VERTICAL IS THE NEW HORIZON:

AN OVERVIEW OF VERTICAL GARDENING IN THE 21ST CENTURY

by

NICHOLAS ALLEN PETTY

(Under the Direction of Bruce K. Ferguson)

ABSTRACT

With the large-scale expansion of the built environment, the amount of vegetation present in those regions encroached upon by development has correspondingly decreased. In an era where building upwards is quickly replacing the practice of building outwards, a considerable amount of vertical surface area is available for the integration of vegetation within new or existing architecture. The parking deck, viewed by many as a necessary evil in today's automobile-driven society, is one structure that possesses tremendous potential towards the implementation of such a strategy. Via a general analysis of current vertical gardening practices and specific case study applications on the University of Georgia Campus and within downtown Athens, Georgia, this thesis explores the manner and degree to which vertical gardening technologies can and should be integrated into (and onto) existing parking structures – and all structures, for that matter – as a means of improving their appearance and function within the greater landscape.

INDEX WORDS: vertical gardening, façade greening, living walls, *mur vegetal*, green walls, parking structures, climbing plants

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NICHOLAS ALLEN PETTY

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NICHOLAS ALLEN PETTY

Major Professor:	Bruce K. Ferguson
Committee:	R. Alfred Vick Tim Smalley Linda Henneman

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
The University of Georgia
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To Annie

Your patience and support are mesmerizing
I love you more each day

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CHAPTER 1

INTRODUCTION

Purpose

Verticality is, and has been, a vital characteristic of the garden since its earliest conception. Therefore, the term "vertical garden" is an essentially redundant phrase. All gardens are influenced by the verticality of plant life and verticality in the garden has been forever enhanced by those artificial structures that symbolize human intervention within its confines. However, only within recent decades has the practice and perception of vertical gardening assumed a more prominent role in a larger conception of the built environment. As the amount of available open space for vegetation continues to dwindle within an increasingly dense urban environment, a subsequent call for new and innovative methods by which to integrate plant life into the greater fabric of towns and cities worldwide has gone out. Rising environmental concerns and a renewed focus upon the quality of urban experience have lent greater legitimacy and urgency to this charge, as designers continue to consider the dual aesthetic and ecological benefits of plants within an otherwise harsh and increasingly paved urban setting.

Concurrently, the success of green roof technologies and contemporaneous advances within the realms of material production and horticultural practice has opened the door for enhanced levels of experimentation that continue to blur the division between architecture and landscape. From this point, the latent potential of vertical gardening emerges as an exciting method by which to further projects both large and small, representing "one of the last horticultural challenges" for designers in the present day (Dunnett and Kingsbury 2004: 28).

Certain high-profile vertical gardening projects have generated the majority of the headlines (primarily outside of North America) via innovative artistic gestures and/or their inclusion within larger architectural schemes. However, vertical gardening methods must pass beyond the glossy pages of design magazines and into the everyday workings of the built environment. This is not to suggest that such projects should somehow become banal and commonplace through assimilation, but rather it is in hope that these methods begin to serve a critical role in the design scheme for those endeavors, both planned and existing, that might otherwise be labeled as such.

One oft-overlooked setting that must then be explored in this vein is the parking structure. Since the inception of modern vertical gardening techniques, many leading authorities on the subject have commonly referenced parking structures as one arena in which these new methods might be applied (Dunnett and Kingsbury 2004; Leenhardt and Lambertini 2007). Due, in part, to the relatively recent introduction of the various modern approaches to vertical gardening, such schemes have thus far failed to materialize at the highly-propagated scale that many have envisioned. However, as the efficiency and ecological sensitivity of surface parking continues to be scrutinized, parking structures have assumed a greater presence in many areas in which space is at a premium.

Though credited with minimizing potential land use and serving a required function, parking structures are nonetheless viewed as a type of necessary evil. As a common generator of noise, particulate matter, and harmful gaseous pollutants, the parking structure is often considered to be a mono-functional blight upon the landscape. Furthermore, as monolithic, impervious additions to the landscape, parking structures subsequently contribute to the urban heat island effect that has been identified and monitored in metropolitan environments throughout the preceding decades.

This thesis will explore the manner and degree to which vertical gardening technologies can – and should – be integrated into (and onto) existing parking structures as a means of improving and alleviating both the appearance, function, and ecological shortcomings of such structures within the greater landscape.

Timeliness

Experts and non-experts alike share a common consensus that innumerable benefits may be obtained via the controlled introduction or reintroduction of vegetation to the built environment. Planting trees and shrubs within dense human settings have been common practice for centuries. In considering such efforts, a clear historical emphasis is upon the therapeutic effects of plants within a constructed atmosphere. Nature served as a means of improving individual and collective well-being (though it tended to be valued on a purely homocentric level). The benefits of vegetation has been confirmed in the present and gained greater acceptance through the merits of scientific study (Ulrich 1986).

While this critical assumption on the part of early designers and theorists has proven correct and might therefore provide adequate justification for modern vertical gardening activities, deeming this aspect to be the sole catalyst for current awareness of the subject would be erroneous. The present interest in vertical gardening practices worldwide may be considered a result of four additional factors which have only been identifiable in recent decades:

1) Advances in horticulture and botany: Recent scientific expeditions and studies focusing on the botanical strata of tropical forests have demonstrated the unique abilities of certain plants to survive in vertically-oriented conditions with little or no soil. These plants tend to be situated somewhere between the undergrowth level and the canopy, feeding off of

nutritional reservoirs accumulated at considerable height. Such discoveries have served as templates for soil-free, hydroponic methods of vertical gardening.

Additionally, contemporary studies concerned with the biological properties of vines – an often neglected category of plant – have generated much interest in the vertical and ecological properties of climbing plant species for cladding vertical surfaces in urban environments.

2) Advances in building materials: Vertical gardening has been made possible via the application of modern technologies able to support a much wider range of climbing and non-climbing plants to heights that had been thought impossible to achieve. Stronger and more lightweight trellis and steel-cable systems allow climbing plants to grow uninhibited without compromising the support structure to which they are attached.

Furthermore, advances in geotextiles have generated products able to support root growth and provide vital capillary watering without the use of soil. Parallel development and implementation of automated irrigation systems and soil enhancement measures currently facilitate watering and nutrient delivery over larger surfaces.

3) Growing environmental awareness: The concepts of "sustainability" and "green" building practices have generated a great deal of interest in recent decades. Concerns and practices regarding the environment that were at one point considered to be marginal and associated with counter-cultural proclivities are now considered mainstream. In the construction industry, the U.S. Green Building Council's LEED (Leadership in Energy and Environmental Design) Building Rating System, initiated in December 1998 (U.S. Green Building Council) has become the "benchmark for environmentally responsible construction practices" (Henneman 2006).

Additionally, the scientific and non-scientific community has become concerned with the harmful emission of gaseous pollutants and particulate matter that are expelled by human activity. In the present understanding of things, vegetation may lessen the effects and dissemination of such byproducts through natural biological processes.

4) Limited availability of green space: Understanding the ecological and therapeutic benefits of vegetation does not necessarily translate into greater implementation given the scarcity of available space within the built environment. As cities and towns continue to develop in a vertical manner accompanied by impervious surfaces and underground infrastructure, opportunities to introduce greater biomass and biodiversity are often thwarted by economic factors, space restrictions, and improper soils and soil availability.

This thesis will explore botanical science and materials technology (factors 1 and 2) related to vertical gardening strategies that address environmental concerns and the limited and ever-shrinking availability of green space within the built environment (factors 3 and 4).

Thesis Approach

One might be inclined to question the supposed "newness" of the vertical gardening concept within the popular consciousness. Such an inclination would not be without warrant. Vertical gardening cannot be considered a novel or distinctly modern practice. Like contemporary rainwater harvesting efforts or the implementation of the green roof, a clear historical precedent informs the vertical gardening endeavors of the present. As a means of illuminating the origins of modern vertical gardening practices, Chapter 2 will briefly elaborate upon the history, methods, and motivations that underscore the practice of vertical gardening as it exists today.

Having provided the necessary background in Chapter 2, Chapter 3 will examine the modern benefits, both ecological and aesthetic, now commonly attributed to vertical gardening techniques. Following this natural course, the chapter will then briefly examine one specific type of structure that may be highly conducive to vertical gardening devices: parking structures. Of particular concern will be the shortcomings of existing parking structures and the means by which newer projects have attempted to impart a greater degree of ecological and aesthetic sensitivity into their designs. With a particular focus upon existing parking structures, the thesis will endeavor to show that many of the current efforts to improve the character and quality of parking structures can be further enhanced by the utilization of vertical gardening practices.

Through the use of examples drawn from across the globe, the fourth chapter will seek to sketch a distinction between the two fundamental vertical gardening methods: the *mur vegetal*, or living wall system, and façade greening. From this vantage one may begin to address the benefits and restrictions of basic vertical gardening strategies at a more case-specific level.

Through an analysis of the methods described in Chapter 4, the creation of unique structural, botanical, and cost-effective strategies that will responding to individual building conditions at either site then becomes possible. Chapter 5 will examine two distinct parking structures, the North Campus Parking Deck on the University of Georgia campus and the College Avenue Parking Deck located in downtown Athens, in which vertical gardening strategies might be adapted for use with existing structures.

The final chapter, or conclusion, will review the case-specific applications elaborated upon in Chapter 5 before broadening the discussion once more towards a more general dialogue about the efficacy of vertical gardening methods within the context of sustainable building practices.

CHAPTER 2

HIGH HOPES: VERTICAL GARDENING THROUGH THE AGES

All gardens are essentially a testimony to long lasting traditions borne from the renewal of ancient practices under changing circumstances. Gardens grant us access to the "*longue durée* of the intimate history of human relationships with nature" (Conan 2007: 3). Many aspects of knowledge, beliefs, practices and gestures that foster human engagement with nature are conserved over surprisingly long time periods, often independent of the ever-morphing cultural climate in which they occur. Yet it is also clear that many garden practices change to a dramatic degree as new tools, techniques, and plants become acclimated within the larger gardening traditions. The practice of vertical gardening is no exception.

Verticality has been, by the very growing habits of plants themselves, an intrinsic feature of the garden – and the landscape as a whole – since its earliest conception. Verticality punctuates the horizontal plane that would otherwise extend to infinity, bounding and enlivening the spaces that surround us all. The roots of verticality are found in the principles of life itself. The photosynthetic relationship of vegetation and sunlight determines that all plants adopt some form of vertical growth to ensure their survival. This has led to the myriad means of plant manipulation that gardeners have carried out over the ages in the form of tying, staking, and pruning – practices which define the basis of all vertical gardening endeavors from ancient times onward (Leenhardt and Lambertini 2007).

Through the process of locating and identifying the historical precursors of current vertical gardening techniques, it will become possible to view such modern endeavors as both a continuation of, and departure from, those traditions that have been cultivated over preceding millennia. Such an exploration will reveal that, while vertical gardening is not a new phenomenon, the import and scope of the practice has shifted dramatically in the present through recent advents in technology and scientific understanding necessarily absent in past historical epochs. In this sense, we may ultimately begin to categorize contemporary practices as a new stage in development – vertical gardening 2.0, so to speak – that transcends the historical conception and manipulation of verticality in the garden towards a more ecologically-focused and functional aesthetic with the potential to alter the quality of the built environment for the better.

The origins of vertical gardening practices can be traced backward to ancient Mesopotamian cultures in which the first evidence of lasting civilization and urbanism manifested. Among the most illustrious and enduring forms constructed during this period were temple structures, the most notable type of which is known as the ziggurat. Constructed of trodden clay and mud-brick with a baked-brick exterior veneer, the outward sloping walls and steep terraces of the ziggurat were initially believed to have been planted. When Sir Leonard Woolley excavated the ziggurat at Ur, he found that the entire structure was perforated at regular intervals by holes penetrating the outer brickwork of the structure. Woolley interpreted this discovery as evidence of a primitive drainage system that would have been used to cultivate trees and shrubs along the ascending terraces of the ziggurat. Unfortunately, recent archaeological evidence suggests that given the mud-brick construction methods employed, the planting of vegetation at such a large scale might have caused enormous structural problems. Furthermore, the mechanical issue of raising water high enough to irrigate such vegetation would have severely compromised the structure of the temple given the high volume and pressure of water that would have been necessary for such a system to function in the first place (Dalley 1993).

The popularity of Woolley's description poses further problems when considering the most well-known, and controversial, of early vertical gardening endeavors: the Hanging Gardens of Babylon. The Hanging Gardens of Babylon were described in great detail by ancient historians and explorers (Dalley 7). When these accounts are considered in conjunction with Woolley's findings, many had previously concluded that the fabled gardens had been planted along the platforms of an ancient ziggurat. However, in addition to the structural issues referred to above, there is little physical evidence to support such accounts in the locations in which the ancient historians have placed them. Archaeological excavations within the ancient center of Babylon and the palaces of Nebuchadnezzar (ruled 604-562 B.C.E.) – to whom the Hanging Gardens are most commonly attributed – have been well mapped in recent years. Excavations have yielded few discoveries able to support historical claims, and certainly none that exhibit the grandiose properties of Classical descriptions. This embarrassing detail can be attributed to two factors that had remained unexplored until recently. Firstly, the English word "hanging" implies trailing plants that grow downward from the place in which they were rooted. The Greek word, *kremastos*, commonly used in Classical accounts, is a reference to "artificial slopes raised up on terraces constructed of stone, bitumen, and timber like a Greek theater, upon which soil was heaped and trees planted," (Dalley 7).

Secondly, according to Dalley, confusion between Nebuchadnezzar and Sennacherib, the Babylonian and Assyrian kingdoms, and Nineveh and Babylon was not uncommon, even in biblical times (1993). However, such hypotheses regarding the Hanging Gardens have not been entirely discarded in the present.

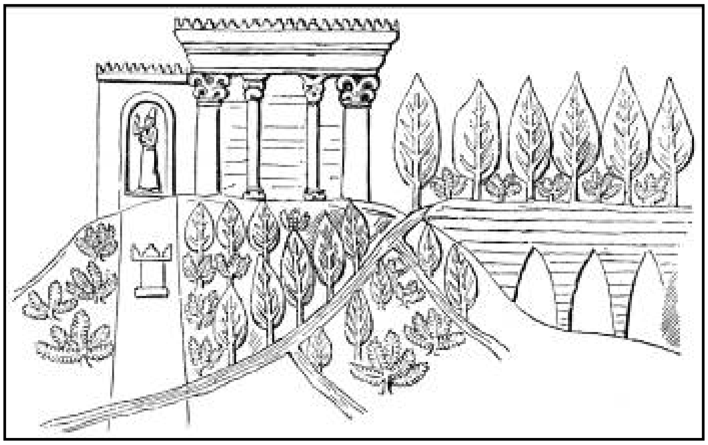


Figure 2.1 A Temple and Hanging Garden at Nineveh (Gothein 1966: 37)

In light of archeological confusion, a breakthrough seems to have come from new attempts to understand technical description of the Assyrian King Sennacherib's (ruled 705-681 B.C.E.) "Palace without a Rival" at Nineveh. Unearthed inscriptions portray the grand layout and technical innovations of the newly constructed royal garden complete with terraces, lavish plantings of trees and shrubs, and a unique watering system fed by aqueducts and channels (figure 2.1). The water was dispersed within the garden in a top-down manner via series of cisterns and a copper Archimedean screw, nearly four hundred years before the birth of its namesake. One might conclude from the archeological discrepancies that the hanging gardens referred to by the ancients was not singular to Nineveh or Babylon, but rather an allusion to a type of garden more widely disseminated throughout Mesopotamian cultures than has been previously recognized. Regardless, these hanging gardens represent the first true examples of specifically engineered vertical gardening methods in ancient times.

One facet of vertical gardening that appears universal: artifice. As further historical examples will show, vertical gardening methods often take vegetation out of its natural context, repositioning plants within an entirely contrived setting that is nonetheless conducive to the intrinsic growth habits of a given plant. During the reign of Assurbanipal (ruled 668-627 B.C.E.), vine cultivation underwent a considerable degree of change. Earlier monuments dating from Sennacherib's reign illustrate creeping vineyards oriented along the ground, whereas in later representations from the reign of Assurbanipal one notices hanging vines spanning between overhead trees as the king and his courtesans dine leisurely within the garden (Figure 2.2). This depiction implies a distinct degree of horticultural training that had not been identified in prior cultures. Moreover, the training methods illustrated by early Mesopotamian examples begin to hint towards an architectural function of vines and their supports within the garden setting. Such an intuitive use of climbing plants would serve as ancient precursor to some of the more enduring methods of vertical gardening practices over the ensuing millennia: the pergola, arbor, and trellis. However, as we shall see, archaeological records suggest that the ancient Mesopotamian cultures may not have been the first to employ such devices.

