

ABSTRACT

Title of Thesis: INSTRUMENT OF ARCHITECTURE
Joshua Kilian, Master of Architecture, 2017

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The objective of this thesis is to study the audible impacts of architecture, and explore how music and sound can enhance learning.

Modern culture is known to be ocular-centric, relying heavily on vision. Aesthetically, visual beauty often overshadows aural beauty. Pragmatically, visual cues often influence our behavior, understanding, and navigation more than auditory cues. Due to this, the implications of sound often go unnoticed. Even undesirable sound, or noise, is tolerated on a daily basis. This becomes an issue when noise starts to influence users psychologically, physiologically, behaviorally, and even cognitively.

Architecture has become more visually-dominant in the modern era, so architecture itself contributes to this visual distraction. How can architecture address these visual biases and promote aural stimulation? How can architecture manipulate sound so it is celebrated rather than tolerated? This thesis exploits sound to increase aural spatial awareness, and as a byproduct, enhances learning

INSTRUMENT OF ARCHITECTURE: HOW SONIC SENSIBILITY CAN
ENHANCE EDUCATION

by

Joshua Kilian

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Table of Contents

Table of Contents	ii
List of Tables	iii
List of Figures	iv
Chapter 1: Theory	1
Issues of Noise	1
Health	1
Community	2
Sound Theory	3
Sound Level	4
Frequency	4
Propagation	8
Benefits of Music	11
Health	11
Community	12
Education	13
Timbre Taxonomy	14
Chapter 2: Program	16
Concept	16
Why K-8?	23
Detailed Program	26
Chapter 3: School Design & Precedents	32
School Organization	32
Classroom Organization	36
Precedents	38
Chapter 4: Site	40
Criteria	40
Site Selection	46
Chapter 5: Pre-Design	64
Chapter 6: Design	66
Chapter 7: Conclusion	74
Bibliography	75

List of Tables

Table 1: Timbre Taxonomy. By author.	15
Table 2: Optimum Program Checklist. By author.	17
Table 3: Museum Checklist. By author.	18
Table 4: Library Checklist. By author.	19
Table 5: Healthcare Checklist. By author.	20
Table 6: Residential Checklist. By author.	21
Table 7: Office Checklist. By author.	22
Table 8: School Checklist. By author.	23
Table 9: Mid-Atlantic Cities - Adjusted Cohort Graduation Rates. By author.	42
Table 10: District of Columbia Public Schools - Adjusted Cohort Graduation Rate. By author.	43
Table 11: Optimum Site Checklist.	46
Table 12: Site A Checklist. By author.	49
Table 13: Site B Checklist. By author.	51
Table 14: Site C Checklist. By author.	53
Table 15: Site D Checklist. By author.	55
Table 16: Site E Checklist. By author.	57
Table 17: Site F Checklist. By author.	59
Table 18: Site G Checklist. By author.	61
Table 19: Site H Checklist. By author.	63

List of Figures

Figure 1: Sound Level. By author.....	4
Figure 2: Frequency. By author	5
Figure 3: Sound Comparison. By author	6
Figure 4: Frequency Absorption and Reflection. By author.....	7
Figure 5: Frequency Diffusion. By author	8
Figure 6: Propagation. By author.....	9
Figure 7: Sound Classification. By author.....	10
Figure 8: Centralized Resource Plan. By author.....	33
Figure 9: Dumbbell Plan. By author.....	33
Figure 10: Spine Plan. By author.....	34
Figure 11: Courtyard Plan. By author.....	34
Figure 12: Single-loaded Spine Plan. By author.....	35
Figure 13: Clustering Plan. By author.....	35
Figure 14: Courtyard Cluster Plan. By author.....	36
Figure 15: Classroom Organization. By author.....	37
Figure 16: Cluster Organization. By author.....	37
Figure 17: Practice Corridor Concept. By author.....	38
Figure 18: Grand Pavilion. By author.....	39
Figure 19: Urban Schools vs. Suburban Schools. By author.....	40
Figure 20: Footprint Area Range. By author.....	45
Figure 21: Potential Sites. By author.....	47
Figure 22: Site A Region. By author.....	48
Figure 23: Site B Region. By author.....	50
Figure 24: Site C Region. By author.....	52
Figure 25: Site D Region. By author.....	54
Figure 26: Site E Region. By author.....	56
Figure 27: Site F Region. By author.....	58
Figure 28: Site G Region. By author.....	60
Figure 29: Site H Region. By author.....	62
Figure 30: Parti Study. By author	65
Figure 31: Public Space. By author	66
Figure 32: Ground Level. By author.....	67
Figure 33: Basement Level. By author	67
Figure 34: Entrance Lobby. By author	68
Figure 35: Pre-function Space. By author.....	68
Figure 36: Recital Hall - Tuning A. By author	69
Figure 37: Recital Hall - Tuning B. By author	69
Figure 38: Level 3. By author	70
Figure 39: Level 4. By author	70
Figure 40: Music Center and Acoustic Corridor. By author.....	71
Figure 41: Typical Classroom. By author.....	72
Figure 42: Level 5. By author	73
Figure 43: Aural Playground. By author.....	73

Chapter 1: Theory

Issues of Noise¹

“Calling noise a nuisance is like calling smog an inconvenience. Noise must be considered a hazard to the health of people everywhere.”

– Former U.S. Surgeon General William H. Stewart

Noise can be defined as sound that is undesirable. It is something that we experience in our everyday lives, therefore it is easily ignored and often overlooked. However, without careful consideration of acoustics, architectural problems often arise which could be avoided.

Health

The most direct consequence of noise is hearing impairment. It is generally understood that exposure to sound levels exceeding 85 decibels for longer than 8 hours is potentially hazardous. This sound level is comparable to heavy traffic on a busy road. Furthermore, brief durations of sound exceeding 140 dB in adults and 120 dB in children, can potentially cause sudden and permanent hearing loss. These explosions of sound are considered “impulse noise exposures,” such as firecrackers or gunfire.

¹ Goines, Lisa, and Louis Hagler. 2007. "Noise Pollution: A Modern Plague." *Southern Medical Journal* (Lippincott Williams & Wilkins) 100 (3): 287-294.

Another direct consequence of environmental noise is sleep disturbance.

Uninterrupted sleep is vital for physical and mental health, and noise levels as low as 30 dB can potentially disturb sleep. Whether the disturbances involve frequent awakenings, difficulty falling asleep, or waking too early, they can lead to other adverse effects including fatigue, depressed mood, decreased performance, and decreased alertness.

In addition to the repercussions of sleep disturbances, excess noise pollution can lead to temporary and permanent effects on the nervous and cardiovascular systems. Long-term exposure to levels above 65 dB or short-term exposure to levels above 80 dB can lead to temporary increases in blood pressure and heart rate. In terms of permanent damage, studies confirmed the correlation between cardiovascular disease and environmental noise. Although the risk is small, the population and noise levels continue to increase.

Mental health is also effected by noise pollution. Although noise is not considered the direct cause of mental illness, it is believed to accelerate the development of these issues. Noise contributes to anxiety, stress, nervousness, emotional instability, mood changes, hysteria, nausea, and many other symptoms of mental illness.

Community

Noise has been shown to negatively affect behavior, communication and how we relate to one another. For example, annoyance is stimulated by vibration and low frequency noises. Annoyance, or feelings of displeasure caused by an agent, include

feelings of anger, dissatisfaction, withdrawal, helplessness, anxiety, agitation, or exhaustion.

Although subtle and indirect, everyday behaviors are also effected by noise exposure. For example, one may close window or avoid the use of a patio due to environmental noise pollution. Or one may turn up the volume of the television to overcome interference. These effects are subtle and often go unnoticed. Noise exposure can also have emotional and social effects. For example, extended exposure to noise has been shown to cause aggressiveness, unfriendliness, disengagement, or even depression.

According to the EPA, noise can also greatly interfere with spoken communication. Noise pollution directly affects comprehension of normal speech and can lead to problems with concentration, fatigue, lack of self-confidence, irritation, interpersonal relationships, and stress reactions.

Sound Theory²

In order to design for sound, one must understand the physics of sound on a fundamental level. What causes sound? How does sound travel? How do we hear sound? What makes sound loud or quiet? How do sounds differ? Understanding basic characteristics of sound can start to reveal how we perceive sound, and how it impacts our lives.

Sound is created when an object disturbs the molecules in a medium, whether that medium is solid, liquid or gas, and that disturbance is heard. In reference to architectural

² Ermann, Michael A. 2015. *Architectural Acoustics Illustrated*. Hoboken, NJ: Wiley.

acoustics, air is the medium that is most closely examined. Sound travels in a radial motion from its source, and decays at a constant rate until it can no longer be perceived. Therefore, there are three areas of interest regarding sound: sound level, frequency, and propagation.

Sound Level

Sound level refers to the amount of energy that the source transfers. For example, a hard-plucked guitar string excites its adjacent molecules much more than a gently plucked string. This is why a hard-plucked string is perceived as louder. Therefore sound level, or energy, is directly related to loudness: higher energy causes louder sound.

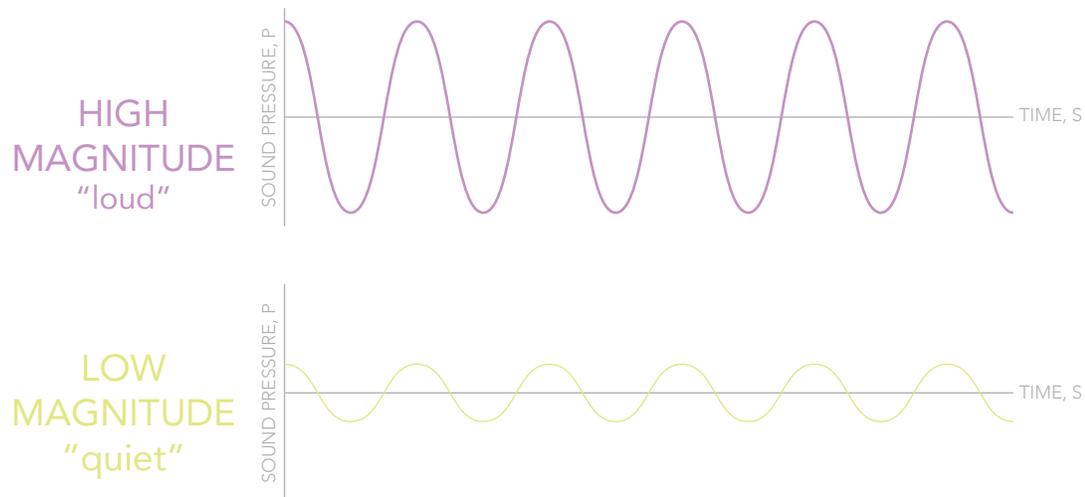


Figure 1: Sound Level. By author

Frequency

In physical terms, the frequency of a sound wave is the number of vibrations per unit of time. The way that we perceive different frequencies is "pitch." Higher frequencies are perceived as higher pitches, and vice versa.

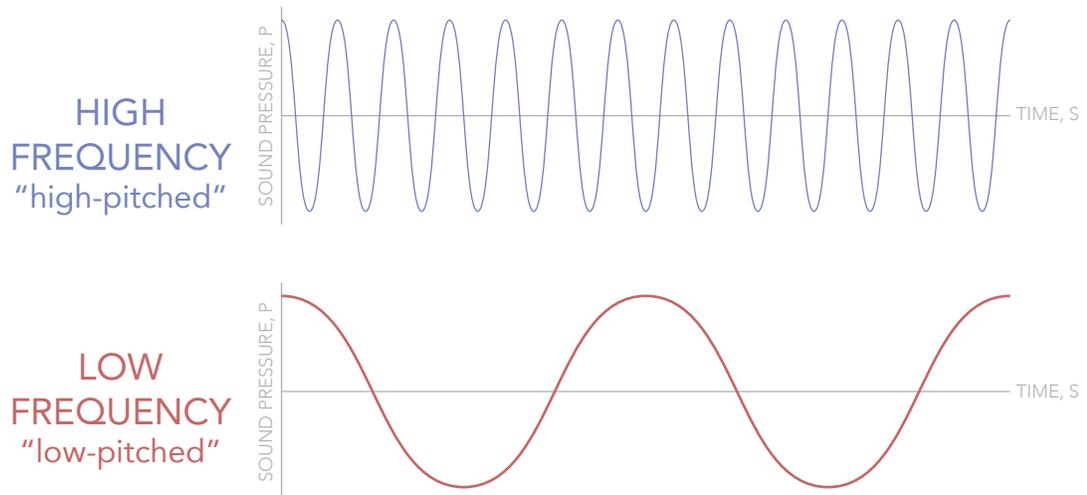


Figure 2: Frequency. By author

Furthermore, there are varying degrees of complexity regarding frequency. A tuning fork, for example, produces a “pure” tone, which means the sound energy is transmitted through a single frequency. Some pure tones, such as an alarm, can be considered annoying to individuals. A “musical” or “harmonic” tone is composed of a fundamental frequency, layered with other proportional frequencies. For example, bowing a violin string produces a “harmonic” tone. “Harmonic” tones are generally the most desired degree of frequency. The majority of sounds we encounter are “complex” or “common” sounds. These sounds are produced by speech and everyday objects, composed of a wide spectrum of frequencies.

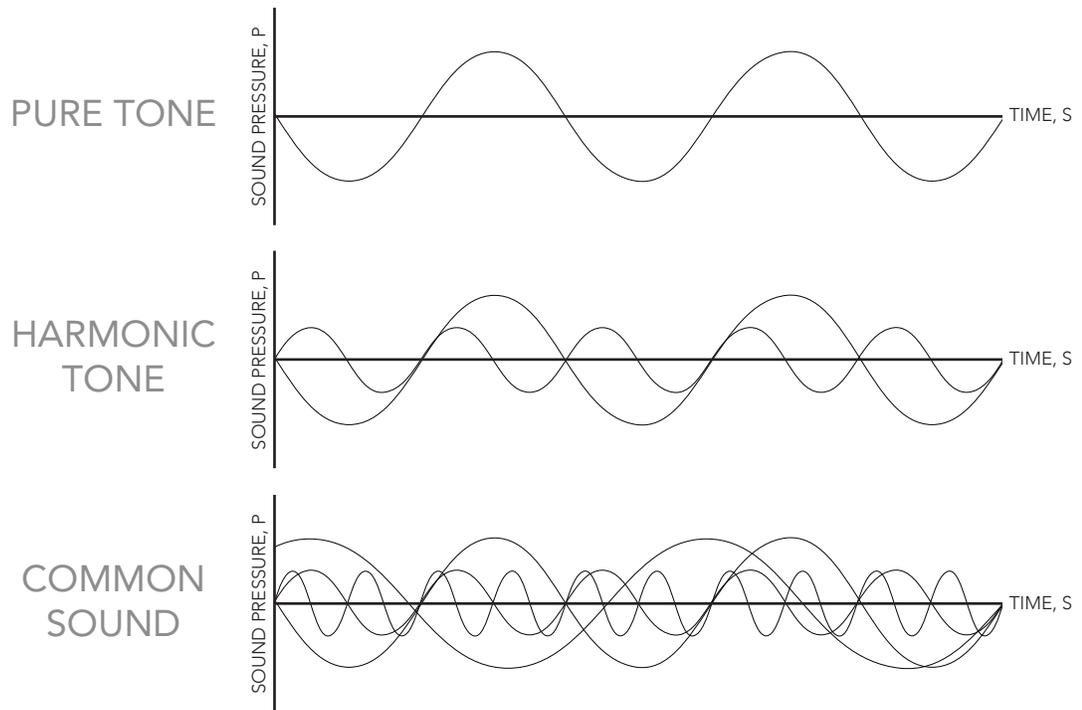


Figure 3: Sound Comparison. By author

In addition to layered frequencies sounding different, individual frequencies themselves have different acoustic behavior. Lower frequencies, for example, require more massive materials to be reflected or absorbed. Similarly, higher frequencies can be absorbed or reflected with less massive materials.

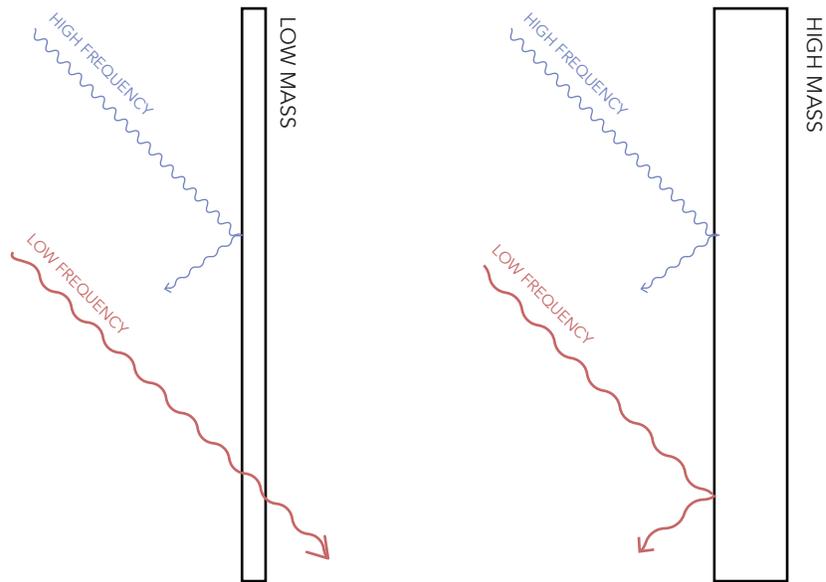


Figure 4: Frequency Absorption and Reflection. By author

Another characteristic of frequencies regarding reflection, is diffusion. Lower frequencies require a material to have larger irregularities in order to be diffused, otherwise they'll simply be reflected. High frequencies require smaller irregularities for the same outcome.

