



Morristown National Historic Park – Washington’s Headquarters Unit

*Traffic Noise Level Modeling **Preliminary** Report*

June 2011

Background Information

Per the National Park Service Organic Act and Chapter 8 of NPS Management Policies 2006, the fundamental purpose of all national park units includes providing for the enjoyment of park resources such as the acoustic environment. In addition to these policies, the Morristown National Historic Park’s (MORR) enabling legislation requires the park to protect the tranquil and contemplative visitor experience where possible. One of the major issues identified in the MORR 2004 GMP is the protection of park lands from sound pollution, especially that generated by Interstate 287, a busy eight lane highway adjacent to the park’s Washington’s Headquarters Unit. The highway noise makes outdoor interpretive talks difficult.

In order to achieve GMP goals and meet enabling legislation requirements, MORR staff requested technical assistance from the Natural Sounds and Night Skies Division (NSNSD) to identify means for mitigation of sounds that are not appropriate to park purposes and management objectives. In order to assess existing traffic noise conditions across the park and to identify potential noise mitigation options, preliminary traffic noise modeling was done using available noise modeling software.

This summary report contains the **preliminary** modeled traffic noise results and operational parameters to help assist MORR and NSNSD staff in understanding potential noise mitigation options and relevant management actions. The report provides tables, plots, data summaries, references to applicable regulations, and interpretation.

Applicable Regulations

The current regulations applicable for federal-aid highway construction or expansion adjacent to national parks are 23 CFR 772 and 23 CFR 774. 23 CFR 772 and the noise related requirements of NEPA require that a noise analysis is performed when potentially impacted receivers are present for Type I projects. Type I projects are Federal or Federal-Aid projects for the construction of a highway (1) on a new location, or (2) the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment, or (3) increases the number of through-traffic lanes. On July 13, 2010, FHWA published a final rule updating 23 CFR 772. The final rule requires each State DOT to revise its noise policy to be in accordance with this final rule. States were required to submit their revised noise policy, meeting the requirements of the final rule, to FHWA for approval by January 13, 2011 (6 months from the publication date of the final rule). It is important to note, however, that FHWA did not require State DOTs to adopt a noise policy until 1995, and therefore, noise analyses which predate state adoption of a noise policy may not be subject to the FHWA noise abatement criteria (NAC).

The current noise requirements for federal-aid highway construction are defined under Land Activity Category A or B. Land Activity Category A “includes lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose. Some examples of lands that have been analyzed as Activity Category A receivers include the Tomb of the Unknown Soldier, a monastery, an outdoor prayer area of a facility for nuns, and an amphitheater.” Land Activity Category B “includes picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals. All land uses except residences listed as Activity Category B are often treated as special use facilities due to the difficulty in determining the number of receiver units. Each State DOT should adopt a standard practice for analyzing these special use facilities that is consistent and uniformly applied statewide.”

The FHWA noise abatement criteria (NAC) are as follows: Land Activity Category A specifies a maximum L_{eq} (hourly equivalent sound level) of 57 dBA at exterior locations and a maximum L_{10} (level exceeded 10% of the time) of 60 dBA. The FHWA must approve a land use as Activity Category A before a noise analysis on an Activity Category A is initiated. Therefore parks which may be subject to Type I highway project noise impacts should submit an appropriate request to FHWA along with justification for Land Category A analysis. Land Activity Category B specifies a maximum L_{eq} (hourly equivalent sound level) of 67 dBA at exterior locations and a maximum L_{10} (level exceeded 10% of the time) of 70 dBA.

If a Type I highway project is proposed, then 23 CFR 772 requires that FHWA-approved methodologies and environmental noise mapping tools must be used. If the applicable FHWA NAC of 23 CFR 772 are not met, highway noise mitigation options must be proposed in order to meet the requirements of the regulation.

Data & Metrics

Sound pressure level (SPL) is measured in decibels (dB), a logarithmic scale where 0 dB represents the approximate threshold of human hearing at 1 kHz. SPL is frequently measured using a frequency weighted scale (A-weighting) such that they resemble the response of the human ear (Harris, 1998, p. 1.16) at the majority of sound levels expected within MORR.