Figure 2.1. Assurbanipal and his Queen feasting in a garden,
relief from the Assyrian royal palace at Nineveh (Rogers 2001: 39)

Contemporaneous to the development of early Levantine cultures, Egyptian gardens also took on the form and character of the larger environment, mimicking the ever-present dichotomy between fertile river valley and barren desert. In what few examples remain from paintings and descriptions, the Egyptian garden was typically walled-off from its immediate surroundings. Like the lush environments adjacent to the river, the garden provided a fruitful and isolated

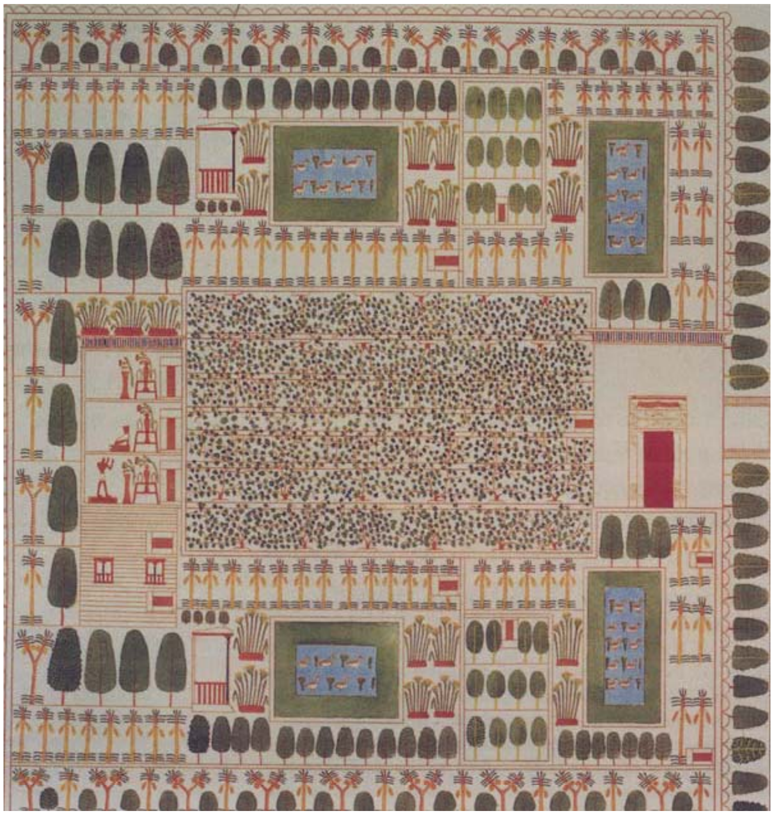


Figure 2.2. Wall painting of a garden from a tomb at Thebes, Egypt (Rogers 2001: 38)

microclimate in which to carry out a variety of sacred and domestic functions. Perhaps the finest, and certainly most published, example of this premise comes to us from a wall painting discovered in a tomb at Thebes that is dated circa 1400 B.C.E. (Figure 2.3). Though often cited in terms of its rigid orthogonal geometry, water features, and lush plantscape (Rogers 2001:38), of greater significance for the purposes of this discussion one must identify what is perhaps the most dominant feature of this garden: the central vineyard supported by what appears to be an early pergola structure. Next to trees, which were greatly valued due to their relative paucity within the arid Egyptian landscape, vineyards were of the utmost importance within Egyptian society (Gothein 1966). The layout of the garden illustration at Thebes supports this premise. The main axial path through the garden bisects the shaded confines of the vine-laden pergola in such a manner that visitors could marvel at the bounty of the vineyard while enjoying a much-needed respite from the unforgiving sunlight characteristic of the region. Because of climatic concerns, verticality within the garden was difficult to accomplish via the use of trees. As a result, the arbors and pergolas of ancient Egypt were the center, and chief ornament, of the Egyptian garden (Gothein 1966).

In terms of construction, early inscriptions documenting the history of grape cultivation indicate that in the earliest days, grapes were grown on simple arbor structures. Stakes were set up vertically with a horizontal transom set across. These early garden devices seem to have been relatively ephemeral arrangements that did not grant the degree of durability, architectural interest or ornamentation that would become prominent during the New Kingdom (1570-1070 B.C.E.). At Amarna, excavators uncovered the remnants of a massive pergola of 70 x 120 m. set upon square brick pillars near the main temple. Though it is likely that the foremost purpose of the structure was as a working vineyard maintained for the production of ceremonial offerings, inlaid ground tiles with a floral motif suggest a secondary leisure role within the greater complex (Wilkinson 1994).

The variety of mimetic vertical elements commonly employed throughout the ancient Egyptian period warrant further discussion in relation to vertical gardening. The hypostyle hall, common to sacred and royal precincts, is noteworthy on the basis of scale alone. However, festooned with stylized lotus and papyrus leaves towards the upper regions of the column, the hypostyle hall also serves as a mimetic device symbolizing the primordial marshes of Egyptian cosmology. Though this curious example may not exemplify the practice of vertical gardening per sé, it does convey to the observer the idea of an artificial vertical garden. This employment of naturalistic architectural devices in Egyptian gardens and in later examples undoubtedly arises from a longing to bring nature into realms in which it may not have been possible to do so. As we shall see in later chapters, modern vertical gardening strategies can now fulfill such desires to much greater effect. In this sense, we might consider the vertical garden of the present day as a fulfillment of ancient human proclivities towards nature.

While Roman civilization seems to owe a great deal to the advances in technology and philosophy put forth by preceding civilizations in Egypt, Greece, and Persia (heirs to the Mesopotamian legacy), the Roman attitude deviated in its views of nature. Whereas previous civilizations had perceived nature as a stage on which the gods enacted their ongoing drama, Romans tended to view the natural environment as "the idyllic counterpoint to civilization, the province of pastoral poetry" (Gothein 1966: 60) and as a resource that could be dominated and exploited for the sake of the individual and the empire.

A central concept to the Roman view of nature is that of *otium*, "a kind of industrious leisure comprised of worthwhile mental and physical pursuits away from the distractions of urban business, politics, and society" (Rogers 2001: 86). For many, the rigors of urban life demanded a means of escape. For wealthier citizens, this often meant the acquisition of a second home located on the sea or in a bucolic rural setting. However, for those unable to afford such luxuries, ornamental gardens – made possible by hydraulic engineering and aqueducts – became an alternative within domestic confines. In densely populated areas, the peristyle garden became a common means by which to bring nature into an otherwise inhospitable environment, thus affording a small, but significant, reprieve from the ardors of everyday life.

Lavishly painted frescoes – otherwise referred to as *paradesoi*, a name derived from the Persian term for paradise – adorned the walls of many Roman homes with depictions of sacro-idyllic landscapes and *trompe-l'oiel* garden scenes. These idealized representations of nature created the illusion of greater space within tight quarters as well as a pleasant faux-garden atmosphere. At the Villa of Livia in suburban Prima Porta, a continuous four-sided mural evokes a lush garden setting within a sunken ancillary space that would have stayed cool during summer months (figure 2.4). This illusory garden features shrubs, tress, flowers, wildlife, and a white-painted lattice fence that indicate an appreciation for the ameliorative qualities of nature. Adorning the walls of houses with fantastic visions of natural scenery was a decorative device employed across class boundaries in ancient Rome. Distinctions tend to arise when one focuses on craftsmanship, as wealthier citizens could certainly afford greater artisanal quality than those of lesser status.

Figure 2.3. Fresco from House of Livia at Primia Porta, ITA (Bowe 2004: 57)

Perhaps the finest written account of Roman gardening practices comes to us from the letters of Pliny the Younger (23-79 A.D.) describing his opulent seaside villa at Laurentinum near the city of Pompeii. In his account Pliny gives a pleasant description of the wonders of his Mediterranean retreat that include "plane trees covered with ivy," vine-laden colonnades, and "a semicircular bench of white marble, shaded with a vine which is trained upon four small pillars of Carystian marble" (quoted in Gothein 1966: 103). In a related description of his Villa Tusci, Pliny describes a many-windowed arbor retreat shaded by vines with a bed recess inside: "There you can lie and imagine you are in a wood but without the risk of rain" (quoted in Bowe 2004: 27). Rather than utilizing vines for agricultural purposes, these vine-clad architectural structures would have created a pleasurable, rustic effect within the garden.

While wealthier denizens may have employed the use of stone or marble sections in arbor and pergola construction, the use of lightweight, perishable timber was a far more common method. Among the extant models, the “Miniature Villa” in Pompeii, also referred to as the House and Garden of Octavius Quartio, provides ample evidence from which to reconstruct a small – but resourceful – middle-class urban garden. At this particular site, a sixty-five foot long wooden twin pergola extends from the home towards the back entrance of the property above a narrow canal amidst an orchard (figure 2.5). Within this walled enclosure, the water feature would have served in coordination with the pergola structures to create of a small microclimate. From these descriptions, one begins to discern critical differences between the arbor as a setting for sedentary activities such as dining and general relaxation and pergola structures which tended to serve the purpose of shading visitors as they actively made their way through the garden.

Figure 2.5. Pergola view, House of Octavius Quartio, Pompeii, ITA (Bowe 2004: 88)

Furthermore, it becomes clear that an arbor would have maintained lattice walls for the intended purpose of guiding plants upwards. Pergola construction, on the other hand, would have trained vines utilizing the support posts themselves, thus affording an increasingly open and multi-directional vantage from beneath the structure.

Like previous civilizations, Romans took a keen interest in climbing plants and vertical gardening practices for reasons that are essentially two-fold: 1) for the cultivation of agricultural products such as grapes and hanging gourds and 2) for pleasure. In either case, climbing plants granted a measurable degree of shade when grown vertically or suspended horizontally above a structure, thus affording comfortable spaces for leisure and labor-intensive activities within the garden.

Though the time span of the aforementioned eras may only comprise a mere fraction of human interaction with the land, within these periods one might begin to view an established vertical gardening tradition that continue unabated into the present. Roman practices, in particular, seem to have been widely disseminated and imitated throughout the ensuing millennia, particularly in Western and Near Eastern gardening cultures.

Despite the destruction inflicted upon Rome by vandal tribes in Western Europe, the Eastern Empire endured for centuries and influenced Islamic gardening traditions by way of Byzantium (Bowe 2004). The basic Islamic courtyard was modeled in much the same way as Roman peristyle gardens from some one thousand years earlier, though tempered by distinct religious and cultural connotations characteristic of Persian influences. There is little evidence to support the use of pergola structures in the Islamic garden. However, the garden pavilions referred to as a *glorrieta*, a Spanish term derived from the Arabic *al-ʻazīz* (meaning "glorious"), were often clad in vines or carefully-trained shrubs possessing similar vertical characteristics as those constructed by Classical gardeners (Jellicoe 1987).

Classical knowledge accrued during ancient Roman times was lost to Western Europeans during the Middle Ages. Only through the efforts of Islamic scholars (who translated many of the great Classical texts between the 8th and 12th centuries A.D.) did the wisdom of the ancients endure. Not until the missionary and military expeditions of the 13th an 14th centuries which renewed contact between Europe and Islamic cultures did classical gardening practices began to percolate once more into the Western tradition. Ironically, the newly-recovered gardening methods of the Classical period found their earliest champions on the Italian peninsula where such practices had initially flourished. This renaissance period also witnessed a renewed interest in vertically-oriented gardening structures and practices not unlike those of the Roman era. As a result, many of the finest examples of Classically-inspired pergolas and arbors can be found upon the lavish estates of the Renaissance aristocracy.

Among the sources of inspiration within this time period, few have possessed such a potent influence as the architect Leon Batista Alberti (1404-1472 A.D.). Alberti's seminal work, *De Architectura*, provided a cornerstone for building and gardening approaches during the era. Drawing from Classical sources, Alberti decreed that gardens should provide outdoor architectonic spaces that link the garden with the home, a tenet of his philosophy that was strongly propagated in many of the grand villas of the era. At the Villa Quarracchi, the country home of Cardinal Rucellai, one witnesses the physical manifestation of this philosophy. Perhaps the most striking feature of this garden was the series of arbors traversing the garden in a cruciform layout that would have provided a great deal of shade for visitors wandering amidst the garden's many wonders. The barrel-like form of the arbors employed at this site, clad in fine lattice work supporting numerous vine and rose species, was soon exploited by many later designers who had previously employed a more angular post-lintel form of construction.

Figure 2.6. A woodcut illustration from the Hypnerotomachia Poliphili [Online Image] http://mitpress.mit.edu/e-books/HP/hyp142.htm Accessed June 16, 2008

Alberti's treatise was only matched in influence by Francisco Colonna's tremendously popular garden narrative, the *Hypnerotomachia Poliphili* (1499). Widely translated, Colonna's garden descriptions would exert a profound influence on gardening culture throughout Europe. Among the luxurious woodcut illustrations, one can observe a distinct focus upon the garden structures that order the fictitious landscape, providing a sensuous backdrop for Colonna's tale of passion amidst a natural setting (figure 2.6). Such accounts captured the imagination of many garden designers and the dissemination of and reference to Classically-inspired garden techniques remained common from this period onward.

As the epicenter of the gardening world shifted from Italy to France during the 17th and 18th centuries, so too did the role of gardening structures. While the French tradition maintained the grandeur and orderly layout of their Italian predecessors, it extolled a far more architectural approach. Carefully trained espaliers of tree species, parterres, and grand pergola causeways would have spanned tremendous distances as a means of shading visitors within a seemingly infinite garden setting. Very often these structures, which by this point were often constructed of cast-iron, would have been admired on architectural merit alone. Moreover, in many cases a decorative cladding of plants would have been eschewed in favor of a bare structure. Such a development is indicative of a newly-emerging admiration for building techniques and materials that had recently come into prominence, a facet of gardening culture which would continue to gain momentum in the ensuing centuries.

As Jacques Leenhardt suggests, “From this moment the history of verticality within the garden depended on the intrinsic capacities of the plants themselves as well as the artifices employed to encourage them to abandon the soil-source of their nourishment” (2007: 14). In other words, a fundamental action would soon become the uprooting of the plant from its natural base. Such activity was fostered by 19th century advances in building materials made possible by industrial advances in Europe and on the North American continent. Concurrently, an influx of new plant specimens began to arrive from around the globe – the fruits of colonial exploration – providing exciting new horticultural marvels that became widely admired and disseminated.

The architect Hector Horeau took advantage of metal architecture that allowed for the design of structures that were both lightweight and transparent in his plans for covering portions of the Parisian boulevards. Horeau devised a method by which to enhance the high glass roofing of the structures by installing containers filled with soil that would allow flowers to cascade from above. In doing so, he was forced to contend with issues of humidity and the provision of nutritive substances necessary for plant survival where no natural substrate was provided. In response, Horeau devised a clever system of rainwater collection and distribution calibrated to the needs of individual plant types. The installation of these suspended hanging planters has become a popular solution in urban decorative schemes and provides an early example of a modern vertical gardening system (Leenhardt and Lambertini 2007).

Towards the end of the nineteenth century, an era characterized by heated debate and sweeping changes in the practice of gardening, landscape design had become the exclusive realm of the gardener and the botanist (Gothein 1966). The architect served little purpose in this scheme. Seizing upon this new discrepancy, a distinctly architectural sensibility toward gardening began to emerge in reaction to the Naturalism and Beaux-Arts formalism that had become predominant over the past one hundred years. Seeking to return the garden to its high aesthetic roots, many European designers took up the charge of restoring the connection between house and garden that they believed to have fallen to the wayside.

In German-speaking countries, the early 20th century saw extensive use of climbers in architecture. This trend, broadly speaking, grew out of the *Jugendstil* (Art Nouveau) movement in art and architecture and found parallels in the Garden City and Arts and Crafts movements in the United Kingdom and North America (Dunnett and Kingsbury, 2004). Pergolas and other structures that linked architectural features and climbing plants were common elements in gardens and parks throughout Western Europe, but according to Dunnett and Kingsbury, "it was only in German-speaking countries, and to some extent in France, that climbers were so extensively used on houses and other buildings" (2004: 129) Architects such as Peter Behrens saw salvation in the new lattice-work, and exhibition gardens from the early 20th century show a tremendous emphasis upon pergolas, bordering, and other architectonic elements that would form the basis of twentieth-century Modernist gardening efforts (Gothein 1966).

As architecturally-based gardening sensibilities began to transcend exhibition gardens and disseminate throughout Europe and across the Atlantic, a new generation of designers would emerge that drew their influences from the likes of Le Corbusier and Walter Gropius rather than Gertrude Jekyll or William Robinson. For these Modernists, the garden became an outdoor room of sorts or, as the 1950 title of Garett Eckbo's seminal publication suggests, a "landscape for living." While the structures most commonly associated with early vertical gardening strategies were often implemented as a means of providing a degree of shade and lighting effect, Modernist designers tended to favor the naked austerity of building materials rather than the more unkempt appearance of naturalistic vegetation. As photographs from the era show, arbor and pergola structures were often devoid of plant life (figure 2.7), a Modernist touch characteristic of the architectural impulses which fueled their creation.

Recent criticism of Modernist practices has primarily been focused upon the realm of architecture, in which it was undeniably prominent. Criticism often tends to identify Modernism with the International Style propagated by such designers as Le Corbusier and Mies Van Der Rohe, who sought a universal style of design that would be appropriate across geographical boundaries; a celebration of mass production and the exponential advances in technology that had occurred since the advent of the Industrial Revolution. While such criticism is often oversimplified for the purposes of debate, it highlights the key tenets of Modernism that would generate a strong reaction in later years from those who witnessed the whole-scale alteration of the environment, both built and unbuilt, over a relatively short time span. Modernist rationality in architecture and urban planning, particularly in the care of dilettantes,

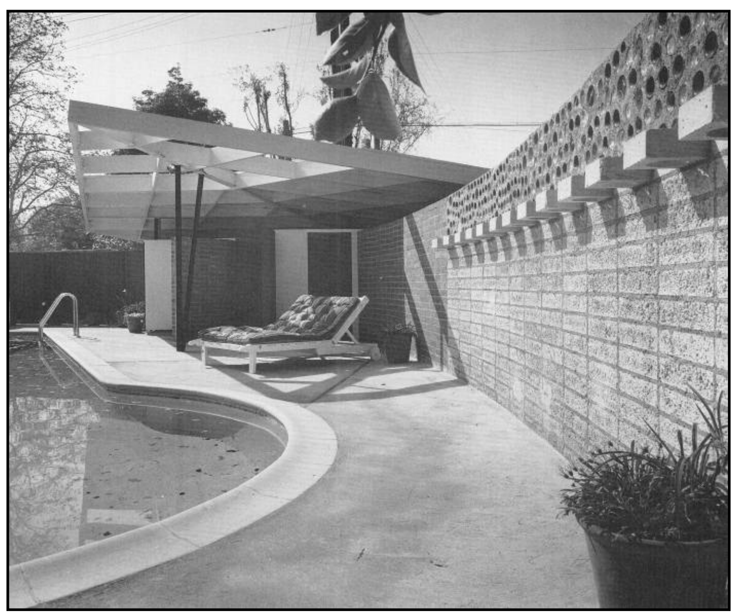


Figure 2.7. Goldstone garden in Beverly Hills, CA
Designed by Garret Eckbo, 1948
(Treib and Imbert 1997:79)

often displayed a severely limited sensitivity towards the natural environment, reveling in the wonders of technology and human progress with only a modest awareness of the long-term effects of such activities.

