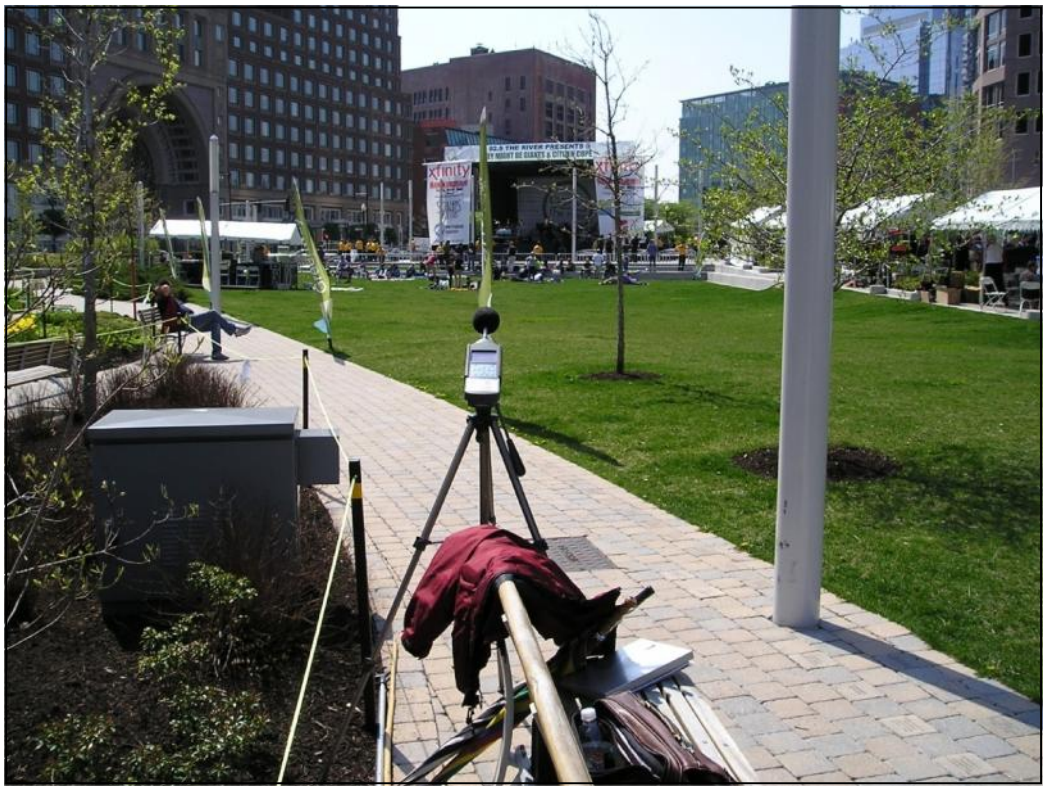


Photo 5 – Noise limit compliance monitoring at the Earth Day concert

Photo 6 – Audience at the Earth Day concert