The logarithmic dB scale can be difficult to interpret, and the effects of a seemingly small change in SPL can be greater than anticipated. When noise interferes with hearing natural sounds, the noise is said to *mask* the natural sounds, and this affects the extent of the area that a person or wildlife can hear (or *listening area*). For example, if the ambient SPL is 30 dB, and oil and gas development noise raises the ambient to 33 dB (a 3 dB increase), the listening area or auditory horizon for humans (and many birds and mammals) at that location would be reduced by 50%. Increasing the ambient SPL an additional 3 dB (to 36 dB) would reduce the listening area by half again, to 25% of the initial area. Note however, that changes in SPL do not proportionately translate to changes in perceived loudness. The rate of change of loudness is complex and dependent on the stimulus itself (SPL, frequency, bandwidth, duration, background, etc.). At a minimum, each 10 dB increase in SPL causes a doubling of perceived loudness (Crocker, 1997, p.1481). To help in understanding variations in sound levels, Table 1 presents park sound sources and common sound sources with their corresponding A-weighted decibel (dBA) values.

Table 1. Sound pressure level examples

Park Sound Sources	Common Sound Sources	dBA
Volcano crater (HALE)	Human breathing at 3m	10
Leaves rustling (CANY)	Whispering	20
Crickets at 5m (ZION)	Residential area at night	40
Conversation at 5m (WHMI)	Busy restaurant	60
Snowcoach at 30m (YELL)	Curbside of busy street	80
Thunder (ARCH)	Jackhammer at 2m	100
Military jet at 100m AGL(YUCH)	Train horn at 1m	120

Table 2 summarizes sound pressure levels that relate to human health and speech, as documented in the scientific literature. Human responses can serve as a proxy for potential impacts to other vertebrates because humans have more sensitive hearing at low frequencies than most species (Dooling and Popper, 2007, p. 5). To help interpret predicted noise levels and the ambient data collected within the park, and to better understand the implications of the data, it may be helpful to consider sound pressure levels in relation to the functional effects listed in Table 2.

Table 2. Effects of sound pressure levels on humans

SPL (dBA)	Relevance
35	Blood pressure and heart rate increase in sleeping humans (Haralabidis et al., 2008)
45	World Health Organization's recommendation for maximum noise levels inside bedrooms (Berglund, Lindvall, and Schwela, 1999)
52	Speech interference for interpretive programs (U.S. Environmental Protection Agency, 1974)
60	Speech interruption for normal conversation (U.S. Environmental Protection Agency, 1974)

Exceedance levels (L_x) are defined as the sound pressure levels exceeded x percent of the time during a given measurement period. For example, the L_{90} represents the SPL that has been exceeded 90% of the time (i.e. 3240 seconds of a measurement hour) while the L_{10} represents the SPL that has been exceeded 10% of the time (i.e. 360 seconds of a measurement hour). L_{90} is the exceedance level that is frequently used as a baseline for continuous ambient sound sources, and it has been found by NPS to be a reasonable proxy for the natural ambient. In the U.S., the time period 7:00 AM to 7:00 PM generally represents daytime for standard sound level metric calculation, and 7:00 PM to 7:00 AM generally represents evening and nighttime hours.

Noise Modeling Parameters

Based on data found at the New Jersey Department of Transportation (NJDOT) Traffic Counts website, hourly vehicle counts were applied to the roads surrounding the Washington's Headquarters unit. This included adjacent sections of Interstate 287 (I-287), Morris Street, Morris Avenue, and Lafayette Avenue.

Vehicle counts were applied from peak traffic periods when the Washington's Headquarters Unit museum is expected to be open. This included the hours of 9:00-10:00 AM and 4:00-5:00 PM. Typical traffic mixes of heavy trucks, medium trucks, buses, and other vehicles were established according to discussions with FHWA personnel. For the aforementioned daytime hours, the total number of trucks and buses are estimated at 15% of the total traffic on I-287 outside lanes and the aforementioned side streets. This number was reduced for the inner passing lanes of I-287. However, heavy trucks were estimated to account for 75% of this total on I-287 and 25% of this total on the side streets.