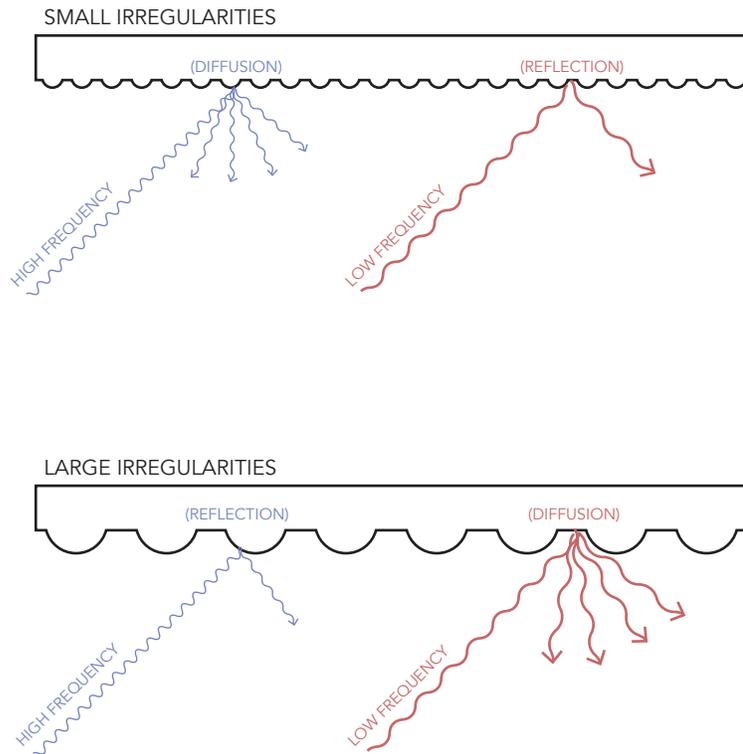


Figure 5: Frequency Diffusion. By author

These behavioral differences will be employed in the final design, which can “filter” or manipulate sounds within a space. Since architecture cannot produce sound itself, these physical phenomena are important when promoting specific qualities of sound that evoke certain moods or social implications.

Propagation

As a sound source begins to vibrate, it transfers energy and excites the adjacent air molecules, causing them to vibrate in turn. From there, the energy continues to transfer in a radial motion, creating a “wave” of molecule vibrations. As the sound wave radiates, the

amount of energy transferred between molecules lessens to the point where the molecule is unable to move the next molecule. This is when the sound stops.

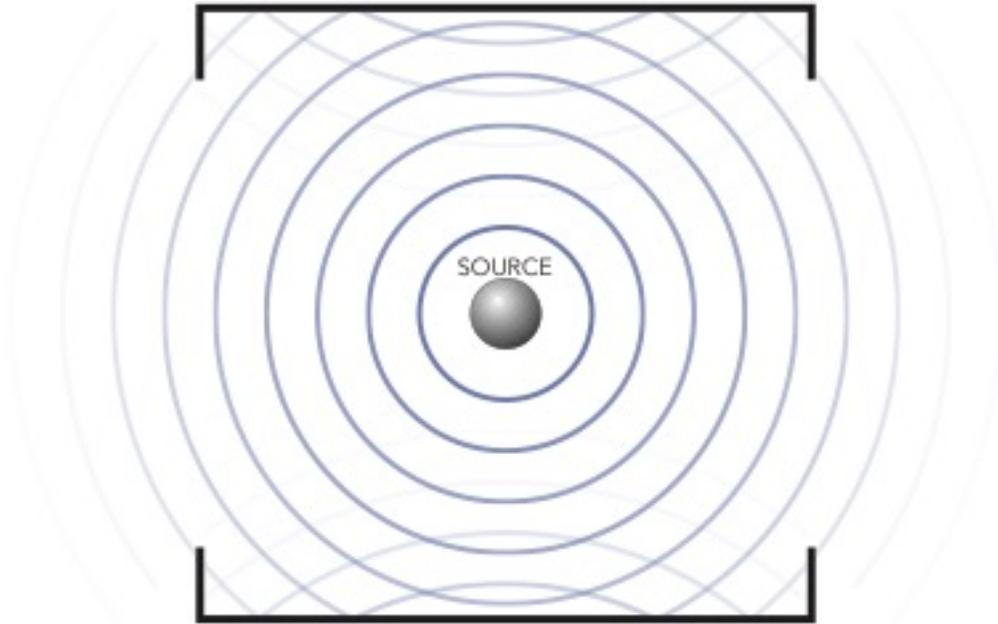


Figure 6: Propagation. By author

*Architectural Acoustics: Principles and Practice*³ compares the concept of a sound wave to a crowded subway car. Consider a person boarding a full train. As that person enters, the passengers nearest to the door must shift their position to make room for the new traveler. This causes passengers further in the train to slightly move, making room for the initial shift. This chain reaction continues, requiring less movement each iteration, until everyone on the train is evenly distributed. The passenger furthest away from the door may not have felt any movement at all. This is the instant where the “sound” stops.

³ Cavanaugh, William J., and Joseph A. Wilkes. 1999. *Architectural Acoustics: Principles and Practice*. New York City, NY: Wiley.

For the purpose of this thesis, sound will be separated into two categories: noise and music. Noise refers to all sounds that are undesirable, whether the sound is loud, unpleasant, or disturbing. On the other hand, sounds that are considered desirable will be classified as music. These sounds may be perceived as pleasant, harmonious, or beautiful.

By separating the tonal layers of different sounds, patterns start to emerge, and one can start to visualize the difference between desirable sounds and undesirable sounds. The figure below illustrates the difference between sound waves by comparing them to a fundamental tone. The musical sound wave is composed of three related tones that form a noticeable pattern. Visually, this sound wave is more harmonious. On the other hand, the “noise” wave consists of several unrelated tones, appearing more chaotic.

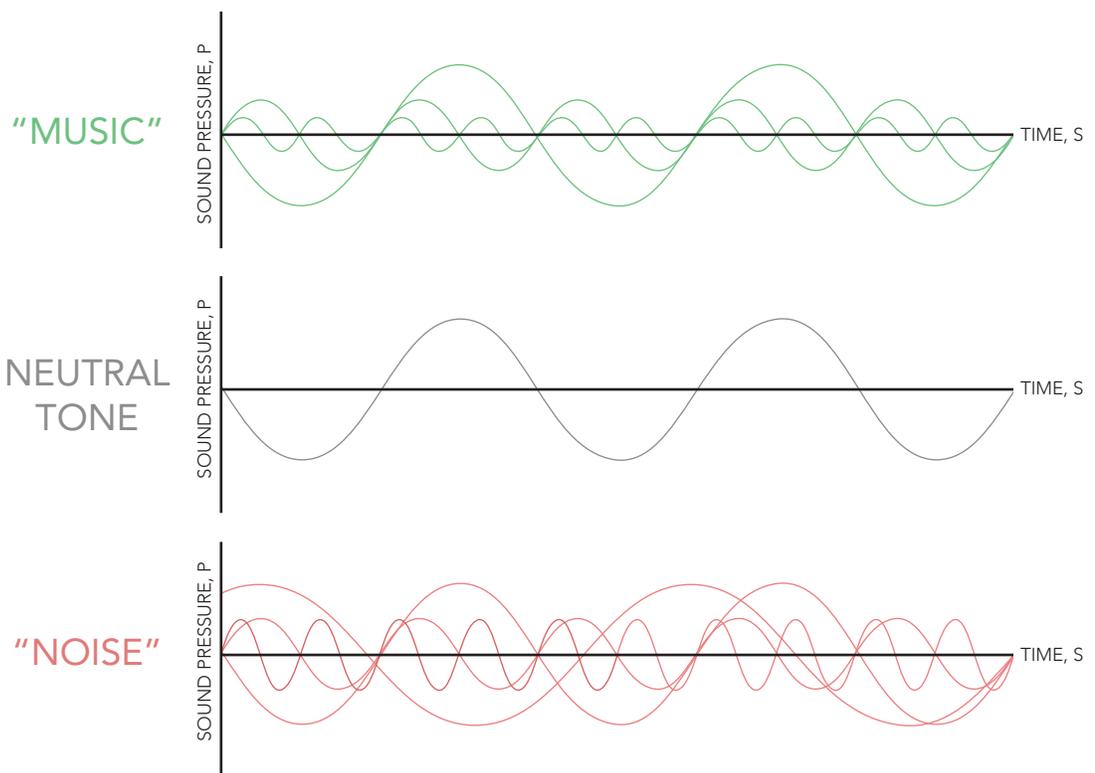


Figure 7: Sound Classification. By author.

Note: This is a scientific generalization. Some sounds are not as easy to classify as “noise” or “music.” For example, the sound wave form of a babbling brook may appear to be complex and disorderly, however many would perceive this as a calming and peaceful sound. This is an instance where emotional perception transcends physical science, and will be further discussed in the section titled “Aural Architecture.”

Benefits of Music

Music is often performed and experienced for the purpose of entertainment and emotional expression. But, there are many benefits of music that go unnoticed. Benefits, ranging from education to physical health, have been scientifically proven. By recognizing these advantages, architects can start to exploit the potential of music to improve the benefits of architectural spaces to those people using them.

Health

Music has been shown to improve health, whether physically, mentally, or emotionally. A study published on *News Everyday*⁴ analyzed the brains of 232 children between the ages of 6 and 18. These brain scans revealed a correlation between musical training and better emotional outlook, anxiety control, and attention to detail. The study

⁴ Kumar, R. Siva. 2015. "Music Makes Your Brain Mature And Improves Motor Skills, Study." *News Everyday*, January 8.

suggests that this is due to “cortical thickening.” By performing music, parts of the brain related to depression and attention become thicker.

Furthermore, a study published in the *International Journal of Alzheimer’s Disease*⁵ suggests that learning music helps protect against dementia. In order to factor out genetic biases, this study focused on identical twins of whom one had already developed dementia. The scientists surveyed the subjects’ musical habits, concluding that those who played musical instruments through adulthood were 36% less likely to develop dementia.

In addition to emotional health and mental health, music has been shown to induce physical improvements. PBS published a study summary⁶ by Boston College regarding motor task competency. Brain scans revealed that children involved in musical instruction had further developed neural pathways. Practicing music requires a degree of repetition and precision that reinforces these neural pathways, which are associated with motor task competency. In short, playing music improves motor skills.

Community

In a review published in *Trends in Cognitive Sciences*,⁷ a series of studies were conducted that compared musical performance and social connection. These studies suggested that synchronous activities, such as musical performances, release chemicals in the brain called oxytocin and vasopressin. Oxytocin is popularly known as the “cuddle

⁵ Davis School of Gerontology, University of Southern California; Department of Psychology, University of Southern California. 2014. "Playing a Musical Instrument as a Protective Factor against Dementia and Cognitive Impairment: A Population-Based Twin Study." *International Journal of Alzheimer's Disease*.

⁶ Brown, Laura Lewis. n.d. "The Benefits of Music Education." *PBS Parents*.

⁷ Chanda, Mona Lisa, and Daniel J. Levitin. 2013. "The neurochemistry of music." *Trends in Cognitive Sciences* 17 (4).

hormone,” due to its role in fostering relationships. In summary, performing music builds relationships.

Education

Education is an area of interest that greatly benefits from music. An article published in SAGE Journals⁸ reviews a series of studies regarding music education and reading ability. In essence, the studies showed a correlation between musical rhythms and phonetic patterns. The studies also suggested that there is a close relationship between learning sounds of music and sounds of the alphabet.

In addition to reading ability, music education has been linked to higher graduation rates. In a survey report *Understanding the Linkages Between Music Education and Educational Outcomes*⁹, researchers discovered that high schools that incorporated music programs had an average graduation rate above 90%. The survey also concluded that high schools without music programs had a graduation rate below 73%.

Music has been shown to aid education in a more general sense as well, improving GPA and IQ's. A survey reported in *The Untapped Power of Music: Its Role in Curriculum and its Effect on Academic Achievement*¹⁰ concluded that music students had higher academic performance rates in all subjects, compared to non-music students. Furthermore, a study summary published in *American Psychology Association*¹¹ concluded that music

⁸ Standley, Jayne M. 2008. "Does Music Instruction Help Children Learn to Read? Evidence of a Meta-Analysis." *SAGE Journals*.

⁹ Harris Interactive Inc. 2006. "Understanding the Linkages Between Music Education and Educational Outcomes."

¹⁰ Kelstrom, Joyce. 1998. "The Untapped Power of Music: Its Role in the Curriculum and its Effect on Academic Achievement." *NASSP Bulletin* 82 (97): 34-43.

¹¹ Munsey, C. 2006. "Music lessons may boost IQ and grades." *American Psychological Association* 37 (6): 13.

education is directly related to higher intelligent quotients. The study was conducted at various age levels, including six-year-olds and college students. Six-year-olds who had received at least one year of instrumental instruction boasted higher IQ's than their non-musical counterparts. Similarly, college students who had at least six years of musical education had higher IQ's than those without.

Timbre Taxonomy

Sounds are difficult to describe. Rather than using basic descriptors like “quiet” or “high-pitched,” sounds can be described in more detail based on their timbre. Often used to describe musical tones, a sound’s timbre refers to its quality or character, independent of its pitch or volume. For example, a middle C played on a piano sounds different than the same note played on a saxophone. The difference is the sound’s timbre. The following table is a list of adjectives and brief descriptions of different timbres. Each adjective is associated with a range of frequencies and magnitudes that could potentially classify the given timbre quality. Furthermore, a range of volumes and materials are proposed, suggesting how these various timbres could be achieved architecturally. These descriptors will be used throughout this thesis to help define the aural quality of the architecture, therefore evoking desired moods, feelings, or senses of various spaces.

Note: Throughout this document, these descriptors are italicized.

Table 1: Timbre Taxonomy. By author.

QUALITY	TIMBRE	DESCRIPTION	EFFECT	CAUSE
INTENSITY	LIGHT	thin, soft, mid-high frequencies	TEMPERAMENT/ MOOD	ATTENUATION DIFFUSION
	HEAVY	full, loud, low-mid frequencies		
GRAIN/TEXTURE	MELLOW	smooth, soft, free from harshness	ATTITUDE/ INTEREST	GEOMETRY REFLECTION ATTENUATION
	STRIDENT	harsh and grating		
REVERBERATION	MUTED	soft, muffled, quiet	SENSE OF SECURITY	ATTENUATION VOLUME
	RESONANT	deep, clear, prolonged and ringing		
SPECTRUM	PIERCING	extremely high, sharp, shrill	EMOTION	ATTENUATION VOLUME REFLECTION
	BRIGHT	high, crisp, thin		
	ROUNDED	balanced, mixture of high frequency and low		
	WARM	full, low-mid frequencies		
	DARK	excessively warm		

Chapter 2: Program

Concept

Before selecting a program type, it is important to consider all areas of life that are affected by sound, whether positively or negatively. Based on the research discussed in the sections “Issues of Noise” and “Benefits of Music,” there are three areas of life that are most effected by sound: health, community, and education. Each of these areas of interest can be subcategorized. The health category includes physical, mental, and emotional health. The community category is composed of communication, relationships, and behavior. And education includes cognitive performance, task performance, and attention. All of these subcategories are directly influenced by sound, whether positively, negatively, or both.

By creating a checklist of these subcategories, it becomes possible to test various program types against their relevance to this project. The program that relates to most aural aspects of life will become the most pertinent thesis project, with the greatest potential for success. This method will explore various programs and rank each subcategory in terms of relevance, ranging from irrelevant to moderately relevant to extremely relevant. The ideal program type will be extremely relevant to all nine subcategories, as it appears on the checklist in the figure below.

Table 2: Optimum Program Checklist. By author.

PERTINENCE CHECKLIST			
HEALTH:			
Physical	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mental	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Emotional	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
COMMUNITY:			
Communication	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Relationships	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Behavior	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
EDUCATION:			
Cognitive Performance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Task Performance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Attention	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The first building type to be tested is the museum. Considering the educational role of museums, this typology is potentially relevant to this thesis. The museum can be music or sound-related, capitalizing on all the benefits of musical performance and education. Therefore educationally, the museum typology is appropriate. However, a museum can be experienced by people individually or grouped, so communication and relationships are less relevant. Furthermore, given the average amount of time a typical person spends in a museum, health is only moderately affected.