Although Modernist landscape designers may have sought a certain degree of universality and autonomy in their new twentieth century conception of landscape, the demands of landscape design have always required a degree of site-sensitivity and specificity which exceed those of architectural counterparts.

In Brazil, the landscape architect and artist Roberto Burle Marx was experimenting with a unique design vocabulary that one must consider as the true twentieth century initiator of modern vertical gardening practices. The technical idea of the modern vertical garden was based on two factors: 1) certain plants like epiphytes and parasites already present in natural habitats did not depend on the soil and 2) this autonomous character might be applied in an urban context. A keen botanical researcher, Burle Marx embraced the intrinsic properties of native South American flora while rejecting the practice of using exotic trees and shrubs from North America and Europe, thus expanding the available plant palate and "Brazilianizing" his gardens (Leenhardt and Lambertini 2007). Taking particular interest in the bromeliaceous species and saxicole varieties commonly found among granite rock outcroppings in the Rio de Janeiro region, Burle Marx would utilize the unique qualities of such vegetation in his gardens to spectacular effect. The abundance of other flora types common to tropical forests, orchids, epiphytes, and bromeliaceous species – parasites that cling to a vegetal structures in the presence of sufficient nourishment – allowed Burle Marx to exploit the aesthetic possibilities made available through the use of climbing plants. His close collaborations with architects during his early career provided a forum in which to make use of these new techniques, often in the context of sites with little or no access to natural soil.

At the Safra Bank headquarters in Sao Paolo, constructed in 1982, Burle Marx employed planted columns, or *xaxims*, composed of bromeliads over a substratum of coconut bark that reinterpreted the natural plant physiology of the Brazilian forest. He also employed vertical planting strategies – using both containers and climbing species – along the walls of an otherwise paved plaza to further integrate vegetation into a primarily architectural context (figure 2.8). These innovative interventions on the part of Roberto Burle Max lay the path for the use of vertical gardens in an urban context. Such improvements to the concept of planting urban space would have a profound effect in the realm of architecture.

Figure 2.8. View of wall garden at Safra Bank Headquarters, Sao Paolo, BRA (Adams 1991: 65)

A general dissatisfaction with Modernist architecture and planning would reach its zenith in the counter-cultural movements of the 1960s from which the basis of modern environmentalist attitudes would emerge. Seminal texts from the 1960s such as Rachel Carson's *Silent Spring*

(1962) and Ian McHarg's *Design with Nature* (1968) expressed the vitriol and timeliness conducive to a new outlook towards the natural world which has gained considerable prominence in the present.

Within the realm of architecture, an attitude began to emerge that sought to integrate the elevated tenets of modern ecology into architectural design philosophy. The work of James Wines, Malcolm Wells, SITE, and others sought to integrate architecture with the principles of ecological planning – understanding that any imposition on the natural environment would have widespread repercussions and should therefore be managed and designed accordingly. Quoting Brenda and Robert Vale:

> It has been argued that it is no longer sufficient that the design satisfies the client, can be built within the budget allowed, and earns the aesthetic approval of architectural peers; the designer of a building must also realize the responsibility that resides in making any part of the built environment, however small – that design for the few affects the many . . . Maybe a green approach to the built environment will succeed not least because it can provide again an architecture for all (1997: 158-9)

Among the solutions prescribed by such architectural voices, a call for the integration of vegetation with buildings surfaces as one means by which to create regional specificity and sensitivity to the processes of nature. Among the leading proponents of this new ethos, Kenneth Yeang has emerged as a pioneer in the charge to seamlessly combine the often antagonistic realms of ecology and architecture. Yeang's Menara Mesiniaga Tower in Malaysia (figure 2.9), completed in 1992, introduces façade plantings and raised vegetated terraces to the overall building scheme in an attempt to generate a structure that responds to and reinforces the character of its surrounding environment. Describing the design agenda of "designing with climate," Yeang writes:

> The practice that followed began with the problem of how to integrate and better relate vegetation with buildings. The starting premise is that vegetation is an important indigenous aspect of place and should therefore be an important regionalist design factor, besides being ecologically vital. It might also be argued that vegetation (and other biotic

> components of the location) needs to be introduced into the built environment in far greater abundance than is currently common . . . (1997: 165)

With reference to Yeang's statement, the issues of sustainability and green building practices have assumed a prominent role in new architecture over recent years. The recent introduction of voluntary building standards, such as the U.S. Green Building Council's LEED rating system, offer greater incentives for innovative designs that extend beyond any moral imperative. As Yeang attests, the integration of vegetation into the vertical fabric represents one means by which to improve architecture from an environmental standpoint. However, there have been few efforts to improve the quality of existing structures within the built environment, structures that may have preceded current trends towards sustainable building. Many of the environmentally conscious building measures employed in new construction are conceived in the initial layout and often dictate the form of a given project before it is constructed. Retrofitting an existing building with available green building measures may be far more difficult and expensive. In this regard, vertical gardening strategies may offer one such

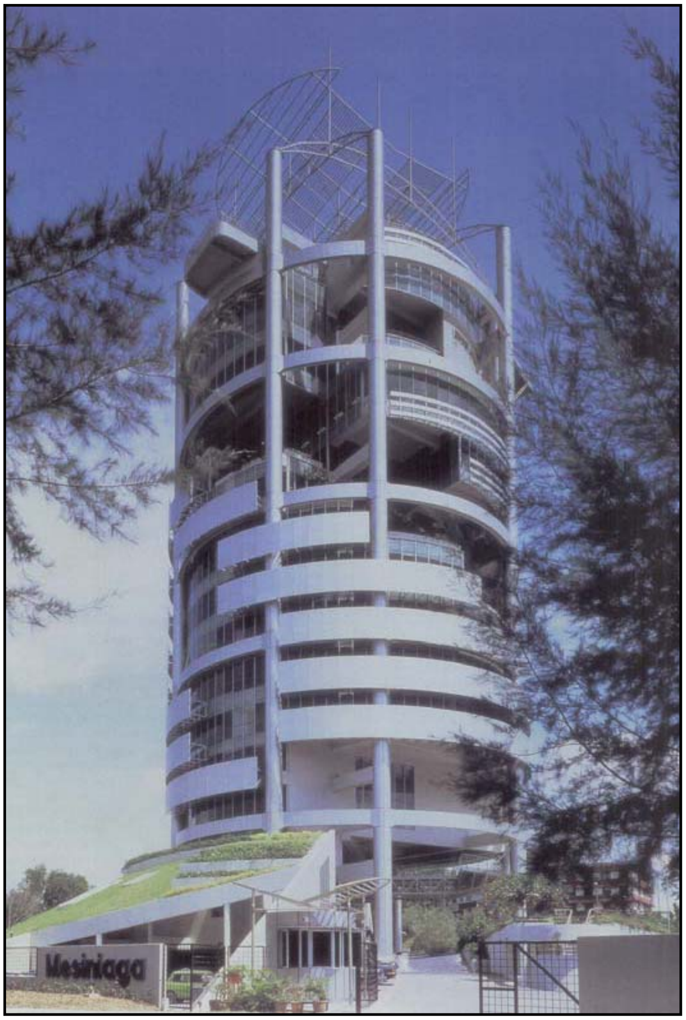


Figure 2.9. Menara Mesiniaga, Selangor, Malaysia.
(Jones 1998: 235)

means by which to furnish sustainable improvements to existing projects with little structural alteration.

Furthermore, in this new conflation of landscape and architecture, one can begin to perceive the built environment from a revised ecological perspective that makes it possible to create a new network of interconnected green spaces linking roofs, walls, courtyards with parks and recreational areas. While these developing strategies may not be considered alternatives to traditional green spaces, they can dramatically increase the plant biomass in urban environments in which vegetated space comprises a mere one-third of the total urban area on average (Johnston and Newton 2004). In this novel conception, buildings offer surface skins akin to natural landforms. When planted following clues from nature, the skin of the city – thus observed – can be transformed into a living landscape (Johnston and Newton 2004) that would benefits both human and non-human actors.

In this chapter, the development of vertical gardening strategies has been traced from their earliest inception towards the present day. Evidence from historical examples indicates that the scope, function, and impetus behind such techniques have been altered dramatically within recent times. Whereas early models provided pleasurable settings and structural support for agricultural and horticultural practices, the practice of vertical gardening may possess far greater potential than early designers may have initially realized. With that in mind, this thesis will now shift its focus towards contemporary vertical gardening approaches employed in the present in the hope of illuminating the incalculable benefits that widespread implementation of such strategies can provide in both new and existing building endeavors.

CHAPTER 3

THE BENEFITS OF VERTICAL GARDENING

In Chapter 2, this thesis introduced the history and theory behind the historical precursors of today's modern vertical gardening strategies. In the majority of the examples presented, vertical gardening devices were often of a distinctly human scale in both theory and practice. One might attribute this factor to maintenance issues, construction limitations, horticultural understanding, or the predetermined function of such structures. Most likely, this aspect has been a combination of factors – with greater prominence granted to a given facet depending upon geographical and historical circumstances. Regardless of the particularities, the conception and practice of vertical gardening has been dictated by human necessity in all cases.

The historical motivation for these practices has typically been of an aesthetic or functional variety, though in particular cases these elements have been harmoniously merged into a single structure. While vertical gardening practices continue to satisfy historically ascribed purposes in their traditional manifestations, the function of vertical gardening techniques has expanded dramatically in recent decades. When considering the techniques employed in the present, one must take into account the enhanced degree of ecological awareness that currently permeates many contemporary approaches to the built environment. Functionality, when considered in conjunction with the concept of sustainability, tends to take on a very different definition than it may have in the past. A truly functional landscape in the present provides not only for immediate human concerns – comfort, pleasure, shelter, productivity – but ensures the needs of future generations and the broad spectrum of interconnected ecosystems currently understood to support all living beings and natural processes on this planet. Moreover, aesthetic qualities (which have often been viewed separate from functional elements) might now be considered in a similar vein as one begins to understand the physical and psychological benefits of a sustainable approach. In light of these considerations, one may begin to see the means by which vertical gardening methods can bring an enhanced level of functionality, to those projects in which the impact of human endeavors might otherwise be considered neutral at best – which is to say, everywhere.

From this standpoint, one must refer to the all-important concept of "ecosystem services," introduced and defined by the Millennium Ecological Assessment as "the benefits people obtain from ecosystems" (2005: vii). Human existence is inextricably tied to – and dependent upon – the flow of these services. They include:

> *Provisioning services* such as food, water, timber, and fiber; *regulating services* that affect climate, floods, disease, wastes, and water quality; *cultural services* that provide recreational, aesthetic, and spiritual benefits; and *supporting services* such as soil formation, photosynthesis, and nutrient cycling (ibid).

Although "buffered against environmental changes by culture and technology," (ibid) a breakdown in any aspect of this system can produce catastrophic results and offer a grim reminder of how important these elements are to human well-being, which (for better or worse) may often be a deciding factor in those design and policy matters that inevitably affect the built environment and those who occupy it. Therefore, one must understand the potentially valuable ecosystem services provided by vertical gardening endeavors. As this chapter will demonstrate, vertical gardening measures can provide a litany of ecosystemic benefits that may exert a profound influence beyond the primary homocentric sphere of experience, greatly affecting those interconnected natural systems – both large and small – of which humans are but a single actor.

With few exceptions, an increase in – or reintroduction of – vegetation in any given area in which it has been forcefully displaced will have a positive effect on that environment. The intrinsic capacities and processes of plant life and interaction form the foundation on which all life is essentially based. Unfortunately, a vast majority of building endeavors, past and present, have tended to strip the land of its native vegetative characteristics to make way for human activities. While humans have altered the land to some degree in most every region which they have inhabited, the urban environment is the critical juncture where such intervention is most visible and where the paucity of vegetation is typically most grievous. The Greater London Authority estimates that only about one-third of typical city centers are comprised of vegetation (Johnston and Newton 2004). While it is true that many dense urban areas may maximize the efficiency of the land by building upward rather than outward, thus saving precious space, it is equally true that in the process they inevitably decrease the amount of vegetation in the area – replacing it with built structures and paved areas that provide little compensation for the callous displacement of plant life.

Vertical gardening is one strategy that has been proven to help alleviate the ecological strain of such development. While green roofing has become a common practice that has proven its efficacy in many diverse urban environments, the potential effects of vertical gardening strategies are multiplied by the sheer surface area of walls in proportion to roofing within the building envelope. Both strategies succeed because they bring the ecological remediative properties of plant biomass to areas in which planting area at ground level might be unavailable or in short supply due to human development. In this sense, both function in much the same way as their historical predecessors. Such a function could not have a much timelier application given the present issues plaguing many urban environments. Contemporaneous with growing concerns over global climate change and man's effect on the environment has been a parallel observation of rising temperatures in cities and towns worldwide. It would seem as if humans were the culprit in this case. As Alexandri and Jones point out:

> With the Industrial Revolution, urban spaces expanded dramatically, much faster and with much more significant changes than in their previous evolutionary periods. The large areas modern cities occupy, their structure, materials and the general lack of vegetation cannot but have altered the climatic characteristics of urban space . . . the general lack of vegetation is one of the factors affecting the formation of raised urban temperatures (2006: 480).

This significant rise in urban temperature and other alterations is known scientifically as the heat island effect. Heat islands form as paving, buildings, and infrastructure replace natural land cover – and are most endemic to large cities in which such elements are widely present. The factors involved are wide-ranging and often tend to be self-perpetuating. The displacement of trees and vegetation minimizes the effects of shading and evapotranspiration processes which otherwise provide a cooling effect in nature. Tall buildings and narrow streets heat air trapped between them and alter airflows which may deprive urban environments of proper wind circulation. Waste heat from vehicles, factories, and even air conditioners can warm their surroundings and intensify urban temperatures (EPA 2008). Additionally, a large number of buildings and paved surfaces commonly possess high heat absorption properties that further retain heat within the urban setting. These factors can lead to augmented night-time temperatures, raised humidity, polluted air and increased concentrations of particulate matter (Dunnett and Kingsbury 2004).

Observing these effects cumulatively, Akbari et al. estimate that "on a clear summer afternoon, the air temperature in a typical city is as much as 2.5º C [4.5º F] higher than in surrounding rural areas" (2001: 295) (Figure 3.1). An increase in air temperatures represents one direct effect of this scenario; indirect effects associated with the urban heat further add to the list

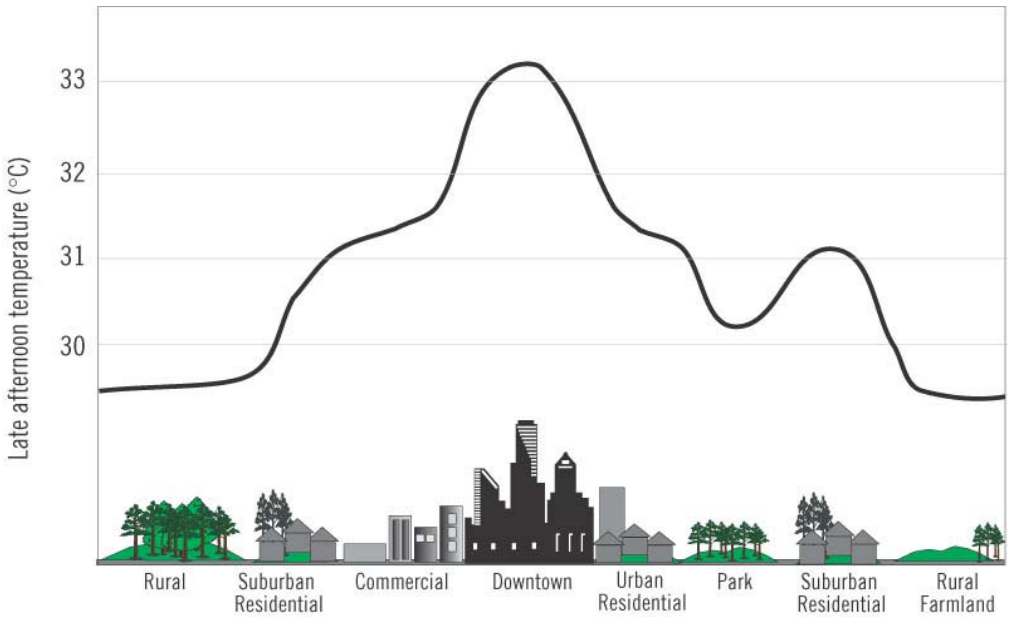


Figure 3.1. Profile of Urban Heat Island [Online Image]
http://adaptation.rncan.gc.ca/perspectives/images/figure2_urbanheat.jpg
Accessed July 23, 2008

of issues raised. Indirectly, increased urban temperatures can raise the peak urban electric demand by 2-4% for each 1º C (1.8º F) rise in maximum temperature above 15 to 20º C (59-68º F). The additional air temperature increase is therefore responsible for 5-10% of peak electric demand at an annual direct cost of several billion dollars (ibid.). Making matters worse, the waste heat produced via the production of energy to meet cooling demands contributes to further temperature increases and thus more energy and money spent for cooling purposes.