Geographic noise predictions were accomplished using Geographic Information System (GIS) data and the environmental noise modeling software package CadnaA and its Traffic Noise

Model (TNM) module. GIS data were obtained from NPS and Morris County sources. Predicted noise levels were calculated taking into account various acoustical factors, such as geometrical divergence, atmospheric absorption, ground effect, and screening due to topography, road surfaces, bridges, and other barriers. All calculations were made according to international standard ISO 9613 – Attenuation of Sound during Propagation Outdoors.

Atmospheric absorption was calculated at a temperature of 10 °C (50 °F) and 70% relative humidity, which are the default CadnaA settings. Ground effect for the entire area was calculated according to a ground absorption value of 0.30, in order to approximate the FHWA Traffic Noise Model value for field grass.

The predominant dense foliage was determined to be deciduous. Because the park size is not large enough to contain a substantial amount of dense foliage and acoustic attenuation due to deciduous vegetation cannot be guaranteed during the winter months, foliage within the Washington's Headquarters unit was not included in the calculations. Screening due to retaining walls and topography was calculated according to available GIS data and ground observations.

The following noise maps have been generated with assumed receiver heights of 1.5 m (5 ft) and the aforementioned parameters. Noise levels were calculated under the conditions most closely expected to match those at the Washington's Headquarters Unit based on these parameters and all information available to the NSNSD at the time of this report.

Existing Noise Levels

Geographic predictions of existing noise levels are provided to assist MORR and NSNSD staff in understanding noise impacts within the MORR Washington's Headquarters unit. The following noise maps are intended to show predicted noise levels within the Washington's Headquarters unit and are not intended for use in noise impact determinations outside this area.

Figure 1 shows the predicted existing L_{eq} (hourly equivalent sound levels) due to traffic during the time period of 9:00-10:00 AM. Figure 2 similarly presents the predicted existing L_{eq} (hourly equivalent sound levels) due to traffic during the time period 4:00-5:00 PM. Inspection of both plots indicates that the average traffic noise levels during this time period vary from 78 dBA near the western boundary to 65 dBA near the historic structures. These levels are far above the 52 dBA and 60 dBA thresholds at which speech interference can be expected to begin for interpretive programs and 60 dBA for normal conversation, respectively (see Table 2 above). Therefore, this confirms that intelligibility of interpretive programs may be difficult for outdoor locations within the Washington's Headquarters Unit.