Table 3: Museum Checklist. By author.

PERTINENCE CHECKLIST			
HEALTH:			
Physical	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Mental	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Emotional	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
COMMUNITY:			
Communication	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Relationships	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Behavior	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
EDUCATION:			
Cognitive Performance	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Task Performance	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Attention	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Like the museum type, libraries are considered educational building types. A significant difference however, is the amount of time spent in a library. Therefore, health becomes slightly more of a concern. Unfortunately, libraries are generally experienced individually, so communal issues of sound are limited, offering little potential for improvement in that category.

Table 4: Library Checklist. By author.

PERTINENCE CHECKLIST			
HEALTH:			
Physical	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Mental	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Emotional	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
COMMUNITY:			
Communication	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Relationships	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Behavior	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
EDUCATION:			
Cognitive Performance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Task Performance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Attention	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The previous examples were relevant regarding education, however the issues of health and community were very secondary. Consider a type related to healthcare, such as a hospital or nursing home. All three subcategories relating to health become vital. The category of community is more relevant as well – communication and establishing relationships among patients and caregivers are important in recovery. Aspects of education, including attention and cognitive performance are considerable as well, but not vital to recovery.

Table 5: Healthcare Checklist. By author.

PERTINENCE CHECKLIST			
HEALTH:			
Physical	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mental	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Emotional	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
COMMUNITY:			
Communication	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Relationships	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Behavior	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
EDUCATION:			
Cognitive Performance	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Task Performance	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Attention	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Next, consider another building type in which individuals spend large portions of their day: residential. Due to the amount of time spent at home, all aspects of health are important concerns during the design of a residence. Furthermore, some of the most important relationships are formed at home, so the community category is critical as well. However, like the healthcare type, the education category is moderately relevant but not vital during the hours spent at home.

Table 6: Residential Checklist. By author.

PERTINENCE CHECKLIST			
HEALTH:			
Physical	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mental	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Emotional	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
COMMUNITY:			
Communication	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Relationships	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Behavior	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
EDUCATION:			
Cognitive Performance	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Task Performance	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Attention	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Another building type where individuals can spend a large portion of their time is the commercial office building, therefore health in the workplace is an important concern. Also, attention and performance are often critical in workers' productivity. Similarly, communication and behavior play large roles in professional environments. Therefore, all three major categories in which sound is influential are present. The only imperfection in the Commercial Checklist is "Relationships." Fostering strong relationships with coworkers can be beneficial, but not necessary for success in the workplace.

Table 7: Office Checklist. By author.

PERTINENCE CHECKLIST			
HEALTH:			
Physical	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mental	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Emotional	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
COMMUNITY:			
Communication	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Relationships	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Behavior	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
EDUCATION:			
Cognitive Performance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Task Performance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Attention	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

While the commercial office type offers nearly perfect relevancy to this thesis, there is little potential for incorporating musical performance or education in a professional work environment. Consider an educational facility, such as a school. Cognitive performance, task performance, and attention are among the most essential criteria for a successful school. Users spend large portions of their developmental years in school, so physical, mental, and emotional health are critical considerations. Furthermore, communication and relationships among students and teachers are crucial for effective learning environments.

Table 8: School Checklist. By author.

PERTINENCE CHECKLIST			
HEALTH:			
Physical	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mental	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Emotional	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
COMMUNITY:			
Communication	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Relationships	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Behavior	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
EDUCATION:			
Cognitive Performance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Task Performance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Attention	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

A school-related program offers the most potential for success in this thesis, due to its relevancy illustrated in the School Checklist. A musical program can be easily incorporated, further ensuring the highest success rate. Therefore, a music school is the most appropriate program for this thesis project.

Why K-8?

The next question to consider is: what grade levels shall be included in this music school to yield the highest success rate? Pre-school? Elementary school? Middle school? High school?

Some of the studies discussed in the section “Benefits of Music” were conducted on teens and adolescents, however the majority of the studies involved children as young

as five or six. For example, the study summary published in *American Psychological Association*¹² revealed a correlation between instrumental music study and higher IQ's in children as young as six years old. This suggests the importance of getting children involved in musical education at a young age.

Many of the studies however, involved a range of students up through high school. The study¹³ relating musical education and academic achievement, for example, was primarily focused on standardized test scores of high school students. Therefore, it is apparent that music-related education is beneficial for all grade levels and ages. It is important to introduce instrumental education to children at a young age, and continue to reinforce this education as long as possible. Ideally, having continuous education in music throughout one's academic career would yield the most successful results.

According to an article¹⁴ published by the Southwest Educational Development Laboratory, there has been an enormous shift in primary school configurations over the past two decades. The article refers to a nationwide Missouri State University database, reporting that since 1994, 1759 schools in 49 districts throughout the country have either adopted, or are preparing to adopt a K-8 school configuration. Why the dramatic shift?

The article explains the brief history of primary school configurations. Up until the late 1960's, K-8 schools dominated the educational scene. Around this time, school districts began separating elementary schools and middle schools to meet the unique psychological needs of young adolescents in grades six through eight. A few decades

¹² Munsey, C. 2006. "Music lessons may boost IQ and grades." *American Psychological Association* 37 (6): 13.

¹³ Kelstrom, Joyce. 1998. "The Untapped Power of Music: Its Role in the Curriculum and its Effect on Academic Achievement." *NASSP Bulletin* 82 (97): 34-43.

¹⁴ Blair, Leslie. 2008. "Back to the Future: The Shift to K-8 Schools." *SEDL Letter* 20 (1).

later, school districts reported dissatisfaction with academic achievement and behavior. In the late 1990's, these districts began converting back to the K-8 model.

According to the article *Revival of the K-8 School*,¹⁵ there is little empirical evidence confirming that K-8 schools are universally more successful than middle schools, due to the inability to control the countless variables. However, local data and speculation have convinced districts across the country to convert. The article states that Baltimore, for example, has reported better attendance, lower dropout rates, and better test scores for children in K-8 schools.

There has been much speculation about the reasons behind this data. The primary reason is the sense of continuity and stability that K-8 configurations offer. Students remain in the same school for longer, therefore relationships between students, parents, and faculty are built stronger. Teachers focus more on students' individual needs, rather than just course content. During these impressionable and transitional years, this type of focus is vital for successful development.

As the previous research suggests, continuity in musical education has the potential for yielding numerous advantages. Every age group can benefit from instrumental instruction in one way or another, so it is important for students to remain in musically oriented classes as long as possible. K-8 schools offer this necessary continuity, therefore a K-8 music school is the most appropriate program for this thesis.

¹⁵ Pardini, Priscilla. n.d. "Revival of the K-8 School." AASA. Accessed April 16, 2017. <http://www.aasa.org/SchoolAdministratorArticle.aspx?id=10396>.

Detailed Program

The program of this K-8 music school is based on data found in the Baltimore City Public Schools Educational Specifications.¹⁶ This document outlines requirements and detailed program spaces for a typical K-8 school with three student capacities: 500, 750, and 1000. This thesis project is designed to accommodate the smaller capacity – 500 students – to promote a more intimate environment. The program has been adjusted to fit a musical curriculum, including spaces like practice rooms, instrumental classrooms, instrumental storage, and other spaces outlined below. These adjustments are based on the program of music schools including George Washington Carver Center for Arts and Technology (Grimm + Parker), and The Clarice Smith Performing Arts Center (Moore Ruble Yudell and Ayers Saint Gross). The spaces are as follows:

Administration (1,500 sqft)

Description: Administration spaces include reception, conference room, principal's office, vice principal's office, faculty lounge, and other support spaces.

Aural Quality: The majority of the spaces in the administration category are offices. The principal's office, for example, is a place for quiet contemplation and an occasional visit from faculty members or students. It shall be designed to evoke a welcoming sense of warmth, while maintaining professionalism and privacy. Therefore, these spaces require acoustics described as *warm* and *clear*. Similar to the office, the

¹⁶ Baltimore City Public Schools. n.d. "Baltimore City Public Schools Educational Specifications." *Baltimore City Schools*. Accessed April 2017. <http://www.baltimorecityschools.org/cms/lib/MD01001351/Centricity/Domain/8784/PDF/20130813-EdSpecs-PartII-PreKto8-ForWeb.pdf>.

faculty lounge is a calming and welcoming space. Unlike the offices however, the faculty lounge is more public to the administration and shall allow for relaxation and casual conversation. Therefore, it shall be aurally described as *clear*, *mellow*, and *bright*. The conference room is another integral space in the administration section. The primary function of this space is hosting professional meetings and conversations. In order to facilitate focus and energy, the acoustics shall be *bright* and *clear*. The most public of administration spaces is general-reception. Serving as the school's threshold, this space welcomes students and visitors, and promotes the school's sense of spirit and pride. The acoustics of this threshold shall be *light* and *resonant*.

Student Services (1,500 sqft)

Description: Student Services consist of three major categories: Guidance, Health, and Support Services. Guidance includes office, reception, and conference room. The Health Suite is composed of a waiting area, exam rooms, rest areas, office, and storage. Support Services include offices for the psychologist and social worker.

Aural Quality: The office, reception, and conference room of the Guidance category host similar functions to the Administration category, so the acoustics shall be designed with comparable qualities that were listed above. The Health Suite, however, is a place of rest and healing. The waiting room, exam rooms, and rest areas require *warm* and *mellow* sounds to ease recovery and relaxation. The Support Services, including the offices of the social worker and psychologist, are treated differently than the Administration offices. These spaces feel more relaxed and comforting to build relationships between students and staff. *Light* and *warm* sounds help achieve this.

Teaching and Learning (24,500 sqft)

Description: Each grade is assigned to two 900-sqft classrooms, clustered in three groups: K-2, 3-5, and 6-8. The clusters are designed to fit the needs of the respective age groups, and allow for interaction among clusters in shared spaces. These spaces are collaborative learning areas and other resources.

Aural Quality: Perhaps the most important spaces of a school, the classrooms require much acoustical attention. In these spaces, students are expected to focus and collaborate, while feeling confident and safe. *Clear* and *rounded* spaces are ideal for this function. Due to the curriculum of the school, musical instruction and performance will often take place in classroom settings, therefore classrooms shall be equipped for such events. Depending on the type of instrument or music, acoustical qualities will vary. Slower, tonal music that is vocalized or played by strings sounds best in more *dark*, *resonant* spaces. Instruments with wider ranges, like the piano and various woodwinds, require a more *mellow*, *rounded* space. And louder, more staccato sounds, like percussion, are best experienced in *clear* spaces. Due to the diverse needs of the classrooms, the school shall include a range of spaces with varying acoustical qualities.

Special Education (3,000 sqft)

Description: The Special Education department is composed of three classrooms, an office, and spaces for therapy and storage.

Aural Quality: The classrooms of the Special Education department have similar qualities to the other classrooms. Due to the special needs of the users, however, these spaces must promote stronger senses of calm and focus, with *warm* and *clear* aural qualities.

Sciences (1,100 sqft)

Description: Lab and storage is provided for upper grade levels.

Aural Quality: Lab users require a space for listening, demonstrating, and collaborating. Hands-on activities and collaboration often produce excess noise, so it is important to provide a space that is *clear* and *mellow*.

Fine Arts (13,000 sqft)

Description: The Fine Arts departments consists of Visual Arts and Music.

Visual Arts includes a studio space and storage. Music spaces are an integral portion of the program, including instrument storage, instrument repair room, practice rooms of various sizes, recording studio, recital room, and 8000-sqft auditorium.

Aural Quality: The Visual Arts studio is a space that must foster creativity and inspiration for hands-on activities, like drawing, painting, and sculpting. Although focus is required, the atmosphere is slightly more relaxed compared to the science lab, in order to promote free thought and exploration. Therefore, *bright* and *mellow* aural qualities are desired. The Music department is a far more complex acoustical consideration. The practice rooms, for example, will vary in acoustical qualities depending on the respective instrument, much like the classrooms. The recital room and the auditorium are similar, in that they are designed to accommodate a wide range of performances. In general, the recital room and the auditorium have *mellow, rounded* sound qualities to satisfy these varied needs. However, each space employs a system of drapes and partitions that can be adjusted depending on the performance. This allows the spaces to sound *light* and *clear*, or *dark* and *resonant*.

Technology Education (1,000 sqft)

Description: Lab and supply storage is provided for Technology Education.

Aural Quality: The Technology lab, much like the other labs, hosts hands-on activities, but require a higher degree of focus. Excess noise is a consideration, therefore a *warm, clear*-sounding space is best suited for this function.

Physical Education (7,000 sqft)

Description: Physical Education department includes 6000-sqft gymnasium, with support spaces including office, storage, locker rooms, and toilets.

Aural Quality: The most prominent space in the Physical Education department is the gymnasium. High-energy activities are performed in this space. Whether the user is an athlete or spectator, the goal of this space is to facilitate excitement, confidence, and school spirit. *Bright* and *strident* are sounds that describe the gymnasium. Similarly, the locker rooms are spaces that promote confidence and school spirit. Since these spaces are more private, however, they have qualities sounding more *mellow*.

Media (2,000 sqft)

Description: Media room is supported by workroom, storage, and head end room.

Aural Qualities: The media room is a space where users experience sounds and visuals that are entirely produced or recorded. Therefore these spaces must be *clear* and *rounded* in order to reinforce the production quality of the media.

Food Services (4,500 sqft)

Description: Food Services include 2000-sqft dining, with support spaces including, storage, kitchen, office, dish room, and other service spaces.

Aural Qualities: The dining hall is a crowded, noisy space where users want to relax, converse, and enjoy a meal. Therefore, to reduce noise and promote a calming

atmosphere, the quality of sound must be *mellow* and very *clear*. Similarly, the kitchen is a noisy space where communication and productivity are important aspects. A calming yet energetic environment is desired, therefore the space is designed to sound *bright* and *clear*.

Building Services (1,000 sqft)

Descriptions: Building Services include security office, custodial closets, toilets, and lockers.

Aural Quality: Spaces in the Building Services category potentially create excess noise for other functions of the building, therefore it is important to acoustically isolate these spaces.

Community Space (700 sqft)

Description: Family resource room, office, storage, and pantry are included for the community.

Aural Quality: In addition to teaching and learning, a primary goal of the school is to engage the community, therefore the Community Spaces must feel very public and welcoming. The family resource room, office, and pantry therefore have qualities of sound that are *warm* and *bright*.

Total Area: 62,000 sqft

Chapter 3: School Design & Precedents

School Organization

The following series of organizational diagrams have been reproduced from a text¹⁷ on school design. These plan diagrams illustrate horizontal spatial relationships, and apply to more normative, sprawling schools. Therefore, their organizations may not directly relate to an urban music school, of which the program will likely be compressed and stacked. However, the ideologies of each are important to study, and can likely be translated vertically.

The diagrams are composed of four major elements: shared facilities, classrooms, class nodes, and circulation. Shared facilities include spaces like the gymnasium, dining hall, and auditorium. These functions are available to the entire school. Class nodes, on the other hand, are located throughout the building and serve a defined cluster of classrooms. These nodes include spaces such as offices, restrooms, and project rooms.

Centralized Resource Plan: The most basic organizational concept is centralizing the shared resources. In doing so, travel distances are limited and classroom clusters are naturally divided. This is common in schools with fewer shared facilities and larger populations, when subdivisions are desired. Due to the nature of this thesis, aspects of this organization are desired.

¹⁷ Kliment, Stephen A. 2001. *Building Type Basics for Elementary and Secondary Schools*. John Wiley & Sons, Inc.

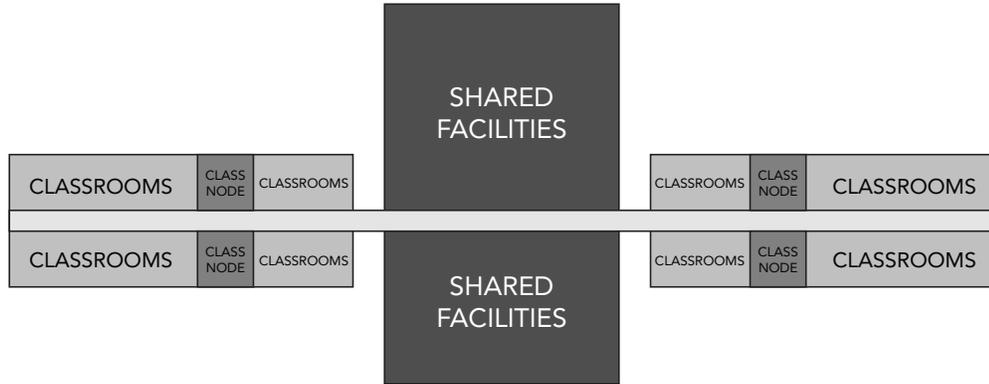


Figure 8: Centralized Resource Plan. By author.

Dumbbell Plan: Contrary to the Centralized Resource Plan, the Dumbbell Plan pushes the resources to the periphery. This prototype is spatially efficient and allows natural wayfinding, however it provides fewer opportunities for classroom clustering. Therefore, this thesis avoids this organizing principal.