In human terms, these factors can lead to heat stress, general discomfort, and respiratory problems. Higher surface temperatures generate convection currents with the strength to raise dust, noxious gases and particulate matter generated via traffic, air pollution and industrial processes. Many of these harmful atmospheric elements have been associated with asthma, cardiopulmonary diseases and even cancer.

Surplus particulate matter in the atmosphere can also have an immediate effect upon weather patterns, particularly with regard to rain intensity. Particulates attach to water molecules to form raindrops as they are carried upward into the atmosphere with the warm air generated by a heat island. Coupled with increased convection currents generated by higher temperatures, such conditions may manifest in the form of violent weather events, such as thunderstorms, which can lead to increased flooding and erosion in those areas that lack proper vegetative cover (Dunnett and Kingsbury 2004).

While the problems associated with the heat island effect are the collective result of a variety of different factors, vertical gardening strategies have the capacity to deal with each aspect in their own highly-effective manner. From the “ecosystem service” perspective provided by the Millennium Ecological Assessment, one might view this as regulatory service – particularly with regards to climatic issues. A main function of urban vegetation, in any scenario, is to harness heat energy to power the process of evapotranspiration from vegetation, thereby achieving a cooling effect. Evapotranspiration is the combined effect of transpiration – the evaporative process by which water is released from the aerial portion of a plant, primarily through leaf stomata – and the evaporation of water from soil and vegetative surfaces. The increase in vegetation provided by the implementation of vertical gardens can raise the level of evapotranspiration that occurs within an otherwise harsh urban climate, thus moderating temperature at a degree proportional to the amount of vegetation that has been introduced. While evapotranspirative properties are common to all plant species, many urban environments simply do not possess the large amount of horizontal planting space necessary to substantially moderate the urban heat island effect. Although efforts have improved to integrate street trees into the urban fabric as a means of providing shade and greater vegetative biomass, opportunities tend to be limited by issues of cost and space. The same holds true for parks and recreation areas: concentrated and condensed green areas that are "incapable of thermally affecting the concentrated built spaces where people live, work, and spend most of their urban lives" (Alexandri and Jones 2006: 480).

By virtue of occupying vertical space within an urban environment – of which there is very little shortage - vertical gardening measures can be easily incorporated into the greater network of urban vegetation. Furthermore, by shielding otherwise heat-absorbent surfaces from sunlight, such tactics can reduce the level of heat radiated from those surfaces in the evening hours, thus providing more pleasant night-time temperatures (Dunnett and Kingsbury 2004). When implemented en masse, vertical gardens can produce a vast corridor of green space connecting street trees, parks, and other vegetated areas, dramatically improving the urban microclimate.

Within the more localized confines of the building envelope, vertical gardening strategies can also have a profound effect on individual structural operations. Vertical gardens can provide a protective skin for structures, protecting the building surface from potential damage incurred by heavy rainfall and hail, while simultaneously shielding vulnerable building materials from the effects of prolonged uV exposure and heat-aging from sunlight (Dunnett and Kingsbury 2004). Simultaneously, this secondary vegetative layer can retard the movement of water on the surface of a building, allowing evaporative cooling to take place on leaf surfaces and enabling better drainage at ground level. As Chapter 4 will put forth in greater detail, many modern vertical gardening methods utilize a structural support system offset from the building by a matter of inches. This miniscule area between vegetative support and building has the ability to trap air that will help insulate buildings from extreme climatic conditions. In warmer periods, vertical gardens can protect the building skin from harsh sunlight that might otherwise be absorbed in its surface. By doing so, interior temperatures are mitigated, thus generating a lesser demand for cooling measures and the attendant energy-use and cost associated with such practices. Additionally, many climbing species of plants raise their leaves in response to the high angle of the sun, effectively creating a ventilation blind of sorts that draws cool air inwards and upwards, thus venting warm air towards the top of the screen (Johnston and Newton 2004).

Where green-roofing measures have been included in the vegetative building scheme, research has shown that vertical gardens can dramatically offset – or in some extreme cases, negate – structural cooling loads and their attendant ecological and financial expenditures (Alexandri and Jones 2006). Such practices can ultimately lead to substantial energy savings from a financial and natural resource standpoint, a win-win situation for businesses and developers looking to save money and enhance their public image by "going green." Furthermore, alternative cooling methods such as those that employ outside ventilation can be introduced and operated more effectively as a result of lower exterior temperatures facilitated by the enhanced integration of urban vegetation.

The ability of vertical gardening measures to moderate the urban heat island effect may alone provide ample justification for the wide-spread propagation of such strategies. However, the benefits of vertical gardening are not confined to merely improving the urban microclimate. Of equal significance to the discussion, vertical gardening can play a prominent role in the purification of air otherwise tainted by the harmful byproducts of human activities. Major efforts need to be carried forth towards reducing emissions of gaseous pollutants and particulate matter from vehicular and industrial sources. Vertical gardening strategies can provide a means by which to moderate their potentially harmful effects. The utilization of climbing plants can provide a large surface area capable of effectively trapping dust and dust-derived pollutants. Acting essentially as a windbreak, vertical gardens can slow down wind speed so that heavier particles can settle out and become absorbed into plant tissue that will eventually be discarded. According to Dunnett and Kingsbury, the trapping of dust is proportional to the amount of leaf surface to wall area, which can be effectively expressed by a leaf area index. Based on such calculations, the higher the index, the more effective the plant will be at capturing particulates. Among the climbing plants with the highest leaf indexes, plants such as *Parthenocissus tricuspidata* and *Hedera helix* can capture approximately 4-6 g. of particulate matter per vertical square meter within a single growing season (2004).

Furthermore, active plant tissue can absorb many of those deleterious chemical compounds that have become increasingly abundant in the atmosphere. Vegetation can greatly reduce the presence of sulfur dioxide (SO_2), a byproduct of coal combustion that comprises a major component of acid rain and can cause respiratory irritation. The same can be said for many nitrogen oxides, particularly nitrogen dioxide (NO_2), produced via internal combustion engines that cause atmospheric nitrogen to combine with oxygen. According to Nowak, "smog is formed when nitrogen oxides and hydrocarbons from biogenic or anthropogenic sources react chemically when exposed to the UV rays of the sunlight" (1992). By reducing the quantity of nitrogen oxides in the atmosphere, vertical gardening can partially diminish the effects of smog that plague many urban centers.

In recent decades, a great deal of attention has been given to the ever-increasing levels of carbon dioxide (CO_2) that can currently be measured in the atmosphere. Despite rising public concerns and ominous warnings from scientists worldwide with regards to the potential climatic effects of such high output, CO_2 emissions have continued to accelerate with each passing decade. During the 1990s, CO_2 levels increased at a rate of about 1.1% annually; in the early 2000s, that percentage increased to 3.1% due to increased global economic activity (Carnegie Institution 2007). Vertical gardening cannot possibly wean human civilization off of the fossil fuels that it so disastrously consumes, but vertical gardening can help to limit the amount of carbon dioxide released in those localized areas in which they are implemented. Although a vast percentage of stored CO_2 is sequestered in oceanic environments, terrestrial plants can fix a marked degree of CO_2 in their tissue in those urban areas where carbon dioxide is most concentrated through automobile-use and industrial activity (Harris 1999). Furthermore, climbing plants (such as those implemented in vertical gardening schemes) may be able to absorb greater levels of CO_2 – proportionally speaking – than trees and shrubs. According to Volkert, the greenhouse gas fixation properties of vines are 60 to 100 times greater than those of trees (2007), though there appears to be scant scientific evidence to support such a claim. Be that as it may, most trees and shrubs tend to dedicate a larger proportion of their biochemical energy towards trunk and limb growth than those climbing plants that require little in the way of self-generated physical support structures. As Williamson reports, increased CO_2 levels have lead to a parallel amplification of vine growth in many environments (2006). Such information may have alarming scientific implications; encroaching vine growth can choke out trees and change forest composition in some instances (Thompson 2007). However, the ability of vines to thrive in CO_2-rich settings can simultaneously provide an impetus for those vertical gardening methods that employ the use of climbing plants in urban environments.

Although there has been little research dedicated to quantifying the carbon-sequestrative properties of climbing plants, vines and other climbing plants can be characterized as allocating a large percentage of their biomass to photosynthetic surfaces (i.e. leaves) with high turnover rates, which essentially serves as a temporary carbon sinks during photochemical processes (Castellanos 1991). Here there must be an emphasis upon the term “temporary” when describing the carbon-sequestrative qualities of plants. CO_2 can be absorbed by leaf tissue, but that tissue is inevitably discarded over time. The carbon absorbed in plant matter is eventually released into soil and air through the slow processes of decomposition.

This cyclical progression of carbon represents a vital component of all life-sustaining exercises here on Earth, but it is equally true that ecologically-harmful human activities have the potential to dramatically alter the tenuous equilibrium of this system to a critical degree if measures are not taken to mitigate such strain. Although plants may have little direct effect upon CO_2 levels in the urban environment (Harris 1999), by reducing the amount of energy consumed to meet cooling demands, vertical gardening can indirectly influence the level of CO_2 produced by power operations – the results of which far surpass the natural carbon-sequestrative properties of plants alone (Rosenfeld et al, 1998).

The effects of urban development are wide-ranging and affect a broad range of actors – human and non-human alike. Natural vegetation serves as a priceless habitat for urban wildlife such that when the flora begin to disappear, so too does much of the fauna that may have previously occupied an area. To be sure, vertical gardening practices cannot restore critical natural habitat on the ground. Vertical gardens can, however, provide some degree of refuge for species that tend to occupy the upper strata of the urban environment – species that have often found themselves estranged from the harsh environment of the city. Studies have shown the presence of a wide variety of invertebrate species that often congregate within the leaves and stems of climbing plants (Dunnett and Kingsbury 2004; Johnston and Newton 2004); these invertebrates can form the basis for a rich web of life, providing sustenance for a wide range of species. Furthermore, well-established climbing plants can provide roosting and nesting sites for migratory birds, as well as provide valuable hibernation sites for insects such as butterflies and moths. As a source of food and shelter, vertical gardening can provide precious habitat for creatures that might otherwise eschew the urban environment or cease to exist in a given region, thus improving the biodiversity of urban areas and the quality of the environment in general.

Thus far, the profits of vertical gardening discussed in this chapter have been of a plainly ecological variety. This is not to say that the qualities attributed to such practices will not have a profound effect on other realms of human experience. There are innumerable performance-oriented financial incentives related to the implementation of vertical gardening strategies that can be obtained under an array of programs propagated by government agencies for the purposes of promoting sustainable building practices. In the United States, applied vertical gardening projects can generate numerous "points" towards Leadership in Energy and Environmental Design (LEED) certification – governed by the U.S. Green Building Council – through optimization of energy performance, innovation in design, water efficiency (where captured stormwater is used for irrigation purposes) and the reduction of the heat island effect. When applied in concert with several other recommended green building measures to meet LEED standards, the cumulative sum – both literally and figuratively – of these specified activities "maximizes operational efficiency while minimizing environmental impacts" (U.S. Green Building Council 2008: 4) and may be rewarded by tax breaks and the less-quantifiable (but equally attractive to some) prestige often afforded by the public. Thus, money may often serve as a primary impetus for vertical garden installation. Elucidating upon the potential financial benefits of such endeavors may offer one of the most effective means by which to influence the public to adopt ecologically-responsible practices; the ecological benefits will continue to remain present – regardless of inspiration. However, as the artist Donald Judd once wrote, "Business doesn't deserve the power and prestige surrounding it. Business is only business" (2000: 1030). It is from this perspective that one may begin to view the aesthetic-cultural benefits of vertical gardening implementation.

Recent studies have begun to explore the psychological effects of vegetation and landscapes as a means of improving physical well-being. There is the scientific verdict that humans show a general tendency towards natural landscapes over urban views, particularly when the latter lacks vegetation and/or a water feature in its overall scheme (Ulrich 1986). Many urban dwellers must bear the everyday monotony of the city for the sake of amenity and convenience. This is not to say that urban environments lack visual interest, it is only to say that cumulatively, urban environments may not provide the degree of natural stimulation that is often found in more pristine settings. This trend may owe much to the relatively recent development of the modern city; humans have existed in nature for far longer than in any concentrated built setting. Be that as it may, a majority of the generally agreeable characteristics of natural landscapes can also be identified in those urban environments that humans tend to find most pleasant. In urban settings ("civilized" landscapes where human influence is clear) a high degree of import is placed upon visual complexity, pattern, depth, and the negligible perception of threat – landscape qualities which have captured human interest for thousands of years in locales both rural and built (Ulrich 1986; Thompson 2000). Vertical gardening strategies, when properly employed, can prospectively provide the degree of visual interest necessary to improve collective conception and experience of the urban landscape – thereby providing a critical cultural service to inhabitants. Architectural triumphs notwithstanding, the presence of such marvelous edifices in urban centers is lopsidedly counterbalanced by an overwhelming majority of non-descript functional structures for industrial, residential, or commercial purposes that offer little interest to the average urban citizen. The introduction of a well-conceived living architectural skin on such structures can establish a level of complexity that may have otherwise been absent.

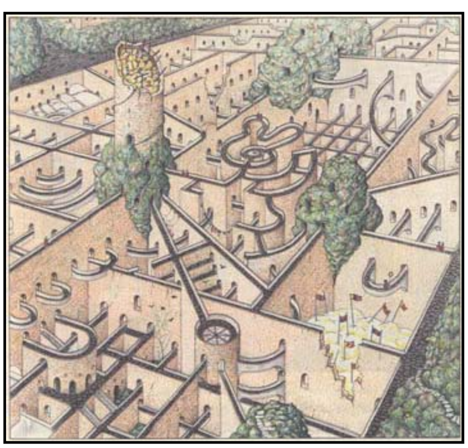
To provide another example, the introduction of dense vegetation at street level can create anxiety – warranted or not (perception can be equally damning) – for urban dwellers by obscuring views while providing both prospect and refuge for would-be antagonists (Thompson 2000). In some cases, this factor has dissuaded planners from integrating a greater eye-level vegetative presence in areas where it may be of benefit. By elevating vegetation above street level, it is possible to provide the advantages of increased biomass without creating the social problems that may sometimes emerge in the process of doing so.

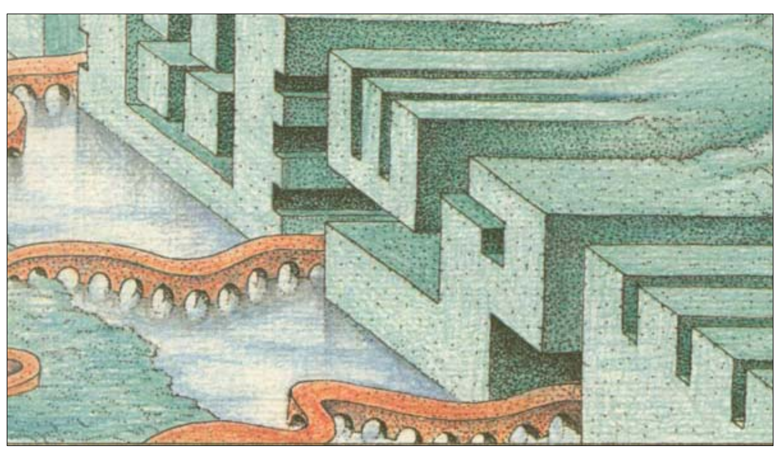
Concurrently, continued interest in vegetation as a foil to the harsh lines and surfaces of built structures that unsympathetically broadcast their artifice to all who might encounter them remains. Who has not marveled at the dramatic contrast between street tree and skyscraper? Too often, natural elements are drowned out amidst a seemingly monolithic backdrop of human structures. In this regard, vertical gardening measures can begin to merge the realms of the natural and the artificial towards a degree of unity that had previously been lost, thus beginning to satisfy basic human proclivities for natural scenery in an urban climate while providing the therapeutic benefits of vegetation to a public that has been regularly denied such an ameliorative presence (Ulrich 1981).

Social and ecological benefits aside, vertical gardening may possess tremendous aesthetic potential in areas where little attention is often paid to such concerns. Ian Thompson proposes a trivalent formula for good design, one that caters equally to social concerns, ecology, and aesthetic delight (2000). Clearly, vertical gardening strategies satisfy the first two criteria with little effort. Many of the historical examples referred to in the previous chapter capture public imagination not on the basis of their functionality, but rather with regards to the remarkable beauty and artistic ingenuity that such endeavors display. In literature and art, we can observe a continuous curiosity with the incredible new visions that verticality may afford. To quote Jules Verne in his epic tale, *20,000 Leagues Under the Sea*:

> Fucus and creepers grew in stiff perpendicular lines controlled by the density of the medium that produced them. They seemed incapable of movement, but when I parted them with my hand, they immediately returned to their original positions. This was truly the regime of the vertical . . . I noticed that all these specimens of the vegetable kingdom had only the flimsiest foundation in the earth. Without roots and seemingly indifferent as to which solid objects they adhere to – sand, shells, husks, pebbles – they ask of the ground not nourishment but simply a point of support. These plants are self-propagated, and the principle of their existence resides in the water that sustains and nourishes them. (1993: 115).

One might note similar fantastical elements in Luigi Serafini's apocryphal *Codex Seraphinianus*, in which imagined cityscapes are presented flush with greenery (figures 3.2 & 3.3), dream-like vegetated visions not unlike those presented in Colonna's *Hypnerotomachia Poliphili* centuries earlier. These once implausible depictions have become less so in the present with the advent of modern vertical gardening strategies, allowing practitioners the potential to realize environments which had previously existed in the realm of fiction alone.