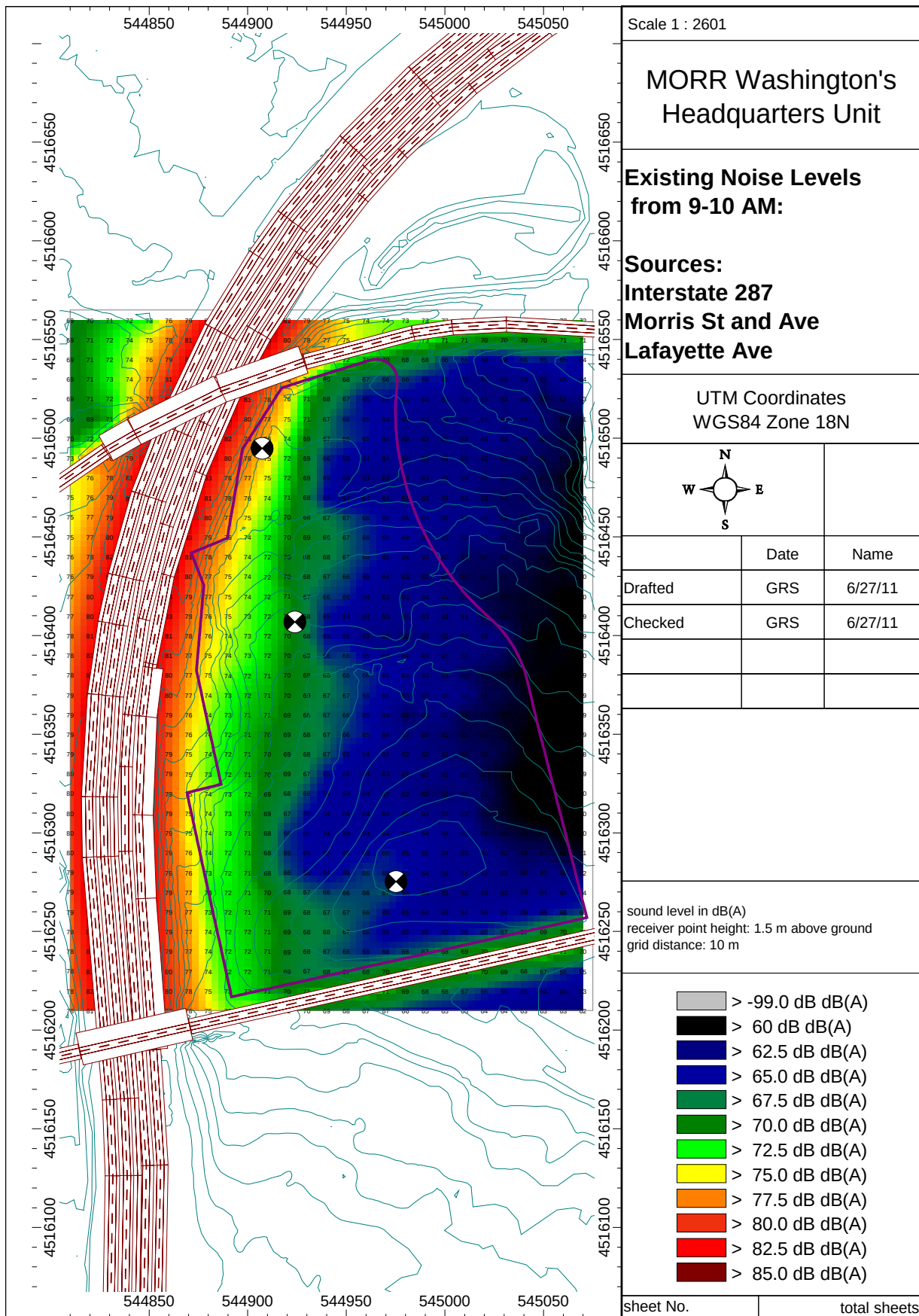


Figure 1 - Existing Noise Levels from 9-10 AM