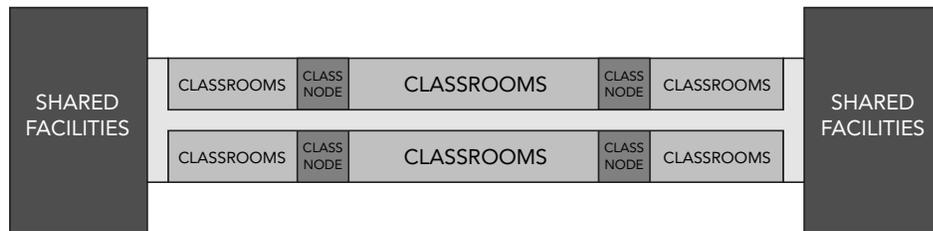


Figure 9: Dumbbell Plan. By author.

Spine Plan: This arrangement is defined by a main corridor with centralized resources and double-loaded classroom corridor branches. This ideology allows for classroom subdivisions and outdoor spaces between.

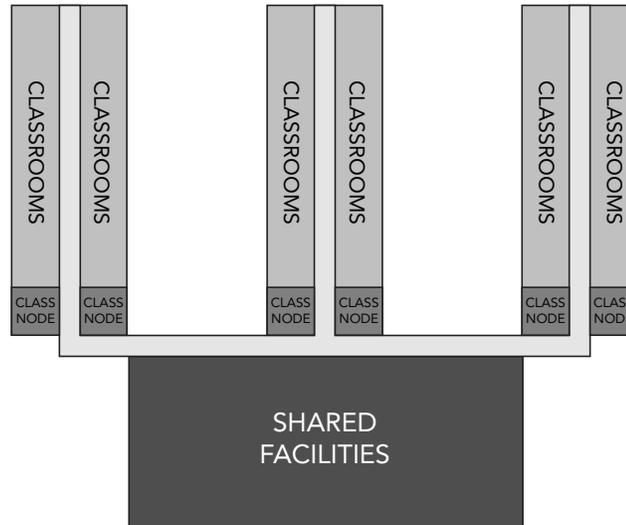


Figure 10: Spine Plan. By author.

Courtyard Plan: This is a very common school parti. Courtyards of this type are secure, and support classroom functions. It is important to consider climatic implications, as well as program adjacencies that could potentially conflict and distract each other in a plan like this.

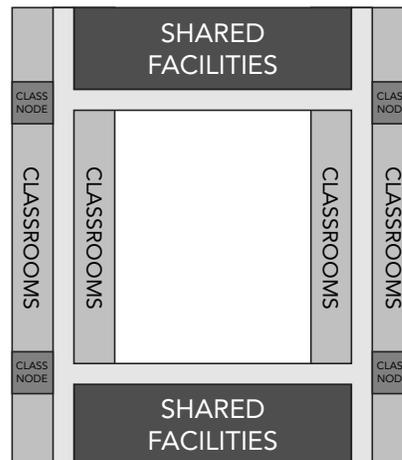


Figure 11: Courtyard Plan. By author.

Single-Loaded Spine Plan: Like the Spine Plan, this parti is organized about a main corridor and centrally located resources. A benefit of the single-loaded corridor is that

each side of the corridor is programmatically differentiated. This allows for easier wayfinding.

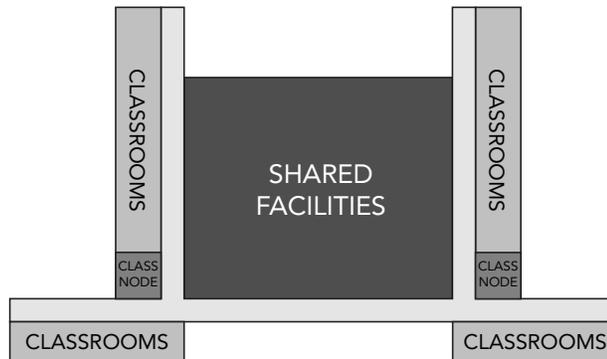


Figure 12: Single-loaded Spine Plan. By author.

Clustering Plan: This plan is similar to the Dumbbell Plan, due to its location of the shared facilities. This organization, however, is defined by its clustered arrangement. This provides a hierarchy of corridors when excess travel noise is a concern. Therefore, this arrangement is greatly desired for this thesis.

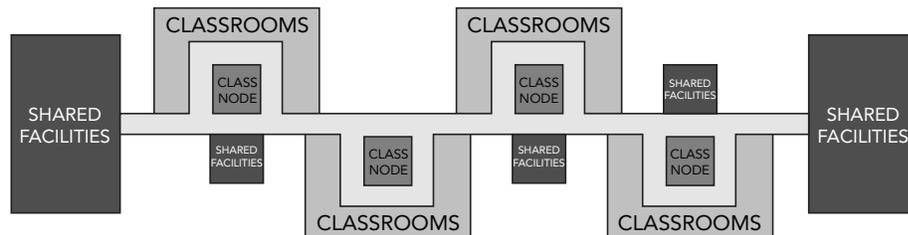


Figure 13: Clustering Plan. By author.

Courtyard Cluster Plan: Various ideologies can be combined, providing mutual benefits. The Courtyard Clustering Plan is a variation on the Courtyard Plan. Like the Clustering Plan, classrooms are subdivided and the circulation is hierarchical, reducing excess foot-traffic.

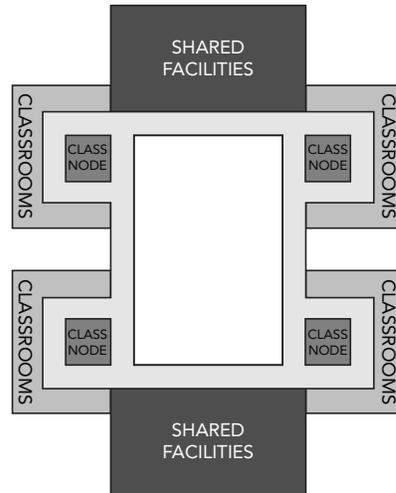


Figure 14: Courtyard Cluster Plan. By author.

Classroom Organization

Now that it has been established that a classroom-clustering organization is desired for this thesis, it is important to understand the ideal spatial relationships within those clusters. A document¹⁸ provided by Grimm + Parker outlines the educational specifications for Baltimore City Public Schools, and includes prescribed spatial relationships among classroom clusters in a 21st century learning environment. The document also illustrates spatial relationships between clusters as well. Both concepts are intended for K-8 school prototypes, and are reproduced in the diagrams below.

According to the document, classrooms must be designed flexibly, supporting one-to-one teaching, group teaching, and group activities. By arranging the classrooms

¹⁸ —. n.d. "Baltimore City Public Schools Educational Specifications." *Baltimore City Schools*. Accessed May 2017.
<http://www.baltimorecityschools.org/cms/lib/MD01001351/Centricity/Domain/8784/PDF/20130813-EdSpecs-PartI-ForWeb.pdf>.

like the cluster illustrated below, each space has access to the resources, planning, and collaborative rooms. The collaborative learning space is the most flexible.

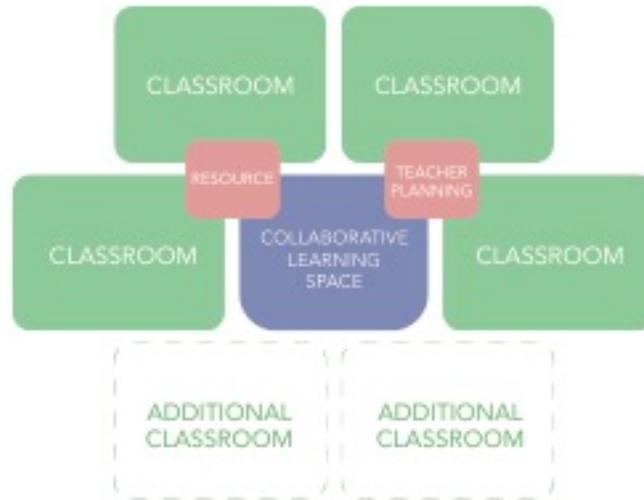


Figure 15: Classroom Organization. By author.

The relationships among the clusters is a careful consideration as well. Spaces like art studios and science labs must be near the edge of the clusters, because these functions are shared among clusters and not repeated throughout.

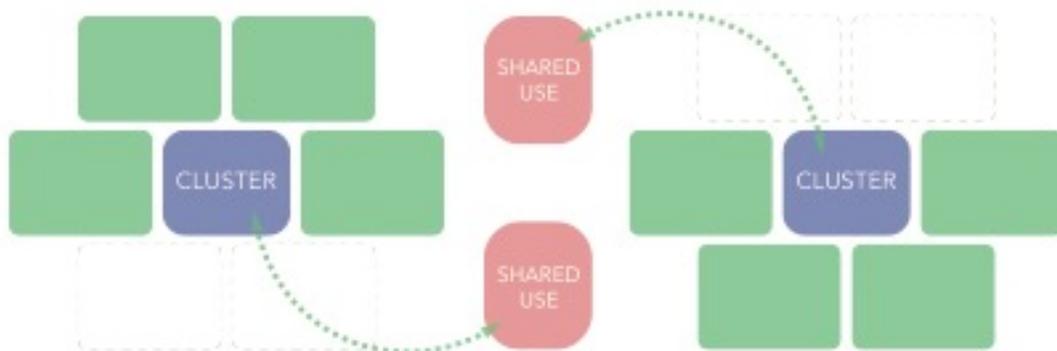


Figure 16: Cluster Organization. By author.

Precedents

Now that organizing principals have been established on a variety of scales, it is important to look to precedents for more specific design moves, relating to music, acoustics, and education.

Grimm + Parker's George Washington Carver Center for Arts and Technology, for example, is a high school that is focused on visual and performing arts. The main atrium space has a wall where student work is displayed for everyone to see. This reinforces the pride and motivation, and allows the students to learn from each other. This visual display can be translated aurally and applied to this thesis. A series of practice rooms, organized along a corridor can allow passersby to experience the music of other students. If each experience is acoustically separated, one can travel along the corridor hearing a spectrum of discrete musical performances. This concept is illustrated in the diagram below.

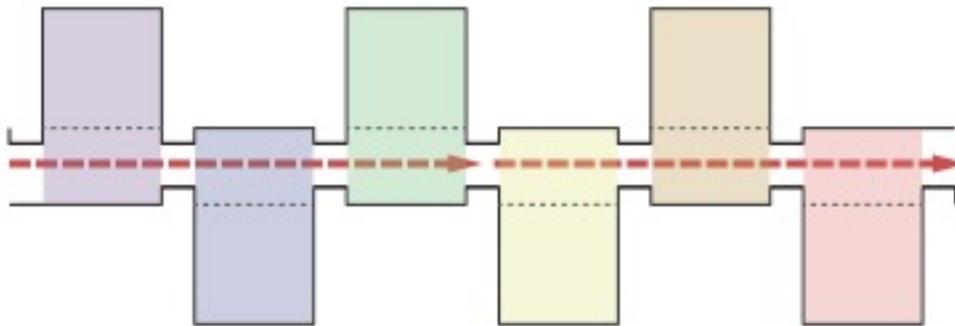


Figure 17: Practice Corridor Concept. By author.

The Clarice Smith Performing Arts Center is another example from which a lot of concepts can be derived. Designed by Moore Ruble Yudell, this performing arts complex is organized around a gathering space called “the Grand Pavilion.” In addition to gathering, this residual space also functions as the primary circulation.

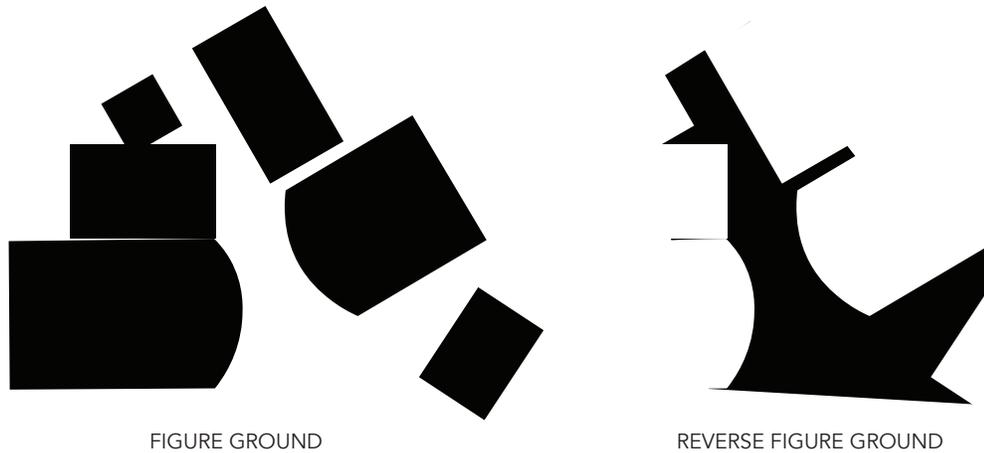


Figure 18: Grand Pavilion. By author.

This concept, along with many other, can be emulated in this thesis. For example, the foundations of each performance space are isolated by rubber barriers, preventing sound waves from traveling through the structure to undesired locations. Furthermore, oversized air ducts are employed and use gravity to circulate, rather than active pumps, to reduce excess noise interference. Circulation corridors are used as sound buffers between performance spaces and public spaces. All of these details, include several others, are pertinent to this thesis.

Chapter 4: Site

Criteria

The goal of this K-8 music school is to improve academic performance, attendance, and graduation rates using sound. Therefore, an important question to ask is: what school district is most in need for improvement? According to The New York Times¹⁹, there is a noticeable gap between graduation rates of urban schools versus suburban schools. In the nation's 50 largest cities, only 53 percent of students graduate high school on time, compared to the 71 percent of their suburban counterparts.



Figure 19: Urban Schools vs. Suburban Schools. By author.

This discrepancy, nearly 20 percent, suggests that this thesis be sited in an urban environment to produce the greatest improvement.

¹⁹ Dillon, Sam. 2009. "Large Urban-Suburban Gap Seen in Graduation Rates." *The New York Times*.

The next unanswered question is: what city? Consider the graduation rates of the 8 largest cities in the central-Atlantic region: Boston²⁰, New York City²¹, Philadelphia²², Baltimore²³, Washington D.C.²⁴, Virginia Beach²⁵, Raleigh²⁶, and Charlotte²⁷.

²⁰ Boston Public Schools. 2016. *BPS graduation rate at historic high*. January. Accessed April 20, 2017.

<http://bostonpublicschools.org/site/Default.aspx?PageType=3&DomainID=4&PageID=1&ViewID=047e6be3-6d87-4130-8424-d8e4e9ed6c2a&FlexDataID=9427>.

²¹ NYC Department of Education. n.d. "Graduation Dropout Reports." Accessed April 20, 2017.

<http://schools.nyc.gov/Accountability/data/GraduationDropoutReports/default.htm>.

²² Cineas, Fabiola. 2015. "Overall Pa. graduation rates respectable, but some urban districts lagging." *Keyston Crossroads*.

²³ Baltimore City Public Schools. 2016. "Graduation Rate Holds Steady, Dropout Rate Increases." February 12. Accessed April 20, 2017.

http://www.baltimorecityschools.org/cms/lib/MD01001351/Centricity/Domain/9714/20160212_GradDropout-PressRelease-FINAL.pdf.

²⁴ Office of the State Superintendent of Education. n.d. "DC 2016 Adjusted Cohort 4-Year Graduation Rate." Accessed April 20, 2017.

<https://osse.dc.gov/sites/default/files/dc/sites/osse/publication/attachments/Adjusted%20Cohort%20Graduation%20Rate%20Overview%202015-16.pdf>.

²⁵ Virginia Beach City Public Schools. n.d. "On-Time Graduation Rate." Accessed April 20, 2017. [http://www.vbschools.com/school_data/content/pdfs/On-](http://www.vbschools.com/school_data/content/pdfs/On-TimeGraduation.pdf)

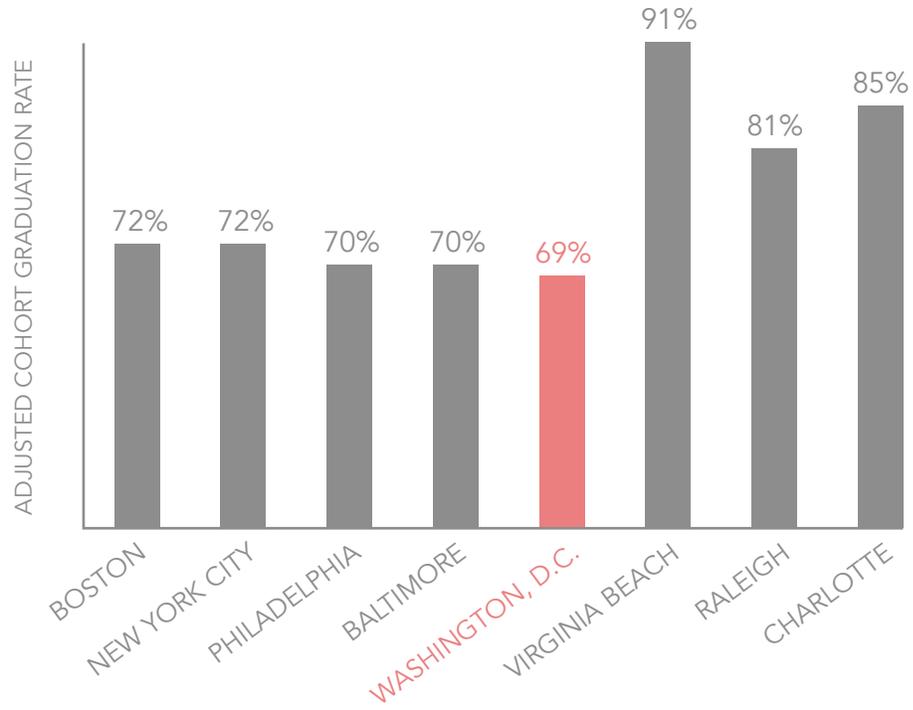
[TimeGraduation.pdf](http://www.vbschools.com/school_data/content/pdfs/On-TimeGraduation.pdf).