Figures 3.2 and 3.3. Images from
Luigi Seragfini's *Codex Seraphinianus* (1983)

Today, aesthetics continue to play a principal role in the design process. Ecologically-focused design might be considered beautiful or be excused from criticism on the basis of its positive effects, a revised version of the old “form ever follows function” adage put forward by early Modernists. One might consider vertical gardens attractive on this judgement alone, but to do so would be to deny the aesthetic worth of such endeavors that exists independent of ecological or social concerns. One might begin to view vertical gardening measures in a manner that may be as concerned with Henri Rousseau as it is with Henry Thoreau. Rousseau’s allegorical depictions of savage jungle landscapes (figure 3.4) provide a thinly-veiled metaphor for the rigors of Parisian city life; tangible vertical gardening applications in the modern urban setting can grant a new and positive meaning to such allusions while retaining similar artistic merit.

Figure 3.4. Henri Rousseau, "The Dream" [Online Image] www.cutting-edge-hypnosis.com/images/dream-section.jpg. Accessed June 24, 2008

Furthermore, the cornerstone principle of vertical gardening practice, introducing plant life into wholly unfamiliar and unprecedented realms, does not appear to be too far divorced from the tenets of early 20th century contemporary artistic ventures that sought new combinations and readings through displacement of the commonplace. Vertical gardening may not entirely capture the proto-surrealist air of Comte de Lautreamont's "chance meeting of a sewing machine and an umbrella on a dissection table" (1978: 217) or the relentless interrogation of Marcel Duchamp's *Fountain*, but it does have the capacity to put forth an element of aesthetic wonder inherent to the satisfactory juxtaposition of dissimilar elements and unfamiliar contexts.

Perhaps the most explicit connection between the realm of fine arts and vertical gardening is in the layout of the vertical garden itself. One would not be far off in imagining a building façade or vertical surface as a canvas upon which the designer can impart his or her aesthetic vision. However, in the case of the vertical garden, the designer is facilitated by a slightly different knowledge base than that which is demanded by traditional art forms. A keen botanical understanding is necessary in every endeavor. Vertical gardening employs an unusual medium (vegetation) that can engender greater levels of artistic experimentation than paint may presently afford. Plants create lines, depth and texture on a planar surface in a manner that few artists might possibly attain with paint or any other material at such a large scale. Like the oil paintings of Jean-Francois Millet or Jasper Johns with their rough, heavy application of paint, vertical gardens are able to achieve a highly-visible level of three-dimensionality that quite literally springs to life with its undulating shadows, colors and vegetated surfaces. In the case of Patrick Blanc's *mur vegetal* (to be explored in greater depth in the ensuing chapter), said botanist-turned-artist arranges plants in a deliberate, yet highly abstract manner that takes advantage of the intrinsic character of individual plant species in much the same way that a painter might select pigments for a composition.

Herein lays the most unique characteristic of vertical gardening composition: while the designer deliberately lays out the basic manner in which the garden takes form, a degree of control is ceded to the unique qualities of individual plant types. Although the painterly metaphors may be apt to a real degree, a finished painting is essentially fixed in composition. On the other hand, a vertical garden – or any garden, for that matter – exists in a constant state of flux: growing, shrinking, blooming, and dying in the course of its tenure. Despite all manner of meticulous planning, the vertical garden will ultimately dictate itself to some degree, a testament to nature's own power. By this right, a vertical garden may never appear the same upon repeated viewings. It can potentially continue to capture public attention and imagination for the duration of its existence, thereby reminding the observer that nature can never be entirely controlled despite all efforts to do so. Concurrently, plants can enhance the ubiquitous "sense of place" so commonly referred to by modern theorists and practitioners. As Iain M. Robertson states:

> Because plants grow and change, they will, if left undisturbed, develop individual forms, arrange their spatial distribution, and adjust the botanical composition of communities in response to prevailing environmental forces. By doing so, plants are, at least potentially, a versatile and potent medium for expressing a regional character or the genius loci of a site through both their innate forms and their physiological functioning (1991: 68).

In addition, the seasonal and annual fluctuations inherent to all gardens can convey a profound message regarding the passage of time. According to Robertson, "plants have the potential to affect our human perception of time and generate experiences that are far richer and more complex than is possible through mechanisms that convey only the uniform abstraction of clock time" (ibid.). Accordingly, plants may evoke three distinct conceptions of time: linear, cyclic, and immanent. Linear time can make us aware of the "endless, linear stream of time, on which we are fellow voyagers" through physical observation and the physiological functions of plants. Simultaneously, "plants may heighten our consciousness of the passing seasons and thus our experience of time as a cyclical phenomenon." Finally, plants encourage sensitivity towards the present moment, or "immanent" time, which may be "imparted through observing ever-present, ephemeral effects such as the falling of petals or the play of sunlight on leaves" (ibid.: 68-9). Under such considerations of time, our experience of living plants is thereby connected to change, "linking us to time in rich, multi-dimensional ways." Plants allow the designer to utilize unique biological phenomena as a means of imparting a powerful set of statements regarding the fleeting and constantly shifting tendencies of life as dictated by the forces of time – a quality otherwise difficult to express using non-living media.

The myriad benefits of vertical gardening strategies presented earlier within this chapter demonstrate that the integration of vertical gardening measures within the urban and suburban fabric represents one multivalent means by which to improve the ecological, social, and aesthetic character of the built environment. Given the nascent character of the modern practice of vertical gardening, one may be surprised to note the degree to which certain forward-thinking municipalities have adopted measures and ordinances that promote the implementation of vertical gardening strategies. In Seattle, WA, Ordinance 122311, enacted in early 2007, has put into effect the Seattle Green Factor, a program emphasizing maximization of the "vegetative potential" of the rights of way through planting of "layers of vegetation and larger trees in areas visible to the public" (Seattle Department of Planning and Development 2007). The program requires new development in neighborhood business districts to use a "menu" of landscaping strategies that can enhance the visual quality of future projects and promote the environmental value of the areas in which such projects may be implemented. Among those strategies most encouraged, vertical gardens (referred to in the Seattle example as "green walls") possess the greatest "value" towards meeting the standard requirements laid out by the city (figure 3.5 & 3.6).

Much of the literature regarding the Seattle initiative concerns building and landscaping standards for newly developed business and housing endeavors. In the scant amount of information supplied with regards to parking standards, there is no mention of parking structures; the focus, in this case, tends to be upon screening surface parking visible from the rights-of way. Furthermore, the initiative only extends to projects constructed after January 2007. Extant structures built prior to this date do not have to meet the demands of the city ordinance. While few ordinances are perfect, in the Seattle example one can observe a concerted effort to integrate vertical gardening measures in future residential and commercial projects as a means of

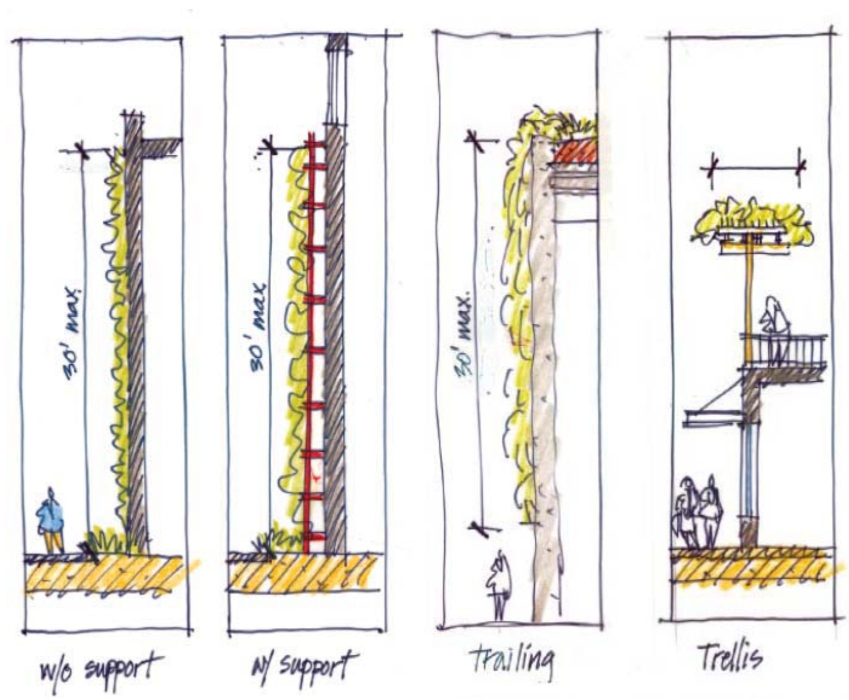


Figure 3.5. Sketch details of green walls for Seattle Green Factor [Online Image] www.seattle.gov/dpd/static/GFpresentation_1_34568_DPDP_019089.pdf. Accessed June 19, 2007

Figure 3.6. Urban landscaping “values” for Seattle Green Factor [Online Image]. Ibid.

addressing environmental concerns and enhancing the character of emerging development. From this standpoint, Seattle’s Green Factor program can serve as a template for new development in urban centers nationwide. However, the Seattle program fails to address those projects that this thesis is most concerned with: existing structures – and more specifically, above-ground parking structures. This omission does not mean that vertical gardening techniques do not have an application in such a scenario, for as Dunnett and Kingsbury point out, parking structures are an excellent example “of a highly functional and often unattractive façade which can be greatly improved by the addition of training wires and large climbers” (2004: 134). While the authors may refer to one specific vertical gardening technique among the countless methods that might be employed in such a scenario – methods that the reader will become familiar with in the next chapter – previous discussions provide evidence that the ecological, social, and aesthetic benefits of vertical gardening projects can be easily and effectively adapted to parking structures.

Jane Holtz Kay effectively sums up the history of parking when she writes "in the immortal words of that late-departed chariot driver, Julius Caesar: 'Veni, Vidi, Vici.' The car came, it saw, it conquered" (2001:76). The modern love affair with the automobile is exceedingly well documented and can be observed in nearly every area in which humans might aspire to venture. So much of this passion derives from the element of movement that the automobile affords. In this regard, stasis is not a quality commonly associated with the automobile. However, as Kay makes clear, "one outward and most unpredictable thing the motorcar brought was the need for its own storage. In repose, as well as in motion, it took space. And, as form follows function, what that need for parking eventually wrought . . . was a new sense of priorities for space, and hence architecture" (ibid.). As the automobile passed from novelty to necessity during the first half of the 20th century, the need for parking in developing suburban and urban centers became a central debate for planners and architects in the United States. As the Conference of Cities declared in 1928, "Aside from the weather there is no question more discussed in our cities today than that of automobile parking" (quoted in Kay 2001: 78) In urban centers, curbside parking – a staple since equestrian times – quickly gave way to new methods for automobile storage as the influx of motorcars came to exceed the space available for such purposes.

In less-developed settings where space was available, large swaths of land were soon paved over, generating vast expanses of asphalt and concrete to service residences, businesses and industrial operations. In those areas where available space for automobile storage was at a premium, planners abandoned the old parking expedients – open lots, warehouses, and the like –

in favor of new architectural solutions that minimized the degree of space necessary to house the ever-increasing volume of cars operating within the urban confines. In Chicago, architects designed a vertically-stacked 5-story structure with a spiraling ramp for the Hotel la Salle as early as 1918 (Kay 2001). This technique would quickly and continually prove effective in dense urban environments in which the option of leveling the existing cityscape to make way for surface parking was relatively nonexistent. In subsequent years, the primacy of parking continued to persist in urban areas. Cities and municipalities began to get in on the act as the motorcar overtook greater areas of space and cemented its position as the preferred method of transportation for all citizens, often at the expense of older streetcar or railway systems that had served urban centers for decades. As urban renewal efforts gained momentum in post-war America, cities maintained the practice of flattening themselves for parking spaces and widening roads to relieve traffic congestion. Furthermore, the ascendance of the suburban manner of living provided that parking would proliferate and gather increasing prominence in areas of lesser density as well.

However, the parking situation in the United States would soon come to a head. Like the motorcar, parking would come to be recognized equally as both a hero and villain in the new 20th century conception of the landscape. As Kay suggests,

> Parking did not remain America's Most Important Product forever. By the early seventies, the freeway revolt, the oil embargo panic, environmental and preservation consciousness, and "eyesore" epithets on the fast food free-for-all combined with 'advocacy planning' to shift the dwelling place for the car (2001: 79).

As this passage makes clear, within recent decades a burgeoning consciousness has emerged that continues to seek means by which to minimize the effects of parking demand as part of a larger agenda, and herein we can begin to extract some of the important issues that surround all parking endeavors. As humans continue to utilize the automobile, there will be a need for such services.

And while it may be unfeasible to suggest that the day on which humans abandon their automobiles is soon approaching, a reconception of vehicle storage represents one manner by which to begin the process of limiting the deleterious presence of the car and its attendant infrastructural needs in the context of the built environment.

The transition towards vertically-stacked parking structures and underground facilities represents a move in the proper direction when considering the vast amounts of paved area required for surface parking. Surface parking makes poor use of the land upon which it is constructed; clearing the area of vegetative ground cover and replacing it with non-porous surfaces can lead to stormwater and runoff issues while simultaneously generating localized heat islands. Moreover, recent studies have proven that automobiles continue to emit evaporative gaseous pollutants in the presence of high temperatures *after* they have been shut off, an effect that can be dramatically limited by the presence of shade trees that are often sacrificed in the process of lot construction (Scott et al. 1999). Such practices take advantage of cheap and available land, and tend to be far less cost and labor-intensive than architectural parking solutions.

Vertical parking methods, ascending or descending from ground level, are able to maximize the number of vehicles stored while minimizing the amount of space cleared, and inevitably paved (if not already done so), for parking purposes. In this regard, one might consider such measures as a more responsible alternative to traditional surface parking. Such a conclusion, though correct for the most part, seems to choose between what ultimately amounts to the lesser of two evils. Though parking structures may consume less space, thus mitigating the environmental effects of large-scale land clearance and urban sprawl associated with surface parking, above-ground parking structures still suffer from the majority of ills that tend to accompany most modern building efforts. The construction of any building structure, parking or otherwise, inevitably increases or maintains the amount of impervious surfaces in the area, a factor which will enhance the urban heat island effect and stormwater issues regardless of land-use economy. Furthermore, the processes of on and off-site construction may further contribute – via energy use and the emission of pollutants and particulate matter – to the total negative effects of erecting such structures. Likewise, the high concentration of automobiles inherent to any parking endeavor create a point-source for air, noise and light pollution that is often disregarded in favor of traditional conceptions of efficiency.

Recently, new construction projects have sought to ease the ecological detriments imposed by parking structures. In Santa Monica, CA, the architectural team at Moore Ruble Yudell Architects and Planners has completed the first above-ground parking structure to achieve LEED certification. The Santa Monica Civic Center parking structure (figure 3.7) employs photovoltaic cells, recycled materials, and other energy-efficient measures that can mitigate

Figure 3.7. Prospective view of Santa Monica Civic Center Parking Lot. [Online Image] www.smgov.net/citycler/council/agendas/2002/20020910/S2003091008-A-1.pdf. Accessed June 19, 2008

some of the concerns associated with parking structures. Certainly, the Santa Monica example is a step forward for designers, but thus far it is the exception rather than the rule in regards to parking structure design. The new techniques employed are most easily applicable to new and future projects, with little attention paid to improving the quality of existing parking structures of lesser design; structures that, numerically speaking, tend to outweigh those projects that seek more ecologically-sensitive construction methods. In such cases, existing parking structures might be considered negatively from an ecologically-remediative perspective, but will nonetheless remain active because of the costs associated with renovation, retrofitting, or demolition and reconstruction. Additionally, extant structures continue to fulfill a critical service in the urban landscape that does not appear to be on the wane. In this sense, techniques that attempt to advance the ecological characteristics of existing structures must be sought.

Vertical gardening strategies are one such means by which to pursue such a goal. By relieving the effects of the urban heat island, capturing gaseous pollutants and particulate matter, reducing noise and light pollution, and providing an unusual refuge for wildlife, vertical gardens can increase the functional character of otherwise banal and ecologically unproductive structures such as parking garages. Regarding stormwater management, irrigation requirements for vertical gardening may provide the impetus for on-site water storage, thus relieving the strain associated with impervious surface runoff. Although little quantitative research to date that can positively elucidate the benefits of such strategies in such a distinct setting, the ameliorative effects of vegetation can only have a beneficial consequences in such an environment – particularly where planting space is limited – and must be taken into consideration in those development processes that seek to improve ecological conditions in the urban realm.

Please note that, in the context of an above-ground parking facility, may not possess the same insulation properties afforded in enclosed residential, commercial, or office applications. This factor can be attributed to the open nature of parking structures that allows for ventilation and natural light. In this sense, vertical gardening cannot offer the dramatic degree of energy-savings or interior microclimatic benefits that can enhance enclosed facilities. However, vertical gardening can greatly enhance the outward appearance of any building at all levels. As this thesis is concerned primarily with parking structures, it is important to recognize that parking structures are often viewed as an unpleasant necessity in the urban environment. In urban centers where the verticality of office and residential buildings are dominant, parking structures may not appear as obtrusive as they do in other densely populated areas in which construction is of a lesser height. In some cases, parking structures may become dominant – and sometimes disruptive – visual features in the urban landscape. Such operations can come to define a streetscape in a negative fashion and dramatically lessen the social and commercial opportunities afforded at ground level. In recognition of such issues, many architects and planners have taken measures towards improving the aesthetic appearance of above-ground parking facilities by employing decorative measures that mask the otherwise utilitarian function of said structures. Interestingly enough, the designers of the LEED-certified Santa Monica project chose to emphasize the unique physical appearance of the structure as dictated by the innovative sustainable measures undertaken in this particular project. The result is a riotous mixture of color and material not out of place in Southern California - but certainly in the context of a parking garage (figure 3.8). In doing so, the designers seem to subscribe to the philosophy that ecologically-responsible design should be celebrated rather than concealed. Even in cases where the design measures taken might not be aesthetically pleasing in a traditional sense, it is hypothesized that the positive function of such devices can be considered worthwhile – and therefore beautiful – in their own sense (Thompson 1999).