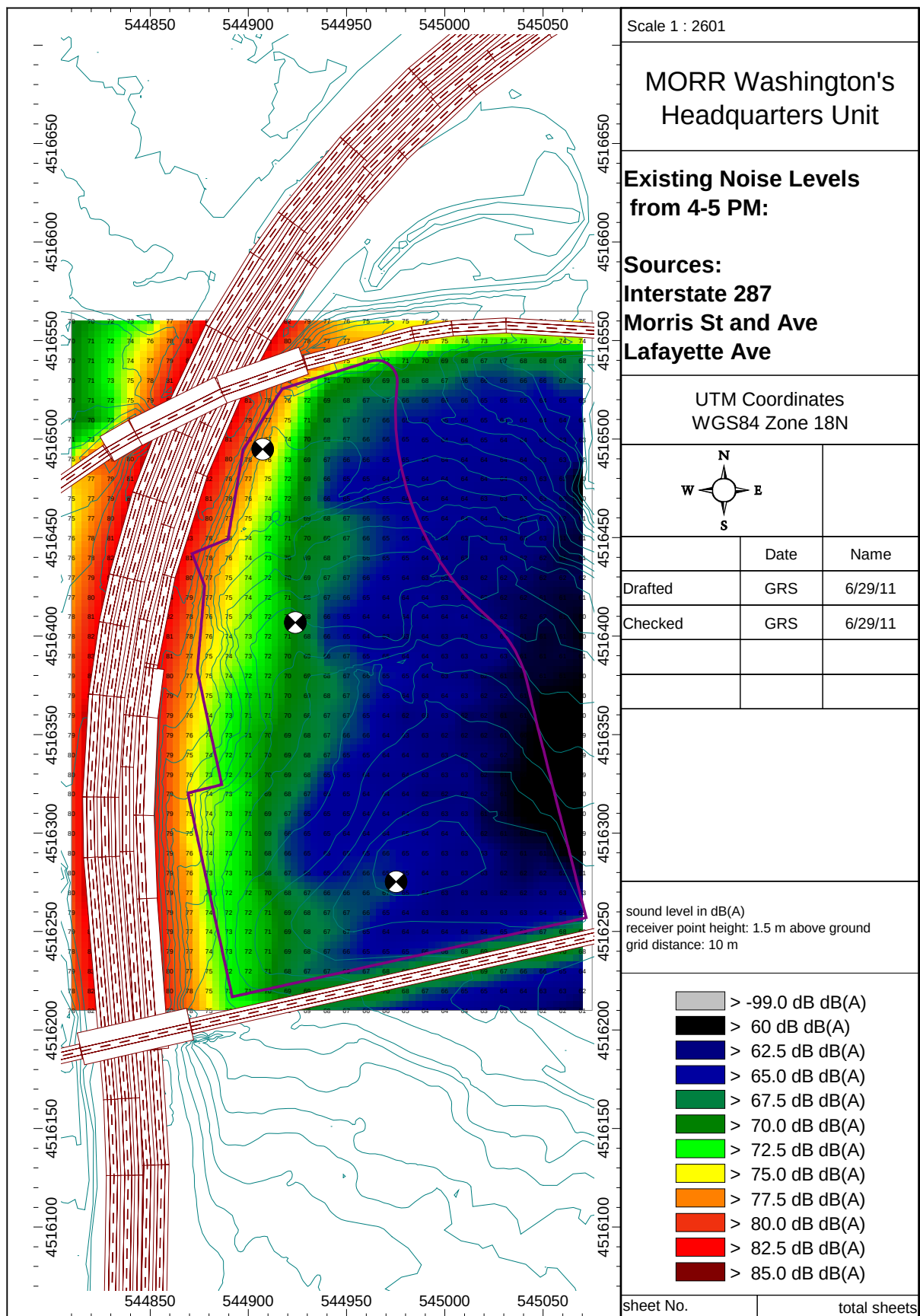
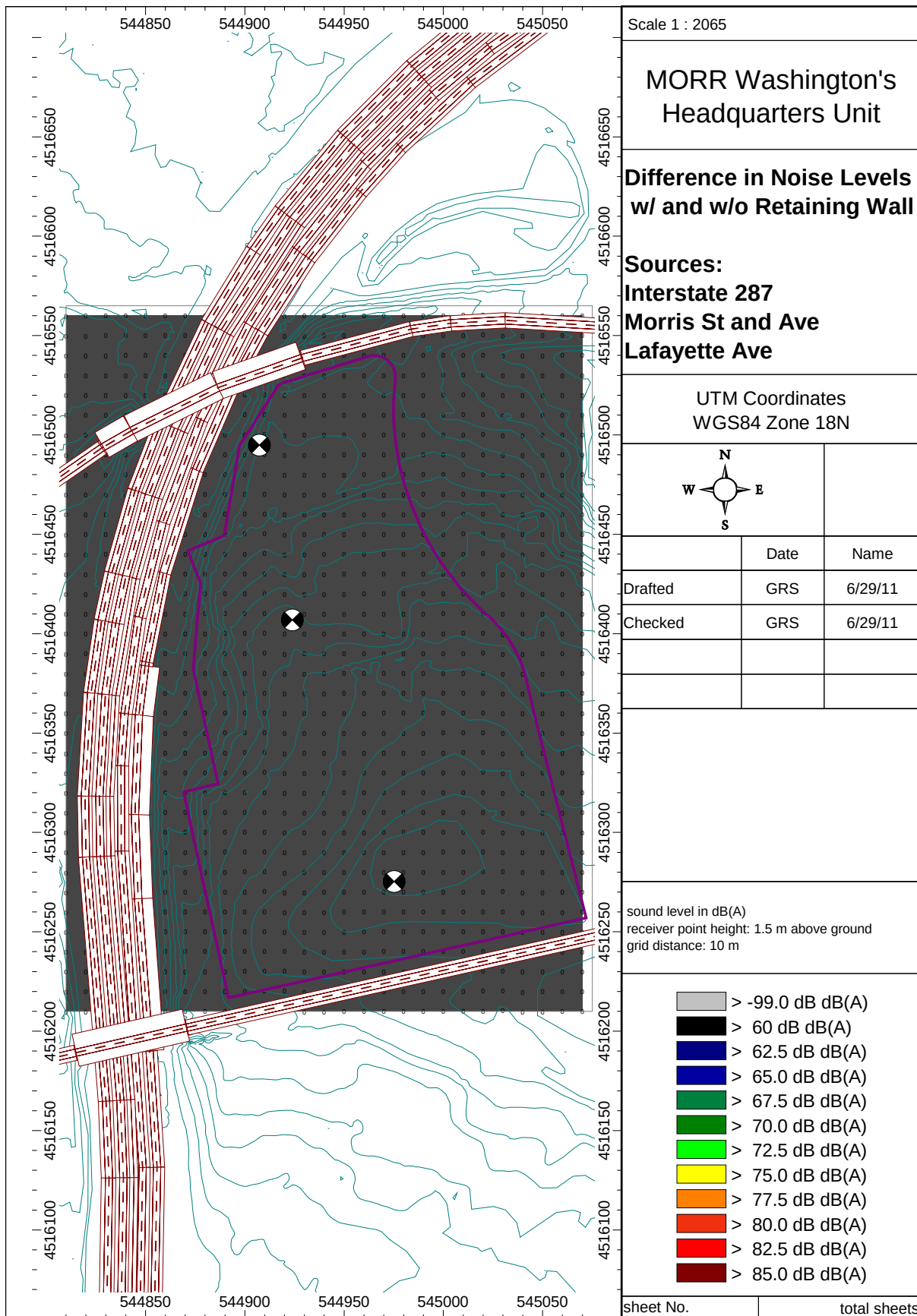