²⁶ Regan, Roger. 2014. "WCPSS High School Graduation Rates 2012-13." May. Accessed April 20, 2017. [https://webarchive.wcpss.net/results/reports/2014/grad-rate12-](https://webarchive.wcpss.net/results/reports/2014/grad-rate12-13.pdf)

[13.pdf](https://webarchive.wcpss.net/results/reports/2014/grad-rate12-13.pdf).

²⁷ Dunn, Andrew. 2014. "Charlotte-Mecklenburg Schools graduation rate hits new high." *The Charlotte Observer*.

Table 9: Mid-Atlantic Cities - Adjusted Cohort Graduation Rates. By author.



Among the 8 cities, Washington, D.C. has the lowest graduation rate – 69 percent. This is the city that requires the most improvement, therefore the site will be located in a Washington, D.C. school district.

Next, consider the nine Washington, D.C. high school districts: Wilson, Coolidge, Roosevelt, Cardozo, Dunbar, Eastern, Woodson, Anacostia, and Ballou.

Table 10: District of Columbia Public Schools - Adjusted Cohort Graduation Rate. By author.



Considering the spatial requirement of 62,000 square feet, potential sites are selected in the high school districts below the 69% graduation rate average: Coolidge, Roosevelt, Cardozo, Anacostia, and Ballou.

Once selected, each site is tested against five criteria: graduation rate, level of urbanity, access, available space, and adjacency to competing schools. The most poignant of the criteria is the graduation rate. By choosing a site in a district with lower graduation rates, there is more of a need for improvement, therefore justifying the project and location. The second criterion is the level of urbanity. For the sake of this thesis, “level of urbanity” refers to the immediate density and traffic of the site. As discussed earlier, urban schools tend to be less successful, so measuring the extent to which a school is “urban” is an important consideration. Furthermore, dense areas tend to be

noisier, offering more opportunity to exploit various sounds and enrich the design. Another important consideration is access. According to the article *Maximizing Walkability, Diversity, and Educational Equity in U.S. Schools*²⁸, adequate access promotes health and diversity in schools. Therefore, access is closely examined through walkability and public transportation. The next criterion to be satisfied is available space. The program requires roughly 62,000 square feet. Including outdoor activity space and parking, the project footprint can be over 100,000 square feet if the entire building is kept at ground level. On the other hand, if program is stacked, including below-grade parking and outdoor roof terraces, the footprint can be as little as 20,000 square feet. Therefore, the ideal site area shall fall within the range illustrated in the following figure.

²⁸ Vincent, Jeffrey, Deborah McKoy, and Mary Filardo. 2013. "Maximizing Walkability, Diversity, and Educational Equity in U.S. Schools." (PolicyLink).

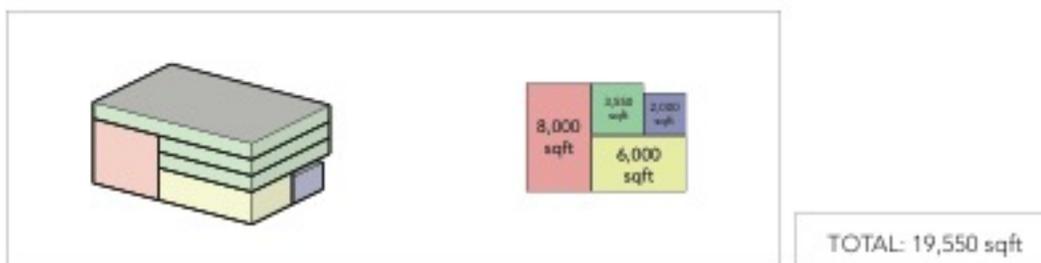
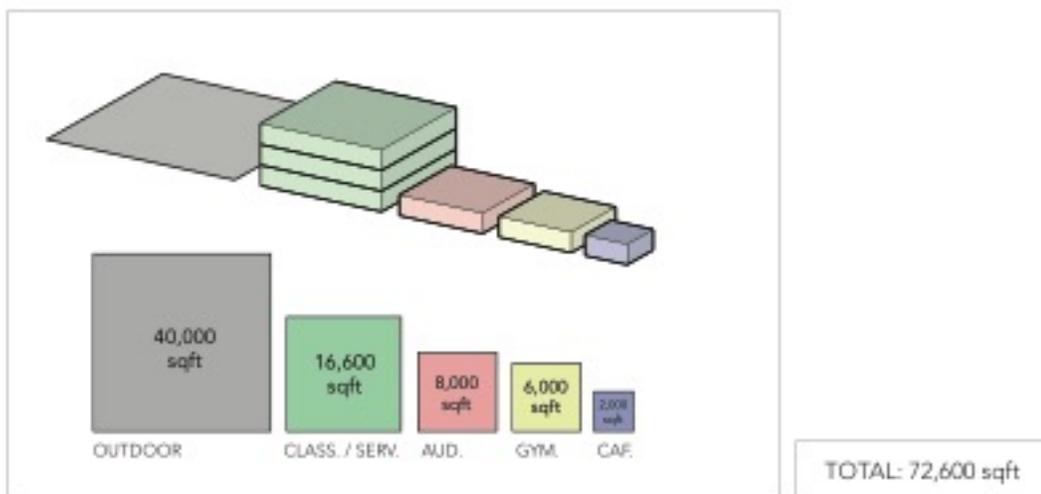
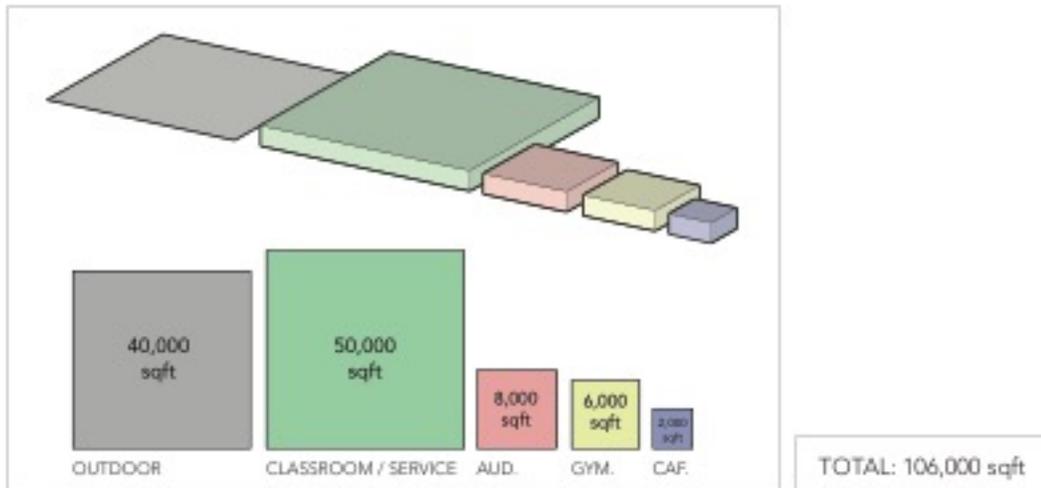


Figure 20: Footprint Area Range. By author.

The last quality considered is the distribution of nearby schools. Ideally, schools shall be evenly distributed throughout the district, such that no two schools are immediately adjacent, and thus competing.

Like the method of selecting a program, the sites are tested against a checklist by rating each criterion as good, neutral, or bad. The ideal checklist appears below.

Table 11: Optimum Site Checklist

PERTINENCE CHECKLIST			
Graduation Rate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Level of Urbanity	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Access	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Available Space	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
School Adjacency	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Site Selection

Now that a general location and set of criteria have been established, the next step is site selection. Every site has a unique set of qualities, opportunities and challenges, so the “ideal site” is difficult to define and identify. Therefore, it is important to have an exhaustive approach with a large sample size of potential sites. In doing so, it becomes possible to compare the numerous variables of each. The below-average school districts have been scanned for open space, parking lots, and outdated buildings within the size

range discussed in the previous section. The following sites have been identified as potentials.

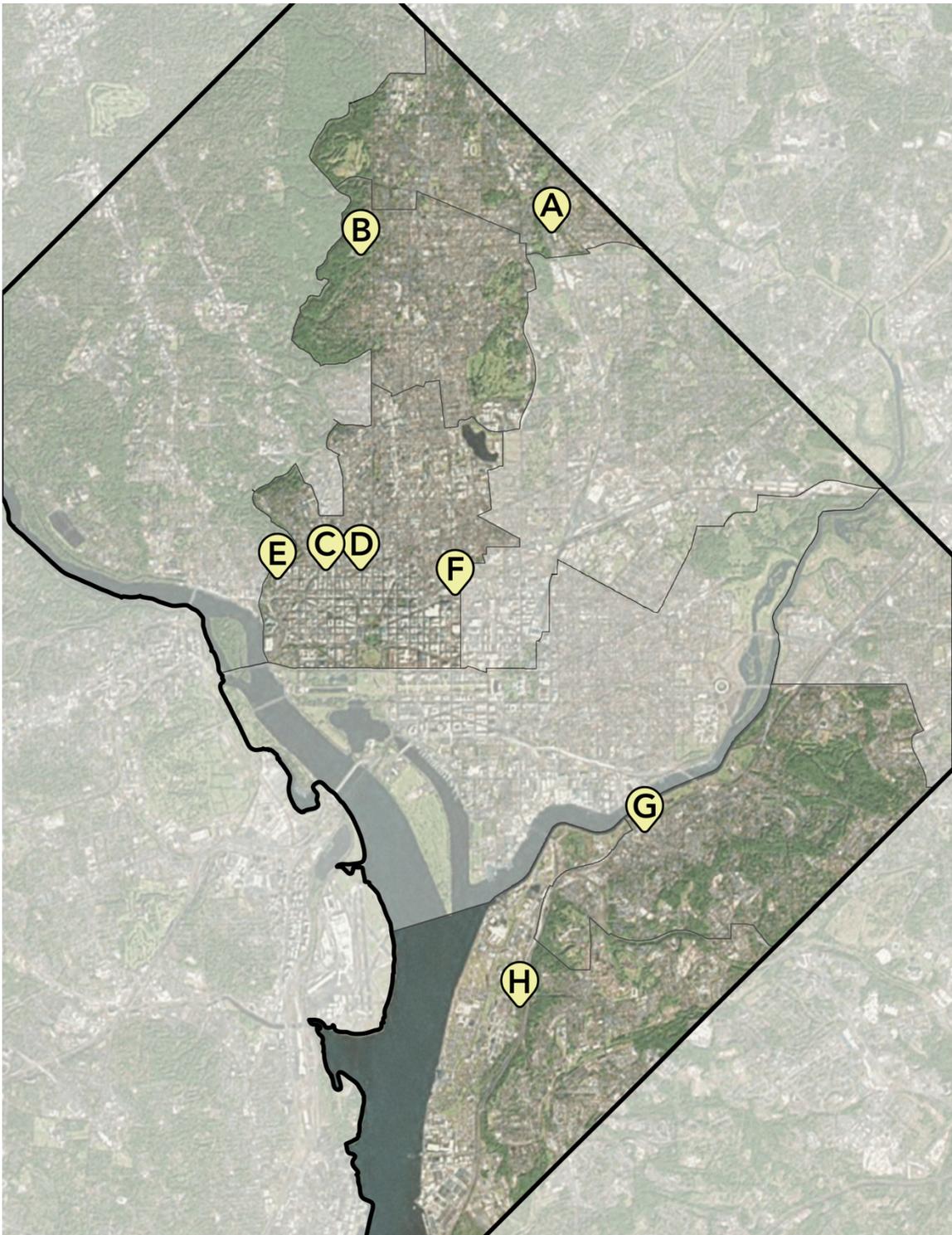


Figure 21: Potential Sites. By author.

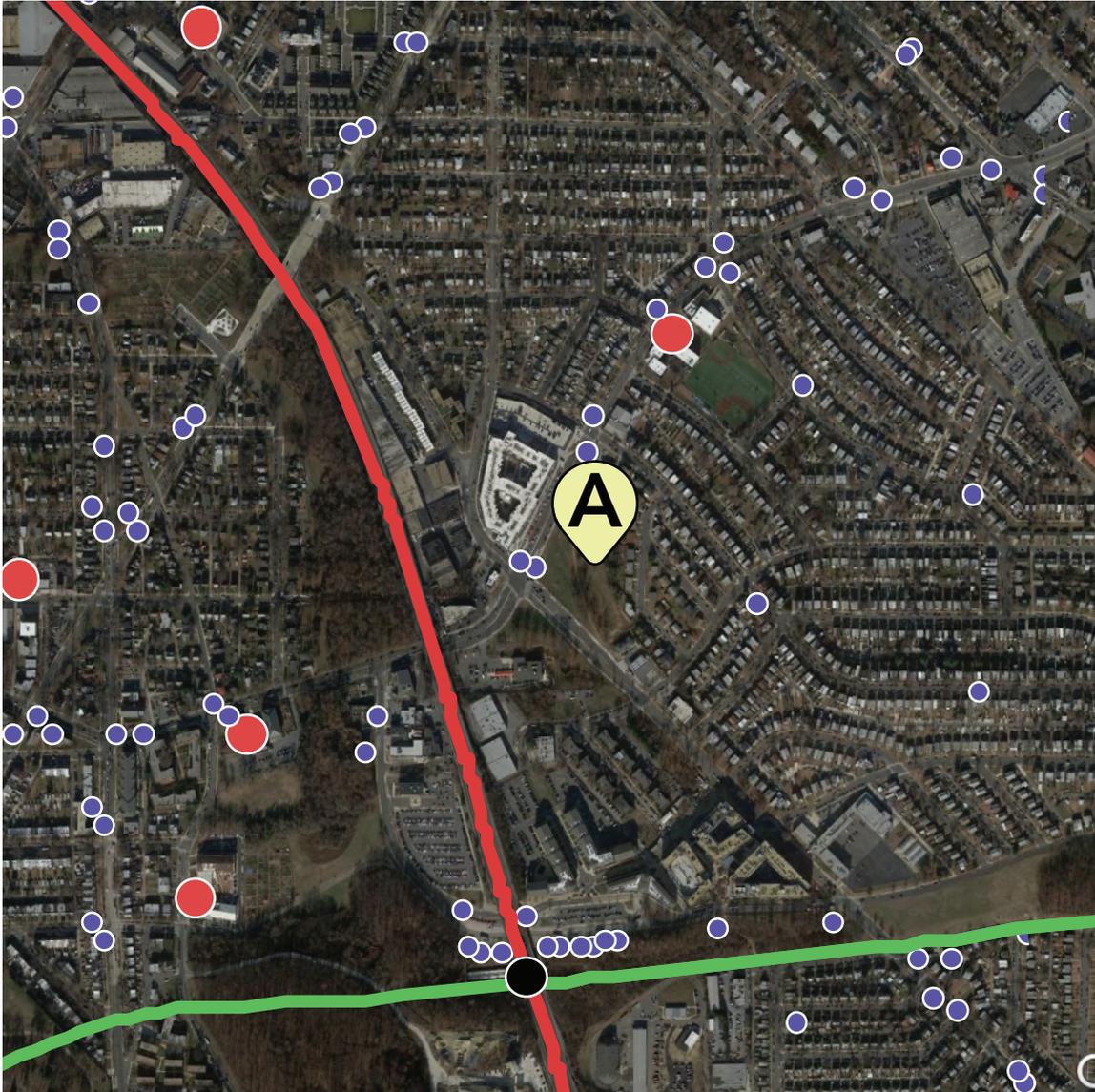


Figure 22: Site A Region. By author.

Site A: The first site is located in northeast Washington, D.C. on the edge of the Queens Chapel neighborhood. This neighborhood lies within the Coolidge High School district, which has a graduation rate of 66%. On the corner of Riggs Road NE and South Dakota

Avenue NE, this site offers roughly 140,000 square feet of open space. It is directly adjacent to a Walmart and a five-minute walk to the Fort Totton Metro Station. There are also several Metro Bus Stops in the immediate vicinity.