Other design efforts have sought to merge the outward physical appearance of parking structures with those of outlying structures or building vernaculars common to the given setting. These endeavors ideally mimic the building materials, architectural features, and scale of their surroundings so as to avoid disrupting the visual flow of the urban streetscape. Revised versions of this strategy attempt to incorporate common street features into the overall design scheme. The inclusion of commercial operations and outdoor pedestrian plazas at ground level can supply a means of connecting and concealing an otherwise monolithic, mono-functional structure within the built environment. However, above street level, parking structures can still interrupt the fluidity of the urban landscape from afar. Street trees may be employed to break up unpleasant features and distract the eye from the potential abomination above the canopy, but such measures may not be entirely effective. Again, vertical gardening efforts can help address such visual concerns by providing a seamless vegetative transition from street tree or streetscape to building façade and minimize the contrast between natural and artificial elements in the landscape. Furthermore, by introducing an uncommon architectural element – large-scale

Figure 3.8. Santa Monica Civic Center Parking Lot at night. [Online Image] www.inhabitat.com/wp-content/uploads/leedgarage1.jpg. Accessed June 19, 2008.

plantings – to an otherwise prosaic exterior, vertical gardening measures can increase the visual complexity of parking structures in the urban landscape while simultaneously providing the therapeutic psychological effects commonly attributed to vegetated scenery. In such an application, parking structures may potentially assume an architectural presence more iconic than eyesore.

In the course of this chapter, this thesis has examined the innumerable benefits of integrating vertical gardening measures into the built fabric of the urban landscape. Parking structures are an excellent example of one such setting where vertical gardening can be highly effective in addressing many concerns associated with the negative ecological and aesthetic conditions generated by such projects. While such methods should certainly be employed in the context of future undertakings, strategies can also be adapted to existing buildings with little structural alteration, as vertical gardens tend to be a minimal addition to an exterior facade. To elaborate upon this premise, the next chapter will provide a detailed survey of the vast assortment of vertical gardening methods employed in the present day. By doing so, it will then become possible to determine which methods are most appropriate for a given set of site conditions, particularly those that will be subjects for the application section of this thesis to follow in Chapter 5.

CHAPTER 4

WAYS AND MEANS

Providing a detailed description of the methods by which vertical gardening strategies might be implemented within the context of extant parking structures necessitates the reiteration of a few key points elaborated upon in previous chapters. Firstly, vertical gardening is not a new practice, but rather one that has undergone a modern transition in both scope and scale as a result of advances in construction technologies and botanical understanding. Secondly, in this contemporary guise, vertical gardening has only gained momentum and acceptance via a newly emergent understanding of the profitability of such measures in addressing certain aesthetic, environmental, and ecological concerns that have enveloped traditional construction practices and conceptions of the built environment in recent decades.

Despite the truth of such statements, there may be no single universal course for actualizing an effective vertical gardening scheme under a given scenario. This may be particularly true with regards to enhancing extant building façade performance. Such a pursuit will undoubtedly be influenced by pre-determined site conditions and the intrinsic capacities of individual plant species to perform their desired function as dictated by growing conditions and the support structures meant to foster their propagation. That being said, an exploration of the wide assortment of vertical gardening approaches and material aids employed in such endeavors will be of great importance to this thesis as it addresses the site-specific conditions and potential application of vertical gardening strategies at two locations in Athens, GA. Considerations of cost have been omitted due to the variable conditions that often exist under a given scenario that may generate considerable monetary fluctuation from project to project, even when utilizing similar configurations.

To begin, one must delineate between the two primary methods of vertical gardening as proposed by Randy Sharp, a leading practitioner and proponent of vertical gardening projects in North America. According to Sharp, the two major categories of "green walls" (the term by which vertical gardening ventures are referenced in a recent article published on the web by *Building Design and Construction*) are: green facades and living walls (2007). In principle, both methods address the vertical gardening challenge posited by Margolis and Robinson of providing external support for plants in their infancy, a period in which their fragile nature may potentially be compromised by wind and other erosive forces that may be exacerbated by urban conditions (2007). The combination of organic and inorganic components separating these elements from extant architectural facades allows for enhanced ecological and environmental benefits while simultaneously minimizing the maintenance and structural concerns often associated with the growth of vegetation on the façade proper. Furthermore, such measures simultaneously reinforce and direct the development of the entire vertical composition, providing a greater degree of aesthetic control that might otherwise have been available.

While the purposes of façade greening and living wall construction are very much in accordance with one another, distinctions exist between the two methods which dictate the viability of each system type and must therefore be taken into consideration when attempting to select the appropriate methods for application. In the words of Randy Sharp, green facades are "wall systems where climbing plants or cascading groundcovers are trained to cover specially designed supporting structures. Plant materials can be rooted at the base of the structures, in intermediate planters, or on rooftops" whereas living walls "are composed of pre-vegetated panels or integrated fabric systems that are affixed to a structural wall or frame" (2007)

Later in the chapter, the principles and methods of the living wall shall be discussed in greater detail. For the moment though, one may focus on the former definition provided by Sharp which can provide an adequate basis for a more in-depth exploration of the principles and practices of façade greening. One may also identify in this statement the principal elements of façade-greening, notably the explicit use of climbing and cascading plant types grown in horizontally-oriented planting media, positioned on a structure for the purposes of vertical coverage.

At this point it must be noted that between the two categories of vertical gardening mentioned above, modern façade greening is the method bearing the strongest resemblance to those early historical practices referred to in Chapter 2. Like the garden structures of old – pergolas, arbors, trellises, etc. – façade greening measures take advantage of the intrinsic growth habits of selected vegetation to create the essential greening effect. By using the structures to guide the form and appearance of the selected plant species, historical practitioners were able to create elements within the garden that synthesized the dual realms of landscape and architecture in a single entity. As previously noted, such practices were all too often limited by a dearth of available building materials and relied on traditional erections of wood, masonry and iron that did not possess the structural capacity to support the towering compositions now made possible in the present by lighter and stronger materials such as steel. In fact, many of the structural advances that allowed for the initial large-scale urban growth of the 19th and 20th centuries are the very same building technologies that presently engender modern vertical gardening projects – which are often coordinated to alleviate the deleterious conditions generated by unmitigated development. From a botanical standpoint, historical design schemes may not have grasped the potential ecological and environmental advantages of climbing plants, most likely because such present-day concerns as the urban heat island or those issues resulting from excessive automobile usage had yet to emerge or remained unidentified during their particular time.

In the present, a comprehensive awareness of the various ills associated with unmitigated urban expansion has percolated into the contemporary design conscience. This new perception has manifested new design strategies that seek to ease the environmental trauma generated by human impact without sacrificing the quality of life to which many have grown accustomed. Vertical gardens, as evidenced in the previous chapter, represent one such means by which to address such concerns. As a result, within the past fifteen years, a substantial array of new products and innovative design schemes have emerged that have attempted to integrate the structural elements of façade greening measures into new or extant projects as a means of enhancing the aesthetic and ecological character of the built environment.

Recalling the definition of façade greening put forth by Randy Sharp, such efforts are enabled by specifically designed support structures that allow for vertical vegetative coverage via the controlled growth of climbing plants and cascading groundcovers. However, before one can begin to elaborate upon the various types of support structures appropriate for façade greening endeavors, it becomes necessary to briefly address the growth habits of climbing plants that direct both the selection and function of those conduits utilized in façade greening systems. Climbing plants in the urban environment are most often associated with a vertical mass of vines firmly adhered to a building surface. For the author, the idyllic summer image of ivy-laced walls at Chicago's Wrigley Field (figure 4.1) underscores the striking visual effect generated by such planting strategies. However, to take a walk beyond the friendly confines of the ballpark –

Figure 4.1. The outfield wall at Wrigley Field in Chicago [Online Image] www.wikipedia.com Accessed August 26, 2008

reveals a somewhat tenuous relationship between climbing plants and the citizens of Chicago. While one may encounter a bevy of charming vine-laden three-flat residences and apartment structures, there always tend to be a few homes or businesses that have become overwhelmed by climbers (figure 4.2). Mercilessly encroaching upon windows, doors and gutters, overgrown climbers can create an unkempt appearance (and maintenance nightmare) that appears as though the concerned parties charged with controlling the climbing plants have simply thrown up their hands and accepted defeat at the hands of nature. Elsewhere, one may notice the remnant scars of climbing plants where they have been peeled away; patches of lifeless organic material often remain as property holders abandon the tedious task of removal (figure 4.3).

These problems tend to emerge in instances where plants have been left to grow unchecked and without a proper understanding of the maintenance concerns and pitfalls associated with climbers. In this sense, one may begin to grasp the divergent ends of the spectrum with regards to the growth of climbing plants on building facades. On one hand, such vegetative schemes can generate fantastic images that may lend identity to a building, street, neighborhood or even an entire city. At the lesser end of the scale, when climbing plants are left unchecked, the effect can tarnish the visual character of those same places, creating a slovenly appearance that may influence local perception.

Figures 4.2 & 4.3. Vines encroaching on windows (left) and the remnant traces of climbers (right) on residences in Chicago, IL (Photos by Anne Roesner)

The Chicago example highlights one means by which climbing plants perform their age-old search for sunlight (phototropism) and other sources of nourishment via upward growing processes. Climbing plants that are able to utilize the flush surface of a vertical plane for the purposes of supporting new and existing growth are referred to as self-clinging. Self-clinging climbers are perhaps the easiest climbers to cultivate in façade greening schemes because they require little support to ensure their spread. Using aerial rootlets, suckers or adhesive, glue-like secretions (depending upon the species) that tend to emerge from the stem of the plant (figure 4.4), self-clinging climbers are able to attach themselves to a variety of building surfaces provided that there is some degree of roughness or irregularity present. These properties

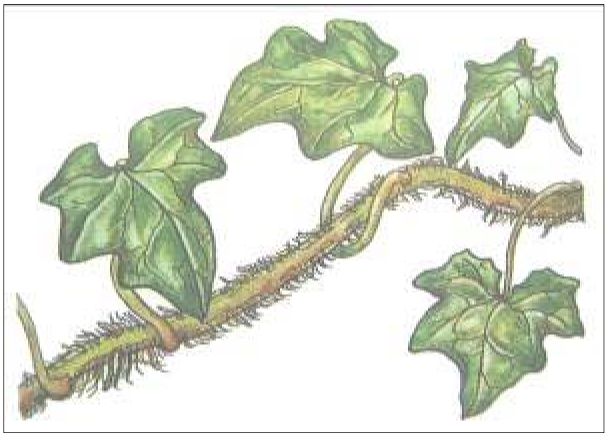


Figure 4.4. Illustration of aerial rootlets on self-climbing plants (Thomas 1999: 34)

make self-clinging plants ideal for stone, brick, or cement surfaces. Though, as mentioned earlier, self-clinging plants such as those referenced in the Chicago example can become difficult to remove over time and may potentially exacerbate pre-existent flaws to surfaces that contain cracks or other imperfections (Dunnett and Kingsbury, 2004). Be that as it may, self-clinging species are capable of a considerable degree of vertical growth. According to Dunnett and Kingsbury, English Ivy (*Hedera helix*) can extend to 98 feet in height and clad a surface of nearly 6500 square feet under proper growing conditions. Furthermore, though some self-clinging species have a relatively shallow profile during early growth periods, many species become arborescent in maturity and may produce a much thicker growth to provide optimal coverage. While the availability, hardiness, and growing capacity of self-clinging species varies geographically, certain species such as Boston Ivy (*Parthenocissus tricuspidata*), English Ivy (*Hedera helix*), and Virginia Creeper (*Parthenocissus quinquefolia*) remain fairly ubiquitous from region to region and must be taken into consideration in most any large-scale façade greening effort. However, as the ensuing chapter will show, the best laid plans can often be thwarted by the particularities of a specific location, and therefore careful consideration must be given to the selection of all climbing plants when planning a vertical garden.

Another common means by which climbing plants are able to ascend a surface is by the use of twining stem mechanisms used to encircle supports both natural and man-made (figure 4.5). Among climbing plants, those that utilize twining methods make up the greatest number of

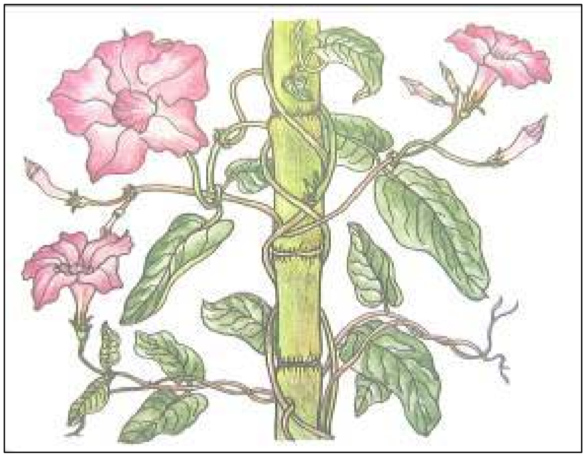


Figure 4.5. Illustration of twining stems (Thomas 1999: 34)

species that occur in nature. According to Howard, individual vines will only twine in a single direction – either clockwise or counterclockwise – and must be trained to grow in their natural manner (1964). In theory, twining species might only require vertical supports with enough surface friction to discourage slippage as the plant develops. In terms of eventual size, twining climbers can range dramatically in both height and growth pattern. Certain large twiners, such as *Wisteria sinensis*, can become woody with age and generate a tremendous degree of stress upon support systems as they mature. Therefore, as a general rule, structures meant to support twining plants – or any climbing plant, for that matter – must be designed and installed with proper consideration for individual plant characteristics, particularly as they age. Furthermore, twining climbers have a high tendency towards vertical growth, making a horizontal spreading effect difficult without extensive tying and pruning efforts. It follows that in order to establish a comprehensive degree of vertical coverage using twining species, multiple plantings spaced at adequate distance from one another may be required.

Certain twining plants may rely upon additional rootlets or tendrils for attachment and support, but more often the situation is of an either/or variety rather than a combination of climbing tendencies. Tendrils are small threadlike stems that twist around objects, thus firmly affixing themselves to a given structure and enabling climbing habits (figure 4.6). While some tendril-bearing plants utilize petioles, others may appear as leaf extensions or as part of the flower spray (Howard 1964). Tendril and leaf-twining species such as *Clematis spp.* often utilize

Figure 4.6. Illustration of tendril devices (Thomas 1999: 35)

these climbing mechanisms on a temporary basis. ounger stems tend to produce the majority of the new growth while older tendrils tend to pass on and become brittle, putting a majority of weight upon the support which the climbing plant will have previously become intertwined within. For climbing species of this type, both horizontal and vertical support members may be mandatory (though diagonally-oriented elements may also be suitable) for such purposes. In those cases where such measures are necessary, an additional element of structural depth may be required. As Dunnett and Kingsbury suggest, "there is some evidence that the shape of the cross-section of the supporting material can make a difference to how well these plants hold on . . . with many possibly preferring an angled cross-section, perhaps because there is less likelihood of slippage" (2004: 143). One might find further evidence in this quote to support the notion that for each type of plant and its attendant habits of attachment and growth, certain demands must be met by the structures meant to bear them and direct their expansion.

Of slightly lesser importance to this brief overview of general plant types that might be implemented in façade greening systems are those plants with growth habits that may be modified to satisfy the criteria for vertical coverage. These include plants that possess long, arching stems which must be tied or trained to supports in order to stand vertically or climb such as Carolina jessamine (*Gelsiumium sempervirens*), and those with prostrate, trailing stems that cannot stand erect without proper assistance such as Trailing lantana (*Lantana montevidensis*) and ivy geranium (*Pelargonium peltatum*). While these lesser species may have little to offer for the purposes of creating a vertical screen of ascending growth, such species may be advantageously employed in a cascading manner to provide many of the same benefits attributed to climbers. A similar effect may also be possible using some traditional climbing species. With little or no vertical support, these species will trail downward from their position, though twining species which may twist around one another and – in the words of Dunnett and Kingsbury – "form a knot of Gordian proportions" (2004: 144) that would prove entirely unsuitable for the purposes of creating an easily maintained and effective vertical gardening system.

In the course of this discussion, it must be repeatedly emphasized that each individual climate and/or plant hardiness zone will foster a vertical plant palette that differs from location to location. Furthermore, recommended support structures will differ based upon plant type and vice versa. With this factor in mind, this exploration may now divert its focus to those traditional structures employed to enable the growth habits of climbing plants for the purposes of façade greening. Many of the various artificial support mechanisms commonly utilized in the present bear a considerable resemblance to those methods exploited historically. However, in most cases the materials and specific approaches have been altered as a means of extending the lifespan and strength of structures that can maximize the effectiveness of individual plant species. As one may recall, self-clinging species require little or no support to cling to vertical surfaces. For cladding an existing wall as a means of simply generating visual interest, support for such plants might be considered superfluous. However, in order to produce many of the advantages of façade greening, and vertical gardening efforts as a whole, offset support systems may be advisable to keep plants from stubbornly attaching themselves to surfaces and becoming unmanageable. This can enable the filtration of particulate matter and provide heating or cooling insulation under seasonal conditions.