Figure 2 - Existing Noise Levels from 4-5 PM

Comparison of Figure 1 and 2 indicates that traffic noise levels for the hours of 9-10 AM and 4-5 PM are very similar. Traffic noise from I-287 remains dominant. There is a slight increase in afternoon traffic noise from Lafayette Avenue, but it is dominated by the noise from I-287.

Figure 3 displays the algebraic difference between the existing noise level and the resulting level if the retaining walls along the eastern edge of I-287 were removed. Inspection of this figure shows that there is no difference in levels, and therefore, the retaining walls have negligible effect on the traffic noise which propagates into the park unit. As expected, other than the depressed roadbed itself, there are no specific noise mitigation measures such as noise barriers or berms to reduce traffic noise in the park.

An inspection of the topography between the Washington's Headquarters Unit and I-287 shows the most effective location to place noise barriers or berms would be the top of the embankment at the western boundary of the park unit. Like the existing retaining walls, noise barriers located adjacent to the eastern edge of I-287 could be expected to produce little or no effect on the traffic noise levels inside the park unit.



Conclusion

The unmitigated noise plots above show that noise levels inside the Washington's Headquarters Unit are very significant, ranging from 78 dBA at the western park boundary, to 61 dBA at the eastern park boundary. This is substantially higher than the speech interruption criteria of 52 dBA and 60 dBA thresholds for interpretive programs and normal conversation, respectively. At these levels, conversations between visitors as well as interpretive talks to an audience are likely to be interrupted. Only a combination of measures, including substantial berms, sound barriers at the top of the embankment at the western boundary of the park unit, or the installation of quiet pavement could be expected to provide noise level reduction substantial enough to approach the speech interruption criteria at specific locations.

Note: This is a summary report designed to assist park staff in understanding proposed noise source impacts and how they may be mitigated. The mitigation options are not intended to be comprehensive or inclusive of all possibilities, but rather a cross section of possibilities that are guided by practical engineering considerations, site layout, dimensions, existing site photos/construction, and possible safety issues. If there are any questions or concerns about the information in this document, please contact the Natural Sounds and Night Skies Division. Thank you for your interest and participation in NPS noise impact modeling.

Natural Resource Stewardship and Science

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