Table 12: Site A Checklist. By author.

PERTINENCE CHECKLIST			
Graduation Rate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Level of Urbanity	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Access	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Available Space	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
School Adjacency	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Site A has great access to public transportation and falls within a lower performing school district – both desirable traits for a thesis site. However, the site is far too large and very close to the LaSalle Backus Education Campus, which can potentially conflict with this project.

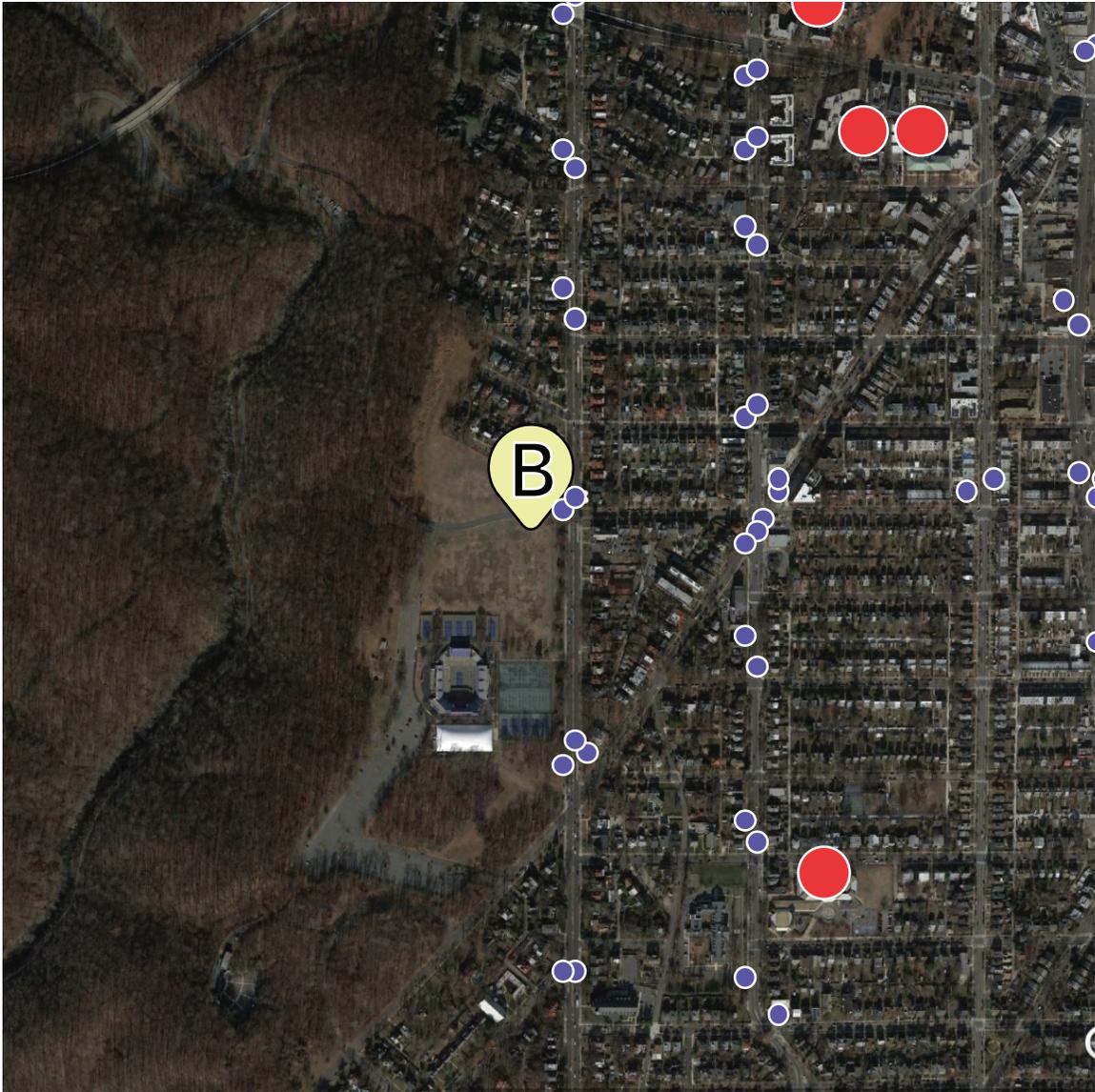


Figure 23: Site B Region. By author.

Site B: This site lies west of Site A, in between the 16th Street Heights neighborhood and Rock Creek Park. As a part of the Theodore Roosevelt High School district, this site is the largest – 450,000 square feet. There are no Metro Stations in the immediate area, however there are a few Metro Bus Stops along 16th Street. Although there are a few other schools in the area, they are several blocks away.

Table 13: Site B Checklist. By author.

PERTINENCE CHECKLIST			
Graduation Rate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Level of Urbanity	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Access	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Available Space	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
School Adjacency	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

The primary downfall of this site is its lack of density. It is located in a residential area and the site itself is vast, so there is little opportunity exploit surrounding sounds and create a rich user experience. It would also be difficult to attract a diverse population due to its mediocre access to public transportation. The school must be accessible from all parts of the city.

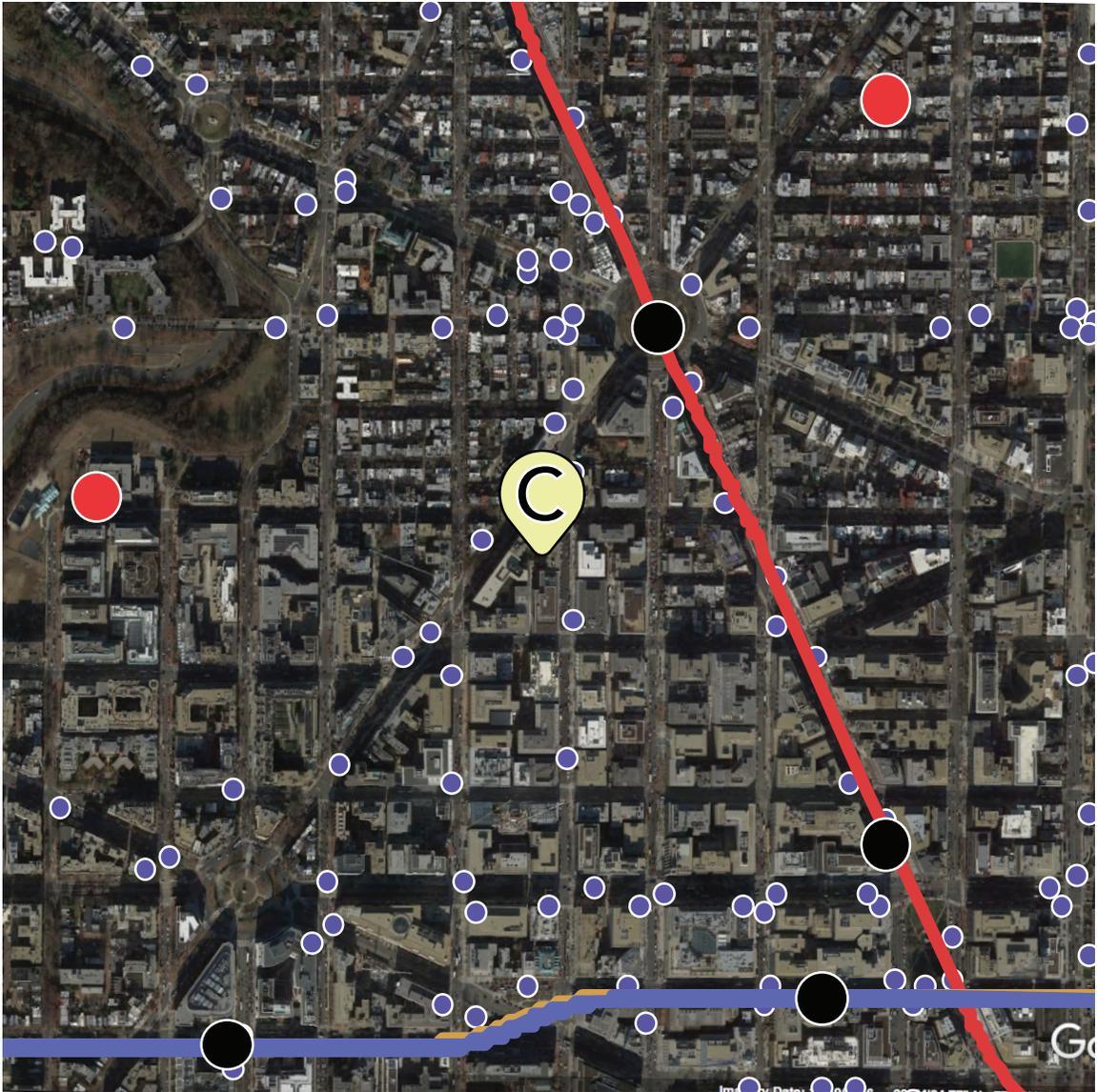


Figure 24: Site C Region. By author.

Site C: The next site is on a block where the Dupont Circle neighborhood meets West End. In a place where commerce and residences meet, this site is desirable because it is a denser location while still maintaining a sense of community. Currently there is a 10-storey apartment building located on the site, which was built in 1966. As an academic exercise, this proposal could potentially replace this somewhat outdated and unattractive building.

Table 14: Site C Checklist. By author.

PERTINENCE CHECKLIST			
Graduation Rate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Level of Urbanity	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Access	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Available Space	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
School Adjacency	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

This location is dense and active, while still offering approximately 30,000 square feet for the program. It does not compete with any adjacent schools, and it is extremely close to the Dupont Circle, Foggy Bottom, Farragut North, and Farragut West Metro Stations. This site is extremely appealing for this thesis project.

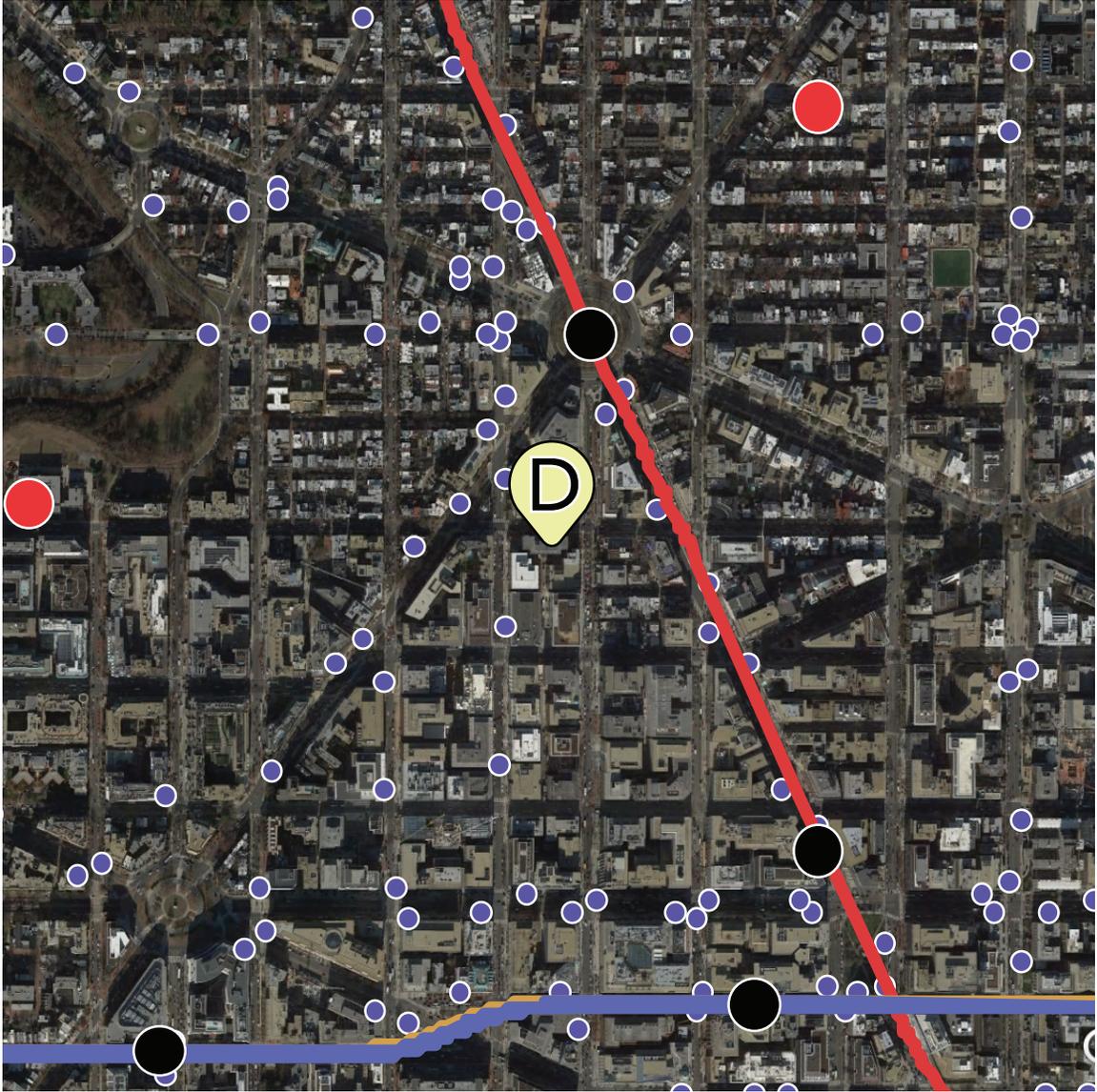


Figure 25: Site D Region. By author.

Site D: Site D is located exactly one block east of Site C, therefore its region shares the same attributes. The 24,000 square-foot site is slightly smaller and hosts an 8-storey office building, constructed in 1981. A new mixed-use development will be replacing this office building in the near future, therefore this thesis could offer an alternative proposal.

Table 15: Site D Checklist. By author.

PERTINENCE CHECKLIST			
Graduation Rate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Level of Urbanity	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Access	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Available Space	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
School Adjacency	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Much like Site C, this site receives the highest marks on the checklist, and therefore it is strongly considered for the final proposal of this thesis. Since there are multiple sites that are desirable, further investigation must take place to make the final decision. This investigation and final decision takes place in the Pre-Design phase, where multiple parti's are proposed and evaluated for each site.

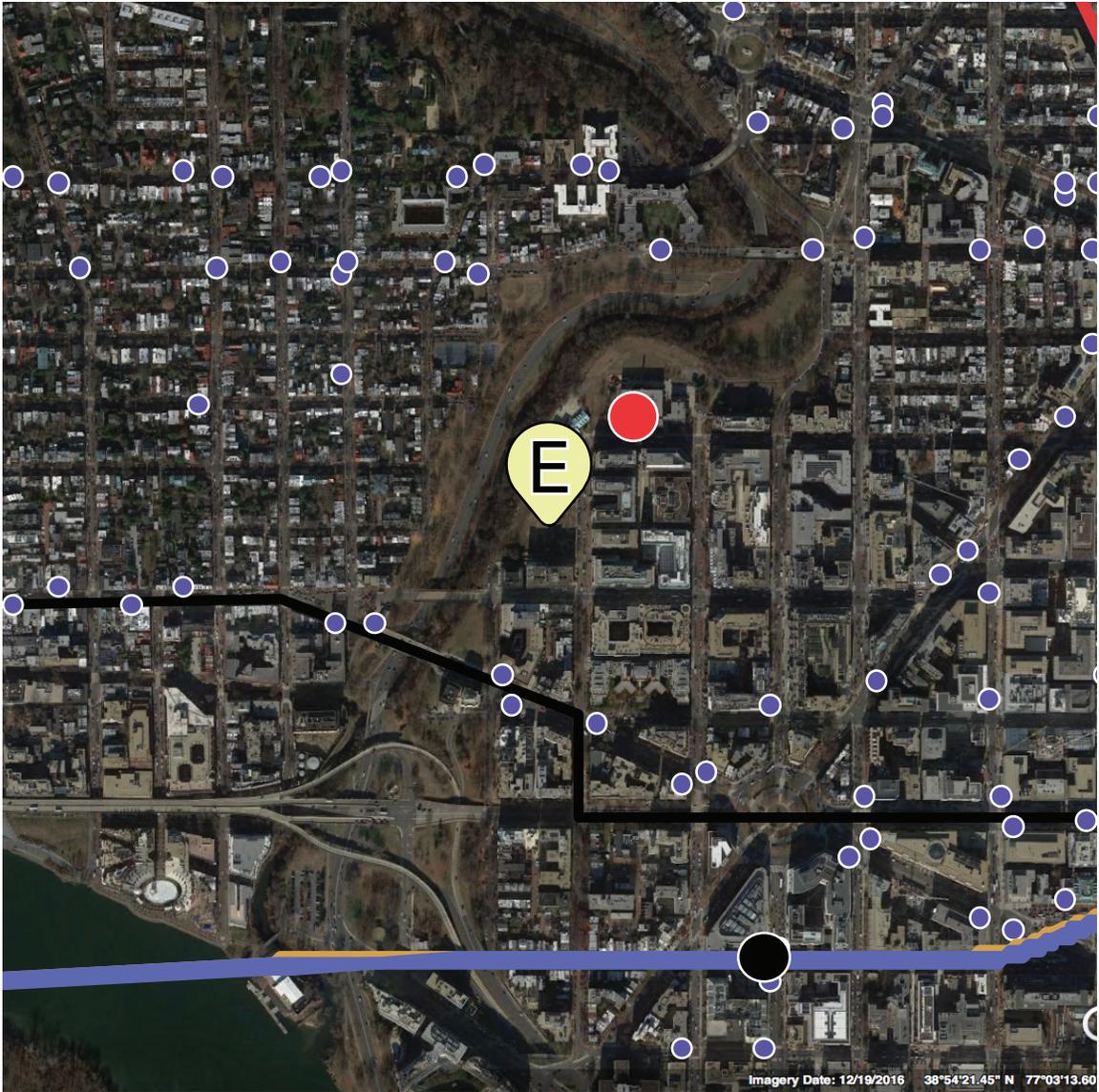


Figure 26: Site E Region. By author.