In general, modern façade greening makes extensive use of tensile steel cables, trellises, spacers and other supplementary materials developed specifically for such purposes. Wood, the most common material used in historical examples, remains a suitable support for domestic and small-scale projects such as low-rising trellises, pergolas, and arbors. When treated in the appropriate manner, wood support systems may last for a considerable period of time. The well-delineated outlines of such systems may in themselves provide considerable decorative quality to a private home or comparable structure. However, in specific cases where dense growth and/or steady rainfall are present, such conditions may compromise the structural integrity of wooden systems. Therefore, the type of timber employed for the purposes of construction must be carefully selected by the designer and consultation with a structural expert may be required to ensure durability and stability. Ideally, such programs must be constructed with species-specific guidelines dictating spacing intervals between vertical and horizontal elements to ensure proper growth. Furthermore, such programs are not advisable past two to three stories because of the weight and strain that may be exerted upon such structures by plants and seasonal forces such as wind and precipitation.

For the most part, support systems constructed of metal have become the primary option in projects where greater height, flexibility, and density may be desired, though such systems must adhere to many of the same principles which apply to wooden systems. As specific examples of the emerging modern approach shall illustrate, the availability of steel and other recently-introduced materials and methods has engendered an enhanced degree of creativity on the part of designers, offering innumerable opportunities for the employment of façade greening. New products are becoming available that are capable of supporting a variety of different species using standardized configurations, limiting those variables often involved in façade-greening efforts to the benefit of emerging practitioners. A few of these approaches that exceed the performance of traditional small-scale approaches to façade-greening have been implemented into original architectural design schemes that weave the environmental and ecological qualities of vertical vegetation into an overall aesthetic that is truly the sum of its parts.

In an outlying section of the bustling resort town of Rimini in the Emilia-Romagna region of Italy, the architectural team from the offices of Mario Cucinella Associates has constructed a small commercial-office space capitalizing on advances in steel frame technology with an explicit nod to the traditional wooden lattice arrangements of old. By exploiting material advances, the designers were able to create a structure that is of a thoroughly modern character, with a scale and comprehensive vegetative coverage scheme that far exceeds those employed by its exquisite historical forbearers elsewhere on the peninsula. Exemplifying the architects' "desire to create a green corner in the city" (quoted in Leenhardt and Lambertini 2007: 131), the architectural program – completed in 2007 – utilizes an integrated shield of vegetation to shelter interior spaces from the urban cacophony just outside. Making use of an extensive grid of twenty-four-inch-square stainless steel cladding oriented at a forty-five degree angle, Mario Cucinella and his colleagues have executed a secondary façade meant to support climbing plants on all but one side of this new structure, an effect which will eventually generate the final form and appearance of the building (figure 4.7).

Figure 4.7. Steel frame latticework by Mario Cucinella Architects in Rimini, ITA (Leenhardt and Lambertini 2007: 132)

The structure in question is situated upon the former site of a Ducati motorcycle dealership which dictates that the site would have been previously layered with an impervious surface. Owing to this factor, the designers were forced to grapple with the quandary of providing an adequate planting medium for those climbers meant to envelop the structure as envisioned. Further complicating matters was the decision to use a curtain-glass façade at the commercial ground floor. With very little natural soil available at street level the architects devised an innovative planting strategy that makes use of what little space is provided above by a series of balconies encircling the office floors above. By installing a continuous string of recessed pits that run along the perimeter of the balconies, which have been situated behind the stainless steel support grid, Cucinella and his cohorts were able to create an elevated planting area in which to root numerous star jasmine (*Trachelospermum jasminoides*), a flowering evergreen climber, at each successive level of the structure to ensure proper coverage over time (figure 4.8).

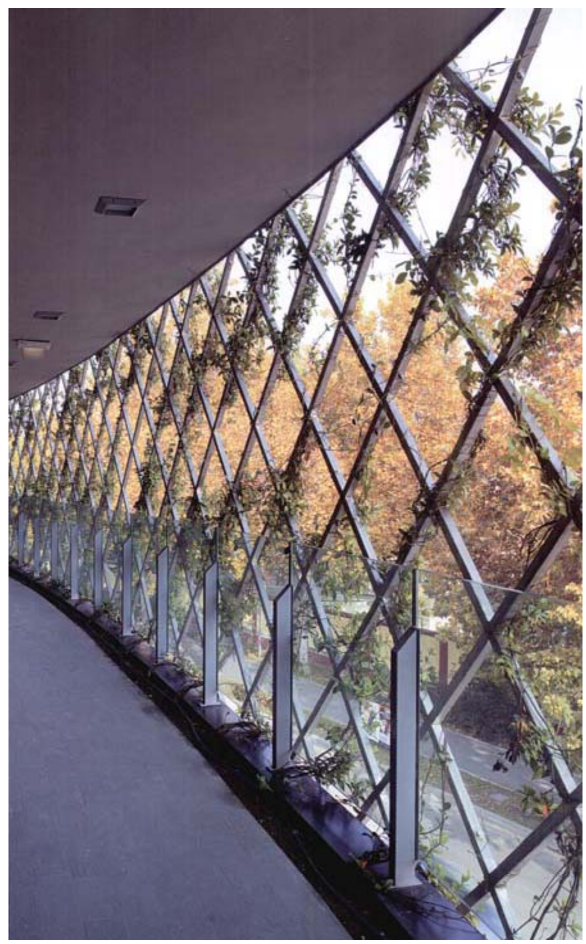


Figure 4.8. Recessed planting pits at upper levels in Rimini, ITA (Leenhardt and Lambertini 2007: 137)

For passers-by, the combination of organic climbers and inorganic steel support patterning must produce a dazzling effect, but one might initially question the decision to obscure office-level windows with vegetation. However, the spacing of the support grid, coupled with a routine maintenance program, would seem to ensure that complete concealment will not be an issue. In fact, the dappled light that would percolate through the porous vegetative façade might be considered a pleasantry for office workers, particularly in the harsh sunlit environment that Italy is well known for.

Regardless of the design particularities, in the Rimini example one might identify two key elements that may inform future design considerations: 1) The use of stainless steel to provide adequate support for climbing plants over a considerable area and 2) the implementation of elevated planting gutters or containers where natural soil may be inaccessible or inadvisable for design reasons.

To date, the number of large-scale modern façade greening projects documented worldwide is limited. One might attribute this paucity of applications to the relatively novel concept of vertical gardening as a whole, but it is the author's contention that scientific studies providing empirical support for such tactics combined with the seemingly unstoppable juggernaut of environmental consciousness can only increase the call for vertical gardening measures. In fact, current examples suggest that vertical gardening is an international phenomenon that may have gained its greatest foothold on the European and Asian continents where energy and environmental issues are often paramount. As evidence, one need only consult the small body of literature available on the subject, a corpus which tends to be translated or imported from overseas nations – France, Germany, Holland, and the United Kingdom, to name a few – where the principles of vertical gardening have been widely understood for at least a decade.

Perhaps the most widely referenced façade greening project in recent years can be identified at the MFO Park in Zurich, Switzerland. A multi-disciplinary undertaking employing architects, landscape architects and horticultural specialists, the MFO Park is a veritable encyclopedia of the various methods and technologies currently utilized in modern façade greening endeavors. In this regard, it may be employed as both a case study and a springboard to a broader discussion of those general elements of façade greening that might be put to use elsewhere. However, MFO Park is not a vegetal-clad building per sé, but rather an enormous skeletal structure constructed for the specific purposes of facilitating plant growth. Completed in 2002 in a post-industrial form reminiscent of the factory previously occupying the site, this multi-tiered vertical garden asks one to reposition fundamental questions regarding both landscape design and architecture, manifesting in a seamless confluence of both disciplines that may serve as a future template for designers.

As the central element in a wide-ranging redevelopment plan for a former industrial area which has been conceived in the present for commercial, residential and recreational use, MFO Park is a unique example of façade greening because it functions as "a futuristic pergola, intended as a new kind of public open space, a contemporary version of the traditional European square" (Dunnett and Kingsbury 2004: 137). The park itself is a double-walled, three-sided erection that evokes the grand European garden structures of past centuries (figure 4.9). To accentuate this premise, traditional trellis and arbor structures are openly quoted among the design inspirations for this project, albeit at a highly exaggerated scale (Leenhardt and Lambertini, 2007). Measuring 328 ft in length x 114 ft in width x 49 ft in height, the park is comprised of massive steel supports that supply the framework for a series of tensioned steel cables that maintain and propagate over 100 species of climbing plant at ground level and among a series of elevated walkways (figure 4.10).

Figure 4.9. Interior space at MFO Park in Zurich, CH (Liat and Margolis 2007: 17)

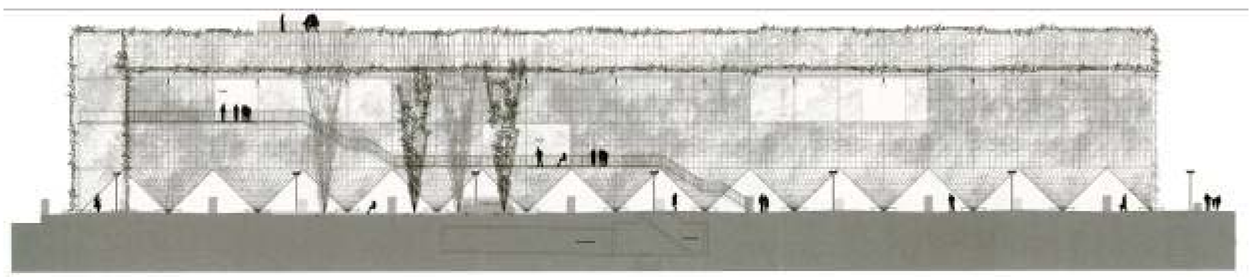


Figure 4.10. East elevation of MFO park showing relation between climbers and steel structure (Liat and Margolis 2007: 17)

The Swiss partnership of Burkhardt+Partner and Raderschall Landschaftsarchitekten designed these vine-growing "nets" (Margolis and Robinson, 2008: 16) in isolation from the main structure to prevent climbers from threatening the integrity of the structural skeleton. Plants have been selected by growth habits and appropriateness within the unique climate of the Zurich region. Species such as *Wisteria sinensis* and *Fallopia aubertii* were selected for their potential height and coverage while slow-growing climbers such as *Clematis spp.* have been integrated into the plan for ornamental value. Planting overlays (not pictured) illustrate the vast

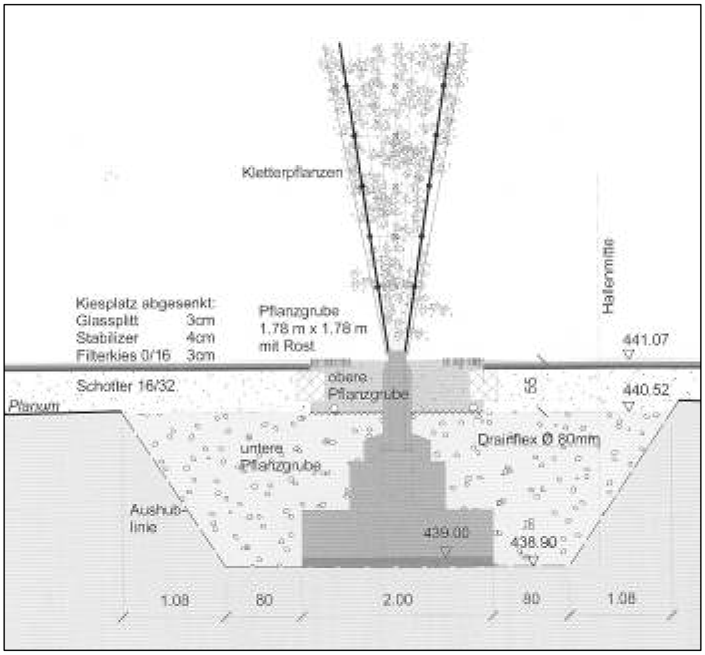


Figure 4.11. Detail section of vine planting pits and structural foundations (Liat and Margolis 2007: 20)

assortment of climbing species dispersed throughout the structure, and one is inevitably captivated by the mélange of textures and colors that might eventually flourish upon maturity. Primary support for this seemingly endless arrangement of climbing plants is supplied by steel cables anchored at ground level within a series of foundations which bearing no overhead load (figure 4.11). These foundations double as planting pits for larger climbing plants fanning outwards from their base. This approach generates a greater volume of greenery at the upper levels of the structure while simultaneously allowing for enhanced visitor circulation at the floor of the complex. Where the height of the structure exceeds the estimated height of climbers installed at the base, a second tier of vines has been trained at the upper recesses of the structure to ensure optimal vegetative coverage (figure 4.12).

Furthermore, MFO Park utilizes a strategy that has become common among many vertical gardening schemes. Making use of the site's internal watershed, the park is fully irrigated by water collected on-site in the multi-functional planting pits, ingeniously graded and engineered to store water in underground cisterns. Harvested water is then pumped upwards for distribution among the plants that occupy the second tier of the park.

According to estimates put forth by Dunnett and Kingsbury, "within seven to twelve years, luxuriant climbers will scramble up the steel cables of the parkhouse, with more covering

Figure 4.12. Vine-laden second tier at MFO Park (Liat and Margolis 2006: 21)

the roof, rooted in high-level troughs and lightweight growing medium" (2007: 137). However, as a trailblazing project of unparalleled ambition and scale, MFO Park is an experiment of sorts. Many of the methods employed have never been attempted at such a grand level. To quote Margolis and Robinson:

> The cumulative load that the vines will eventually place on the structure is variable and difficult to calculate. Factors such as wind resistance, weight of growth, and structural integrity of woody vines create an ultimately unpredictable stress on the structure that prescribes a strategy of structural oversight. The project will have to be periodically monitored to ensure that the skeletal structure is not overcome by the living system it is designed to support (2008:16).

This excerpt highlights both the relative novelty of this particular endeavor as well as many of the concerns that must be taken into account when planning any vertical gardening project, particularly those that attempt to create a composition on par with the scale of urban or post-industrial centers. Presently, little research has been completed that can positively inform designers with regards to the structural pitfalls of large vertical gardening efforts. In the MFO Park example, potential problems may be exacerbated because in the absence of a solid building mass beneath the vegetative skin of the structure, an element which may bear a sizeable portion of the weight generated by façade greening supports and vegetation.

Without question, the success or failure of Zurich's MFO Park will be of great interest to vertical gardening practitioners worldwide, monitored with anxious enthusiasm as it continues to evolve. Simultaneously, this example provides an important design reference for those seeking similar effects in their own region, highlighting the use of steel cable as a conduit for plant growth, an approach that has gained considerable prominence because of the high strength and low weight afforded to such materials.

Figure 4.13. Vegetated "floating windbreak" at Swiss Re complex in Munich, DEU (Decorcable X-Tend Product Manual 2006: 40)

Compared to rigid constructions like trellises or frameworks, steel cable is easily transported to the work site and enables construction over large areas with great design flexibility (Dunnett and Kingsbury 2004). This is the case with stainless-steel mesh systems as well, a variation upon typical steel cable systems that utilize high-strength, flexible nets which can be stretched to span rigid supports or the skeletal contours of a given structure. In a program similar to that employed at MFO Park, layers of stainless-steel mesh have been implemented at the upper levels of the so-called "floating windbreak" (Decorcable X-Tend Reference

Guide 2006: 39) at the Swiss Re complex in Munich, Germany (figure 4.13). After ascending above the ground level via rigid vertical conduits, climbing plants are encouraged to spread throughout the flexible barrier for the purpose of enveloping the allotted structure in time. Similar systems have been employed at a parking garage at the Ohio State University in Columbus, Ohio and an academic headquarters in Frankfurt, Germany**.** The addition of stainless-steel mesh offers a means of "softening the exterior façade" (Decorcable X-Tend Reference Guide 2006: 47) and, as an artist's rendering (figure 4.14) implies in the Frankfurt case**,** the implementation of a cable-mesh layer about the exterior framework of the new structure "enables the building to interact perfectly with its natural environment" (ibid).

Figure 4.14. Artist's rendering of vegetated steel mesh facade in Frankfort, DEU (Decorcable X-Tend Product Manual 2006: 46)

Steel cable systems can be constructed in a variety of layouts, each tailored to the general growth habits of individual species. For self-clinging and twining plants that may only require vertical support systems, the roughness of steel cable can provide adequate purchase for the climbing mechanisms characteristic of these types. All other climbing plants ideally require a degree of horizontal support to reach the desired level of coverage. In either case, one may presently find a vast array of steel cable products engineered specifically for the purposes of façade greening. Many of the manufacturing companies that specialize in steel cable systems for façade greening purposes are based overseas, particularly on the European continent. However, in recent years many suppliers have extended their range to provide domestic services in the

United States and some North American corporations have assumed a leading production role internationally. Manufacturers include Decorcable Innovations LLC, a Chicago-based corporation (www.decorcable.com) and Jakob Steel, a Swiss manufacturing agency with affiliated companies located across the globe (www.jakob-usa.com).

The aforementioned suppliers are mentioned specifically because they offer an array of products – stainless steel cable and cable-mesh – with the explicit function of creating durable and attractive support systems for climbing plants. All vertical gardening systems involve an elaborate configuration of standardized elements with highly-specific functions. In this sense a system is only as good as the individual components it is comprised of. To design a steel cable support system for façade greening purposes, many different factors must be taken into consideration. According to Dunnett and Kingsbury, cables "must be round in cross-section with a diameter of 4-30 mm (0.2-1.2 in)" (2004: 142) as a means of providing the necessary vertical mass to support large climbers. Ideally, the steel cable will be comprised of geometrically-organized sub-strand extensions at ratios of 7:7 and upwards to ensure optimal strength and elasticity (figure 4.15). Most steel cable of this variety has been engineered to withstand strenuous industrial loading duties exceedsing that which may be generated by climbing plants. In fact, similar products are often utilized for highly strenuous industrial purposes. Nonetheless, careful planning in the early stages of the design process is essential to success in any vertical gardening endeavor.