Site E: Slightly west of the previous two sites is Site E. This site is located on an existing recreational lot, where Georgetown and West End meet. It is unique due to its edge condition. Dense commercial buildings lie immediately east of the site, and the Rock Creek Park Trail is directly west.

Table 16: Site E Checklist. By author.

PERTINENCE CHECKLIST			
Graduation Rate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Level of Urbanity	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Access	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Available Space	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
School Adjacency	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Site E is about 90,000 square feet in size, and therefore on the larger end of the area range. Furthermore, due to its edge condition, the site offers little formal and programmatic freedom. Lastly, another school, School Without Walls at Francis Stevens, is located directly adjacent to this site. This is also a K-8 school and therefore programmatically conflicts with this thesis.

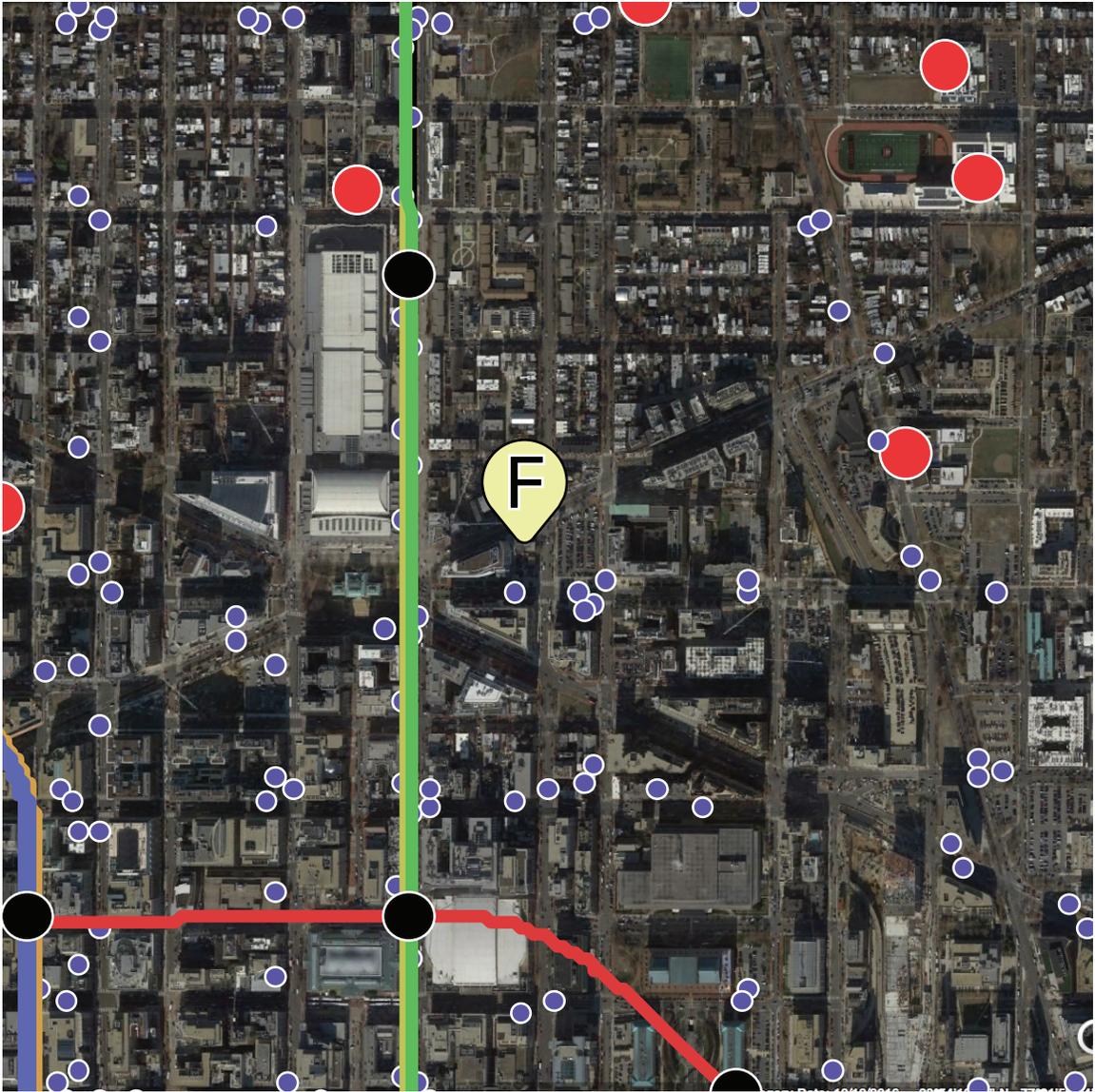


Figure 27: Site F Region. By author.

Site F: Located between the busy streets of New York Avenue and K Street NW in Mount Vernon, Site F is a trapezoidal parking lot with a few small, derelict buildings. Like Site C and Site D, this is a neighborhood where the residential fabric and commercial fabric meet, thus offering that desired sense of community and density.

Table 17: Site F Checklist. By author.

PERTINENCE CHECKLIST			
Graduation Rate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Level of Urbanity	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Access	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Available Space	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
School Adjacency	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Site F is located very close to the Mount Vernon and Gallery Place Metro Stations, as well as several Metro Bus Stops. Like Sites C and D, there are other schools in the area, but they are located at a reasonable distance. At 23,000 square feet, this small, urban site is another strongly considered location for this thesis.

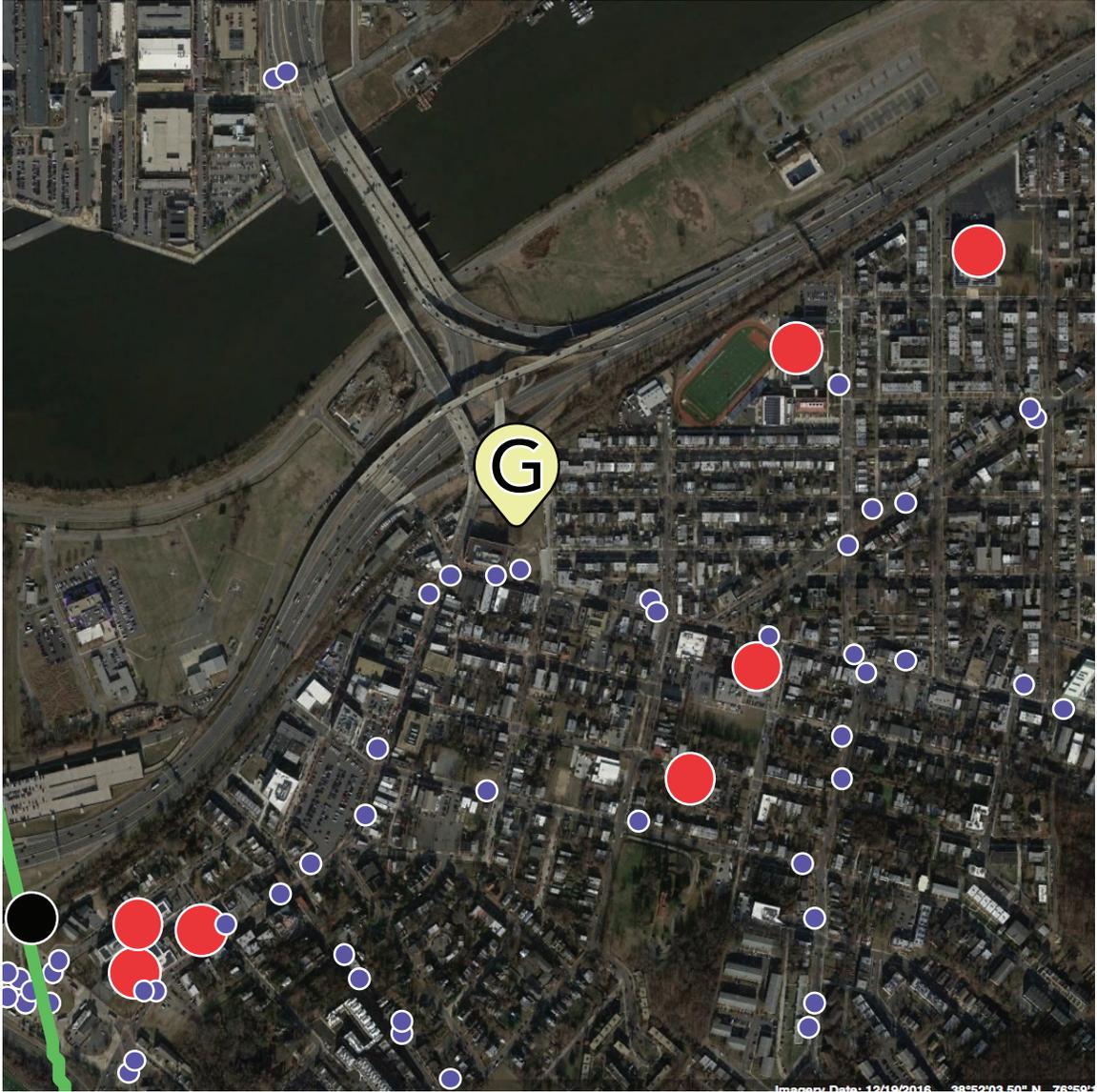


Figure 28: Site G Region. By author.

Site G: Across the Anacostia River is Site G. The Anacostia High School district yields the lowest graduation rate of 42%. Located directly adjacent to Interstate 295, this site proposes unique opportunities and challenges regarding noise.

Table 18: Site G Checklist. By author.

PERTINENCE CHECKLIST			
Graduation Rate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Level of Urbanity	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Access	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Available Space	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
School Adjacency	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Although this site is unique, there are a few deterring factors. There are only a few Metro Bus Stops, so access is limited. Also, the available space is about 90,000 square feet, which is on the larger end of the scale. Most importantly, however, there are several schools existing in the neighborhood, so the demand for an additional school is much lower. Site G is not a feasible site.

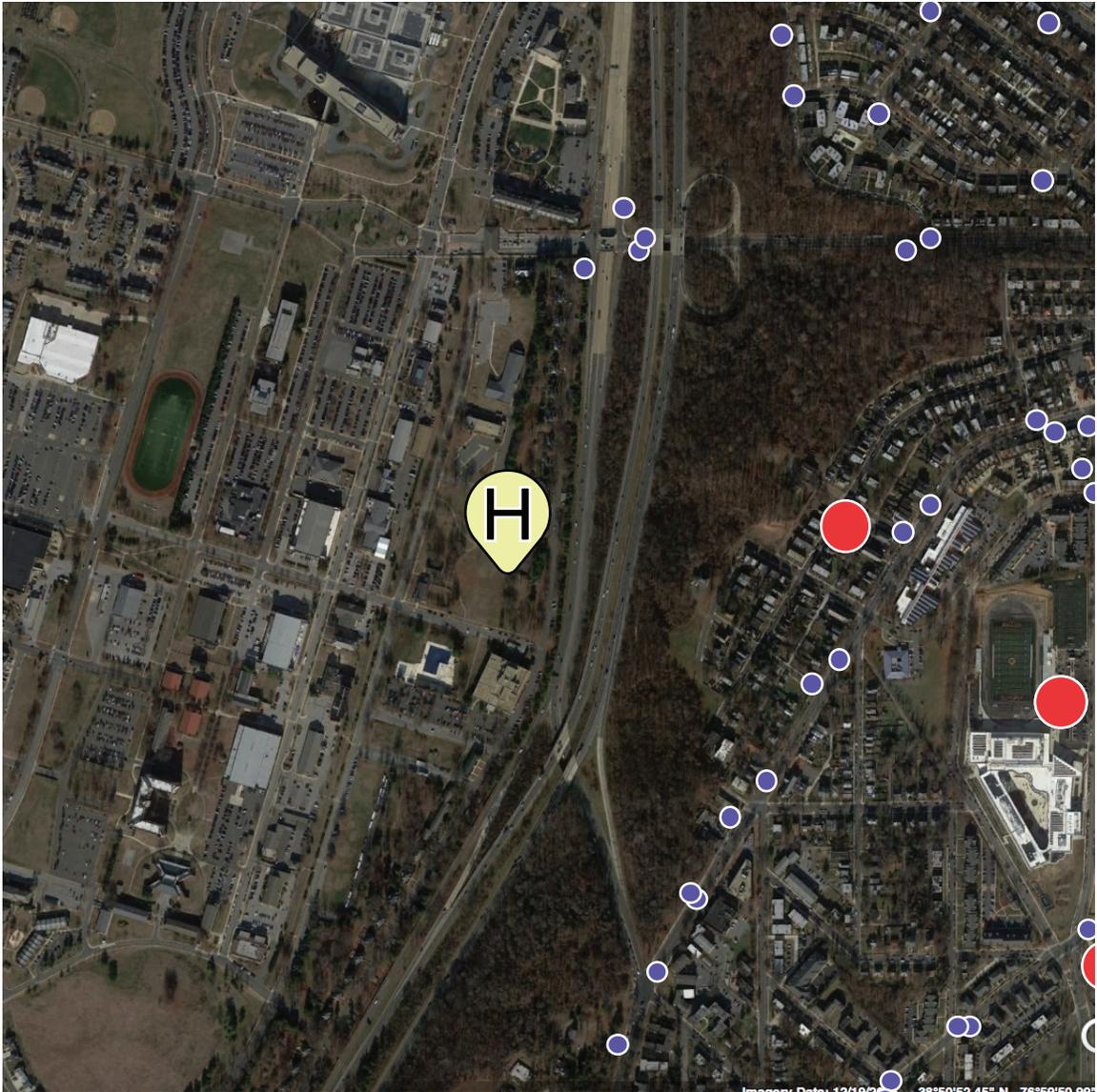


Figure 29: Site H Region. By author.

Site H: South of Site G is Site H, located in the Ballou STAY High School district. Like Site G, this site is immediately adjacent to Interstate 295, which could potentially offer unique design challenges. A downfall, however, is that Site H is located within the Joint Base Anacostia-Bolling. As an academic exercise, it is difficult to justify siting a music school in a military base.

Table 19: Site H Checklist. By author.

PERTINENCE CHECKLIST			
Graduation Rate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Level of Urbanity	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Access	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Available Space	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
School Adjacency	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Although this site is located in a school district with a low graduation rate, there are many negative factors associated with this location. This is the least dense of all the sites analyzed, with virtually no access to public transportation. In conjunction with the implications of the military base, this site is not a valid consideration for this thesis.

Conclusion: Of the eight sites that were analyzed, three of them received the highest marks on the checklist: Site C, Site D, and Site F. In order to make an informed decision, further investigation must be carried out. Since this is a program-driven project, and it is difficult to compare the countless variables between sites, each of the sites is tested with several parti's. The final site is chosen based on the most well-suited parti. This process takes place in the following chapter, Pre-Design.

Chapter 5: Pre-Design

The goal of this thesis is to increase attention and awareness to the sense of hearing. To do this, the students must be provided with aurally crafted spaces and taught to recognize the qualities of them. By providing spaces that are aurally unique, unfamiliar, or contradictory, it becomes easier for the children to recognize that sense. This concept is divided into three steps: Stimulation, Perplexion, and Indulgence. The spaces for the lower grades are designed with the intent of simply stimulating the children's sense of hearing. Young children are unable to recognize nuanced and subtle characteristics of aural design. Furthermore, this is the age where children learn basic rhythm and tones. Therefore, for the first few years, the design goal is to stimulate and excite their sense of hearing.

Once the students become familiar with basic sounds, they enter the grades located in the Perplexion portion of the building. This is where the majority of the aural experiences are unfamiliar, unique, and contradictory. This perplexes the students, and they begin to notice different sound qualities of space, as they are learning different sound qualities of instruments.

The third and final step in this process is Indulgence. The Indulgence section of the building is located on the ground levels, which include shared spaces such as the recital hall, gymnasium, and the cafeteria. These are functions that also engage the community. This is where the sense of hear is indulged, and the spaces are designed to be aurally rich and aesthetically pleasing, so everyone has the opportunity to experience acoustically crafted spaces.

Considering this overarching concept, program, and previous site criteria, a series of parti studies determines the final site selection.



Figure 30: Parti Study. By author

Based on several factors, including site size, flexibility, and prominence, Site F is best suited for this program.

Chapter 6: Design

The building is organized so that the lower levels have the opportunity of engaging the community, and the classrooms are organized around a central public space across four levels. A thickened poche space acoustically separates the central public areas from the private classrooms on either side.

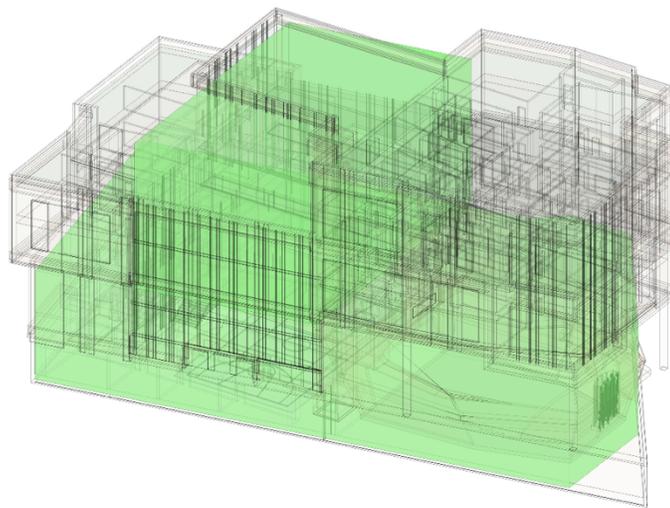


Figure 31: Public Space. By author

The overall structural grid has been shifted ten degrees to orient the recital hall toward the prominent corner of New York Avenue and 6th Street NW. This axial shift also allowed classroom walls to shift, avoiding parallel walls which hinder sound intelligibility. The lower floors include the gymnasium, recital hall, administration, cafeteria, back of house services, and a large gathering space.

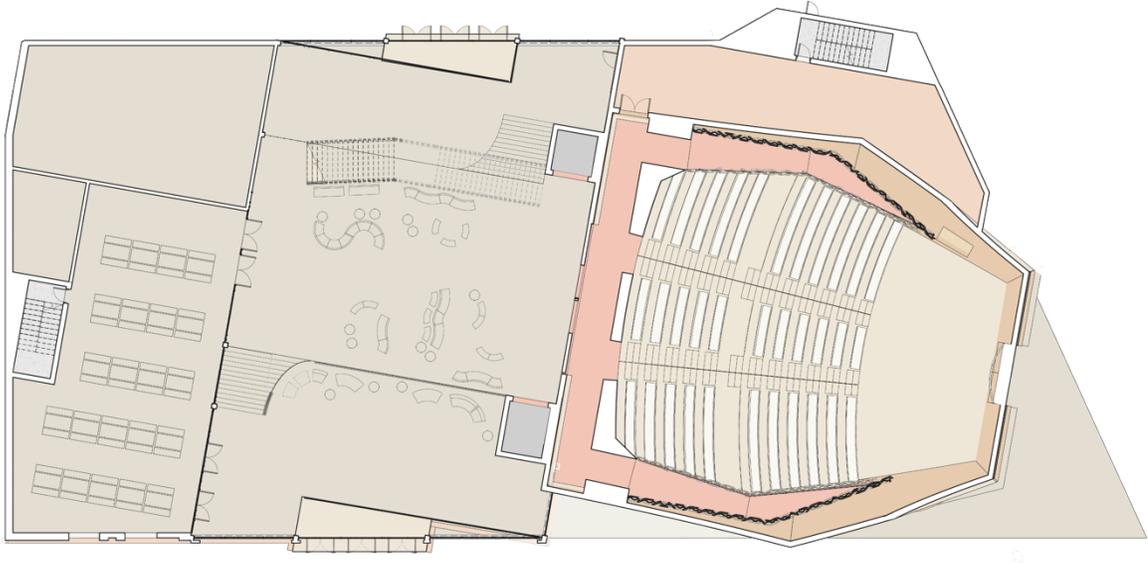


Figure 32: Ground Level. By author

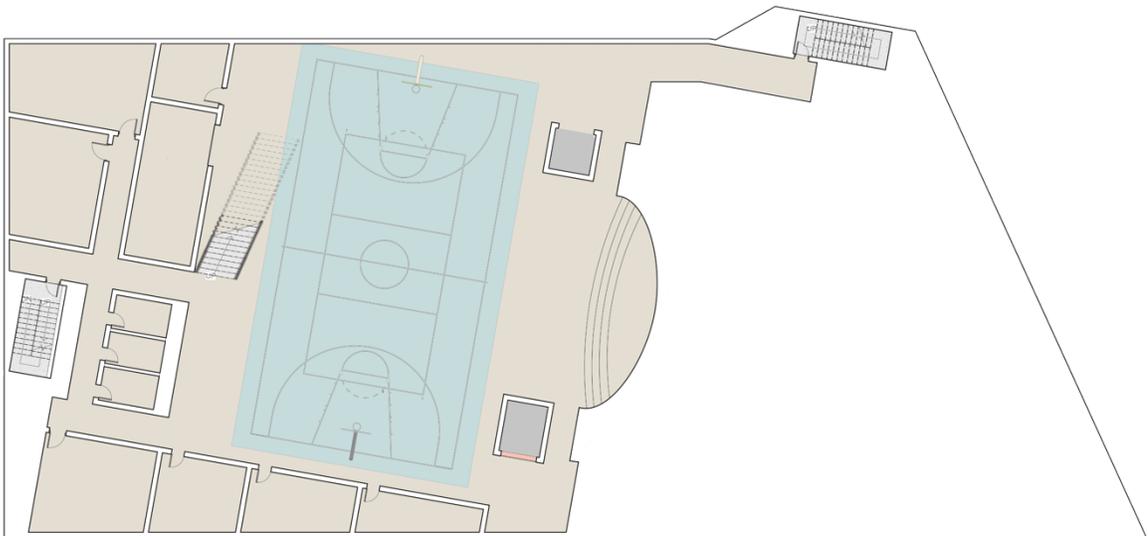


Figure 33: Basement Level. By author



Figure 34: Entrance Lobby. By author

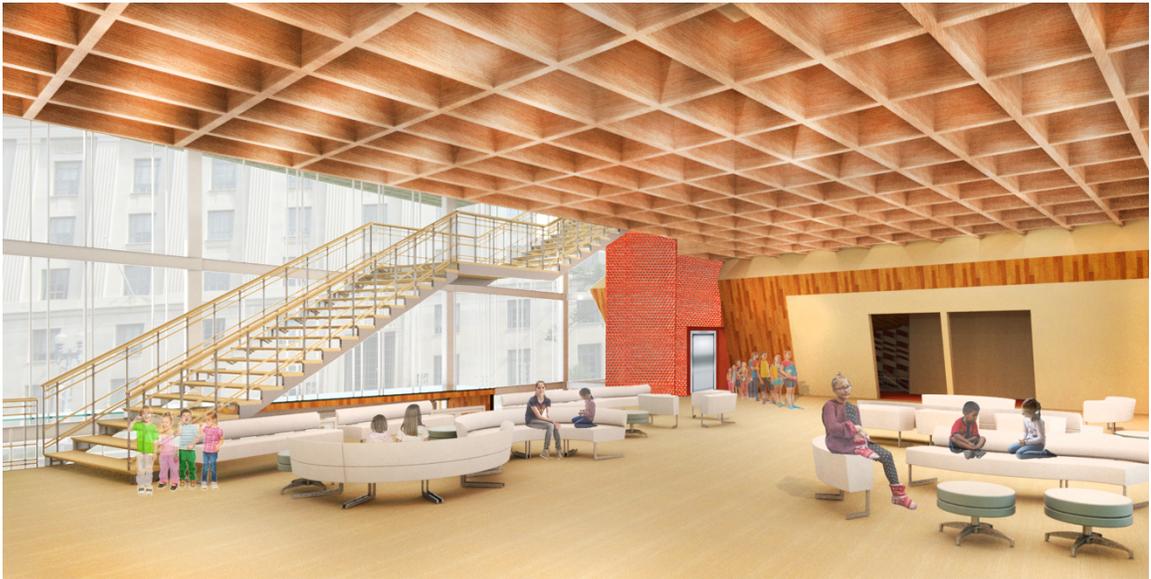


Figure 35: Pre-function Space. By author

The recital hall, as depicted below, is capable of two different “tunings” which allow the space to adapt to different instruments. Strips of curtain can be raised and lowered between the wood panels to decrease reverberation time.



Figure 36: Recital Hall - Tuning A. By author



Figure 37: Recital Hall - Tuning B. By author

Levels 3 and 4, also known as the “Perplexion” levels include grades three through eight. Each grade is provided with two classrooms, and have access to shared spaces including a media center, science lab, art studio, and the Music Center.

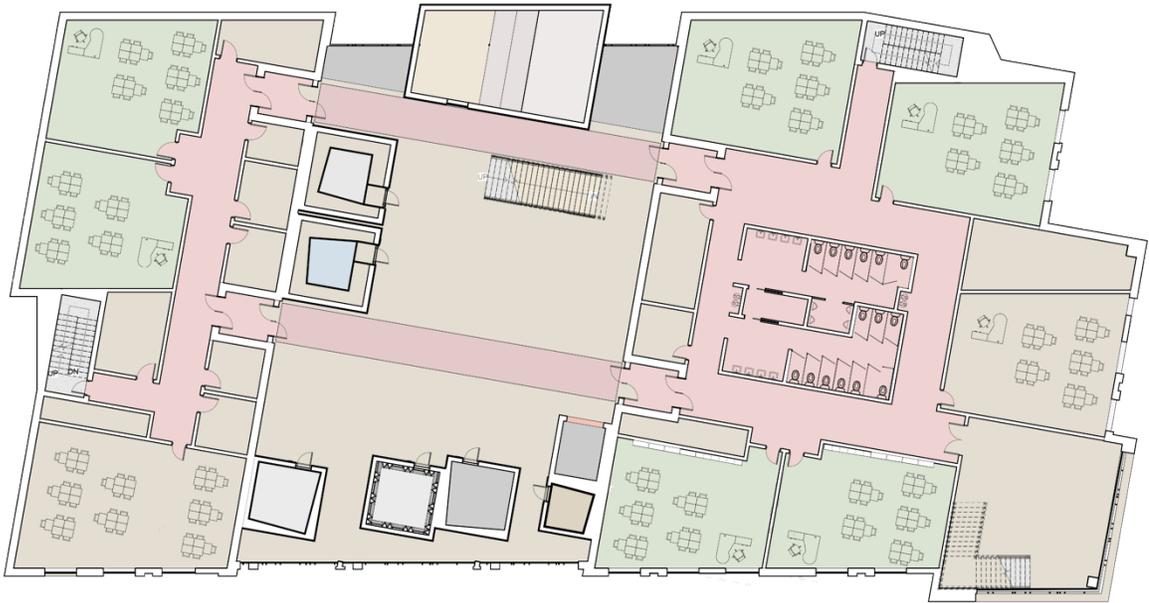


Figure 38: Level 3. By author

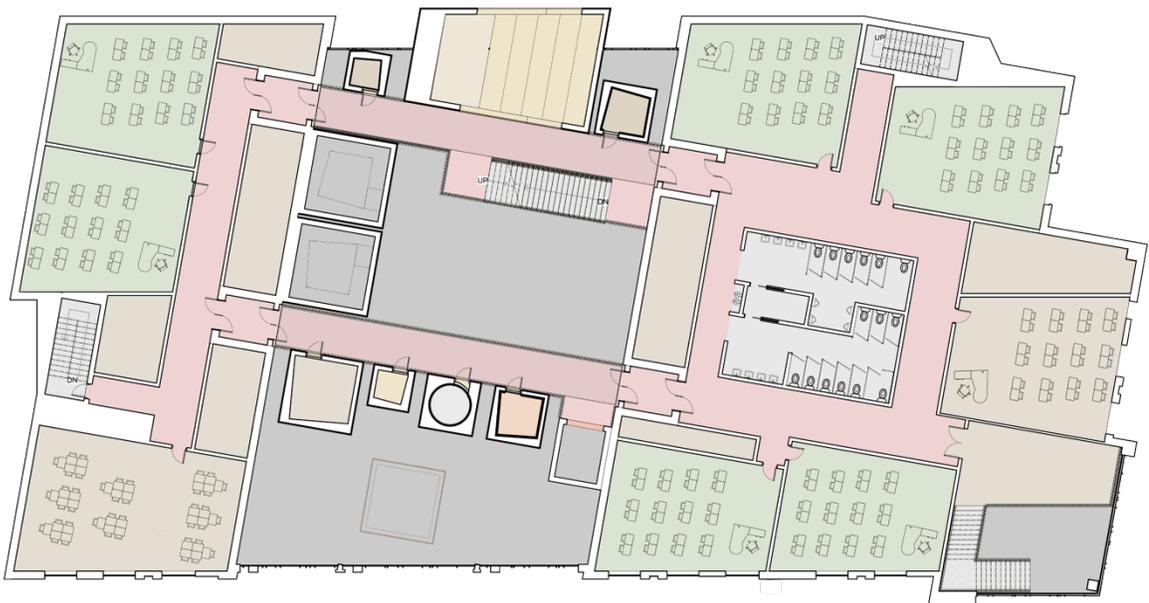


Figure 39: Level 4. By author

The Music Center is a double-height space, located between classrooms, which houses an array of different practice spaces. Each practice space is designed to evoke a different timbre. The different volumes, geometries, and materials modify the sounds within, and illustrate the unique characteristics of each. Furthermore, the corridor, which is highlighted in red in the plans above, continues through the Music Center as an “acoustic shadow.” Sound absorbing devices simulate the continuity of space and enclosure, and aurally distinguishes it from the large volume in which it resides.



Figure 40: Music Center and Acoustic Corridor. By author

The classrooms’ fan shape design is inspired by a typical performance space, increasing intelligibility, minimizing reverberation and flutter echo. This is evident in the plans, and the overall character is illustrated below.



Figure 41: Typical Classroom. By author

Levels five and six are reserved for kindergarten, first grade, second grade, and special education. These are the levels of Stimulation, where young students are introduced to basic musical concepts. Also located on these levels is the Aural Playground – an activity space comprised of equipment and installations that engage the sense of hearing.

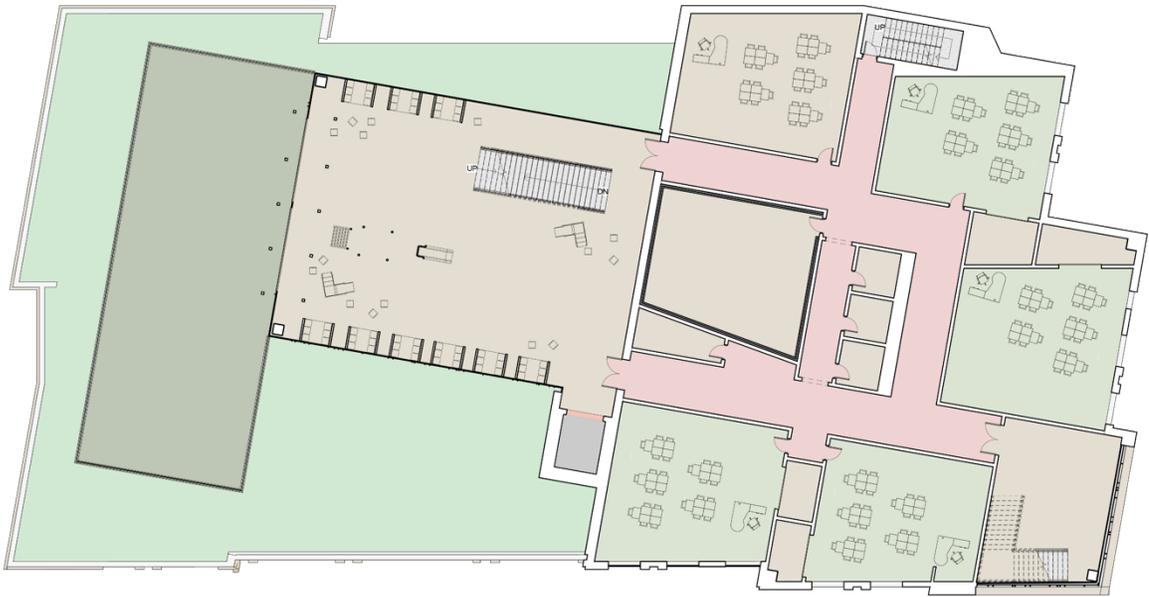


Figure 42: Level 5. By author



Figure 43: Aural Playground. By author

Chapter 7: Conclusion

While the program of this thesis is a K-8 music school, the application of the concept is one that can and should be applied to any building type. Sound isn't something that should have to be tolerated. Sound is something that should be well crafted and celebrated. By raising aural awareness and applying this way of thinking in all building types, cities become symphonies.

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