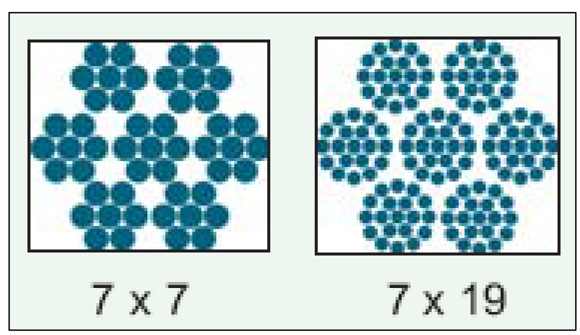


Figure 4.15. Steel cable subs-strand extensions in 7 x 7 and 7 x 19 configurations (Decorcable FacadeScape Cataloguel 2006: 10)

In calculating potential stress to any façade greening support apparatus, one must take a variety of factors into account. First and foremost, one must acknowledge the weight of plants selected – a factor which can vary tremendously – from .09 lb per square foot of vegetated wall area for tender plants to upwards of 4.5 lb for dense or woody species (Dunnett and Kingsbury 2004). However, this calculation alone must be considered insufficient for planning purposes, particularly in the context of large-scale endeavors where additional stress may come from weather and wind. Additional loading inevitably generated by rain and snow can increase the expected weight of mature vegetation by a factor of 2 for deciduous climbers and x 3 for evergreen species (ibid). To provide against horizontal wind shear, designers should further budget for an estimated 17 lb per square foot of surface area for projects ranging from 7-50 ft in height (Decorcable FacadeScape Catalogue 2006). In the event that a proposed support system exceeds 50 ft, individual calculations may be necessary to adjust for extreme wind conditions often present at such an elevation. Therefore, it is advisable that one consult with a structural engineer or other qualified professional before moving forward.

In addition to those ulterior concerns associated with weather, climbing plants themselves may exert sizeable strain upon cable systems as they affix themselves and continue to mature. These forces may, in some cases, lead to warping or failure if product and plant selection guidelines are not given proper consideration. To guard against such concerns, one should include fail-safe and fine-tuning mechanisms such as tension turnbuckles and overload clamps to maintain optimal performance. Where horizontal and vertical cables intersect, cross-clamps are necessary to create a cohesive and high-strength juncture between elements that can be easily adjusted for various cable orientations and sizes.

Perhaps the most important component in the structural equation (with the potential exception of the cables themselves) are the wall-anchored supports which bear the brunt of the load generated by both vegetation and cable trellis patterns. Both Decorcable and Jakob Steel supply a wide array of wall anchors and intermediate supports that can be affixed to a variety of surfaces (figure 4.16). The stoutest individual wall anchoring units boast a maximum axial load-bearing capacity upwards of 2250 lb when mounted at the nearest setting approximate to a vertical surface, far exceeding the loading capacity necessary to support vegetative and structural elements when applied in a proper configuration.

Figure 4.16. Support devices for steel cable trellis system
(Decorcable Facadescape Catalogue 2006: 12)

While it has already been established that allowing for a degree of separation between climbing plants (and their attendant support systems) and the vertical surface on which they are mounted can be of ecological and environmental benefit, it is also true that this gap can mitigate structural problems that may arise as plants mature. Large climbers can possess considerable stem sizes which may leverage themselves against structures, potentially prying supports away from their anchor. For the several reasons mentioned above, a buffer zone of at least 3-6 in is advisable to avoid concern, though this figure may increase under some planting programs and may diminish axial load bearing capacities if the support is positioned further away from its vertical anchoring base. In these exceptional cases, custom support products with the necessary load-bearing capacities may be necessary. However, the comprehensive assortment of accessories available to the designer does seem to allow for a high level of customization and structural integrity. Moreover, the very existence of such products alludes to a comprehensive degree of understanding on the part of manufacturers that may bolster designer confidence in the pursuit of façade greening solutions.

So far, this chapter has explored the innovative use of stainless steel lattice work and cable technologies as examples of façade greening support systems. The latter system in particular provides a flexible, lightweight and easily applied means by which to facilitate the growth habits of climbing plants on both new and extant structures. However, such systems are not the only methods available. Furthermore, certain situations may necessitate the use of alternative methods that, while subscribing to similar support principles, utilize a separate range of material configurations to achieve their desired effect.

In recent years, several types of modular and freestanding trellis systems have been developed that can be easily applied as individual units or as part of more comprehensive façade greening programs. One commonly applied strategy employed in the United States for the purposes of providing support for climbing plants utilizes Greenscreen technologies developed by a California-based manufacturer of the same name (www.greenscreen.com). Whereas steel cable trellis products must be transported to a job site and erected from individual vertical and horizontal elements which may require extensive anchoring, connecting and tensioning components, the Greenscreen system utilizes prefabricated stainless steel trellis panels that can easily be adapted and customized to extant building programs. Greenscreen systems make advantageous use of a unique three-dimensional design that provides not only the horizontal and

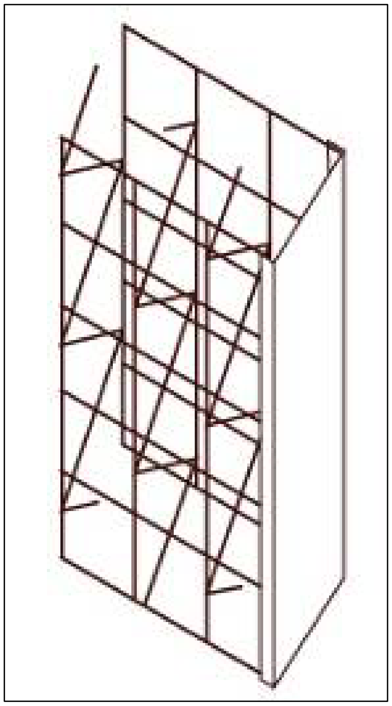


Figure 4.17. Axomometric view of Greenscreen trellis panel [online image] www.greenscreen.com/ Accessed July 28, 2008

vertical support necessary for plant propagation, but also an element of structural depth that promotes greater plant density and support by effectively capturing plant material within its dimensions. Each modular unit, sized at a standard width of 4 ft and a length which can range from 6-14 ft (with custom sizes available in 2 in increments up to 2 x 14 ft per unit) is comprised of a rectangular trellis panel offset from a secondary vertical layer by a series of supplementary diagonal climbing supports which thread themselves upwards through horizontal members (figure 4.17). The gap between vertical panels, positioned at a standard distance of 2 or 3 in, creates a narrow cage engineered specifically to facilitate the various growth habits of climbing plants in a single system – one that requires little tinkering with regards to specific plant species which may otherwise dictate spacing and strength requirements under other programs.

Figure 4.18. Freestanding fence application of Greenscreen trellis panels (Greenscreen Catalogue 2006: 12)

As an outdoor design element, modular Greenscreen units can function in a variety of arrangements. The wire truss configuration may be used as a freestanding fence spanning vertical structural members such as posts or columns (Figure 4.18), thus operating as a vegetated privacy screen or shade element once plants have been allowed to fully infiltrate its structure. Utilized in a freestanding application facilitated by post clips and steel channel or edge trim, Greenscreen panels can provide a welcome substitute for unsightly fencing while simultaneously introducing a sizeable amount of biomass where applied. However, as this thesis hopes to explore the manner and degree to which vertical gardening applications might be applied to large extant structures, one must lend greater attention to those applications of Greenscreen technologies that might be useful at a large vertical scale. More specifically, products that are proven to be successful when mounted to an existent facade. For just such a function, the Greenscreen manufacturers offer modular trellis units and a complete selection of product-specific accessories to make vertical mounting and attachment of individual trellis panels simple – perhaps more so than those efforts involved in large-scale cable trellis installation projects.

Similar to steel cable systems, an appropriate distance between vegetative supports and an existent wall is highly advisable. Because the Greenscreen product is rigid in nature, the modular unit alone may offer a lesser degree of flexibility than stainless steel cable systems. However, by providing an assortment of adjustable mounting clips that can be calibrated to create a uniform trellis face under uneven wall conditions such as split face block, support accessories can adequately provide both uplift and down load support for trellis panels affixed to an extant vertical surface, simultaneously generating the necessary buffer between building surface and vegetated screen. The most commonly utilized Greenscreen mounting clips can be adjustably offset from a surface to a maximum of 9”. For projects that require a greater level of separation, the manufacturer offers custom standoff brackets (figure 4.19) that can hold panels up to 16” from structure surface. In those rare instances where supports must extend further outwards from the building, it may become necessary to fabricate custom steel supports of rectangular steel tubing strong and large enough to provide proper load bearing capacity and anchorage for multiple mounting clip installations. Manufacturers such as Tubular Steel, Inc (www.tubularsteel.com) and Metro Steel Supply (www.metrosteelfl.com) offer customizable products suitable for these purposes. Fortunately, by offering a diverse assortment of similarly conceived mounting clips specifically designed for individual wall surfaces such as steel, masonry and concrete, one can attach modular Greenscreen panels on the majority of building surfaces utilized in modern-day construction. To date, Greenscreen modular trellis systems have been utilized on a diverse range of projects, providing a lush secondary vegetative skin to residential, commercial, and – ideal for the purposes of this thesis – parking structures (figure 4.20) as part of new and retro-fit construction programs.

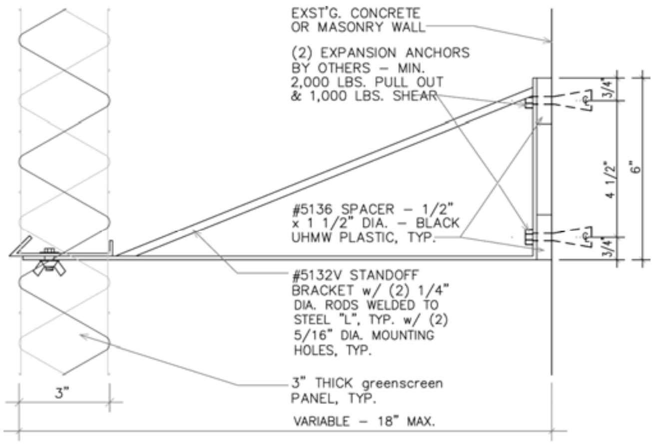


Figure 4.19. Diagram of Greenscreen standoff bracket [Online Image] www.greenscreen.com. Accessed July 24, 2008

Figure 4.20. Greenscreen modular trellis panel application at Fisher's Place Parking Deck in Frederick, MD (Greenscreen Catalogue 2006: 12)

From a design perspective, the rigid geometric form of the Greenscreen panel might be considered somewhat limiting, particularly in cases where one might pursue façade greening opportunities on surfaces that are curvilinear or irregular. To maximize the design potential of this particular product, the manufacturers of Greenscreen modular trellis panels also offers extensive services that can shape and modify panels to meet complicated design challenges. Crimp-to-Curve trellis panels can be modified into standard radiused shapes to create arcs and other curving elements while the 2” x 2” modular grid of individual panels can be customized to meet most design challenges.

The ability to modify the form of Greenscreen trellis panels has also enabled the production of the aptly named “column trellis” currently offered by the manufacturer as a standardized product which can be applied in a diverse manner of ways. Fabricated from a 4’ standard trellis panel, the product produces a cylindrical structure measuring 15-½” in diameter that can be delivered as a single unit to a height of up to 14’ which can then be stacked to generate larger compo sitions. The column trellis – which may also be constructed in custom geometric shapes and sizes – can be installed as a freestanding element or at the base of extant vertical posts or columns to create a decorative vegetated skin to adorn arbor and pergola supports. Incidentally, designers may further utilize Greenscreen modular trellis panels as horizontal members for plant support as evidenced by

Figure 4.21. Greenscreen modular trellis panels mounted upon trellis column supports at Fountain Park in Los Angeles [Online Image] www.greenscreen.com Accessed August 24, 2008

imaginative construction schemes at Fountain Park in Los Angeles (figure 4.21) and the roof deck at the Stanford University Graduate School of Business in Palo Alto, CA . The clever usage of Greenscreen column trellis units provides an ingenious conduit by which to deliver climbing plants to the structural elements above without the maintenance concerns associated with growing climbers directly on the structural supports.

As the 2006 Greenscreen product manual makes clear, “unique applications are limited only by your imagination” (2008: 9). Be that as it may, certain façade greening scenarios may demand more innovative solutions in order to meet their goals. Perhaps the most common challenge in façade greening efforts is the availability of quality soil. Densely developed urban environments, where sidewalks, roads and other impervious surfaces may deny suitable access to a viable planting medium, necessitate designers to provide adequate purchase for vegetation using planter-reliant strategies. The Greenscreen column trellis module mentioned in the previous paragraph can be easily mounted on prefabricated fiberglass planters marketed by the manufacturer at dimensions of 18” (diameter) x 28” in height for basic applications that may require self-contained units. Standard Greenscreen planters also feature special liners and drainage for irrigation control as a means of creating optimal plant growing conditions in areas where they may be otherwise unavailable.

Where planters are required at ground level, the type of planting material selected need only be durable and provide adequate drainage and temperature insulation for those plants selected. The combined weight of the overall planter unit – comprised of the planter, vegetation, soil mixture, and contained water – would be of little concern in such scenarios, thus allowing for an almost unlimited number of combinations. However, in those façade greening programs where street level space for planters may be unavailable, cumbersome, or too low in height for complete vertical coverage of a given structure, designers may utilize wall-mounted planters as a means of generating the desired façade greening effect. In such cases, the weight load generated by planter materials and potential soil mixtures becomes an issue of the highest priority. Moreover, weight concerns may severely restrict the use of common planter materials such as concrete that may exert a tremendous amount of strain upon elevated support mechanisms and threaten safety below.

The easiest means by which to avert structural disaster would be to integrate support systems and/or planter recesses – in a manner similar to those elements implemented in the Rimini example – into the overall design of new structures. Be that as it may, most designers are not at liberty to alter the existent form of a building to accommodate vertical gardening schemes for reasons of labor cost and the risk of compromising structural integrity. In all other cases, practitioners must affix secondary structural elements to the pre-existing façade of a given edifice to realize the potential of façade greening measures. Fortunately, there is precedent for successful implementation of elevated planters acting in concert with vegetative support structures such as the Greenscreen trellis panels mentioned earlier. In fact, among the numerous projects referenced within the manufacturer's website, the façade-greening scheme employed at the Harbor Day School in Corona Del Mar, CA includes just such a program. As a means of alleviating the discordant appearance generated by the upper levels of the campus gymnasium complex in relation to the existent tree line of the surrounding neighborhood environs, a series of fiberglass planters have been mounted along the upper recesses of the structure in hopes of creating an evergreen vegetative skin that will eventually merge with its natural surroundings (figure 4.22). Working in coordination with local contractors, the structural scheme devised by

LPA architects utilizes an overlapping system of high-strength steel support straps as a means of securely binding the planters high above the ground (figure 4.23).

Figure 4.22. View of Greenscreen modular trellis panels mounted upon upper recesses of gymnasium complex at Harbor Day School [Online Image] www.greenscreen.com (Accessed August 20, 2008)

Figure 4.23. Close up of fiberglass planters mounted on wall at Harbor Day School [Online Image] www.greenscreen.com. Accessed August 25, 2008

From an aesthetic standpoint, the design has the undoubted potential to soothe the contrast between organic and inorganic elements – an oft-mentioned sentiment underlying many vertical gardening endeavors. However, the elevated planters do create a certain degree of visual imposition upon the otherwise regular building façade, extruding outward from the flat vertical surface of the structure like some sort of medieval battlement. In defense of this approach, one might conclude that the continued ascension of the surrounding tree canopy will one day obscure this unsightly element from afar, thus mitigating any awkward appearances. Furthermore, considering that the impetus for this project came at the behest of local residents seeking a more seamless transition between neighborhood greenery and gymnasium façade (www.greenscreen.com), one must regard this attempt at façade greening as an overall success –

regardless of the additional environmental benefits – particularly as it may not have been required by any local ordinance or equivalent legislation.

In the Harbor Day School example, design participants combined a variety of construction elements to create a cohesive façade greening system capable of providing adequate support for suspended plant containers and a selection of climbers that may be allowed to spread about the area provided by Greenscreen modular trellis panels. In most cases where planting media must be located above ground level, an innovative, site-specific configuration of custom and standardized materials may offer the best possible solutions to design quandaries. The primary consideration in these instances is the issue of weight versus strength. Among those materials best suited for use as an elevated planter, fiberglass emerges as the most viable option because it is light in weight and can be easily manipulated to create custom planter shapes and sizes. A number of retailers, such as Fiberglass Fabricators, Inc. (www.fibfab.com) and Picken's Plastics (www.pickensplastics.com), may be located on the web offering customizable fiberglass solutions. However, designers should always consult with manufacturers and structural engineers before selecting any large element that might be mounted upon the face of a structure, particularly where persons might be congregated below.

Additionally, one must understand that the planter itself only generates a fraction of the load that may be exerted in such scenarios and the selection of a proper planting medium is equally essential, particularly as it comprises the bulk of the structural mass. With regards to planting media, many diverse factors must be taken into account. Weight considerations are essential. Traditional plantings soils can be extremely heavy and may ultimately prove inappropriate for use under the conditions generated by those façade greening programs that utilize elevated planting media. Moreover, issues of nutrient and water holding capacity, drainage, aeration, stability, and permanence exist and necessitate the use of products engineered specifically to meet such demands. Fortunately, elevated planter substrate considerations call for many of the same elements as those found in the construction of green roof projects and, in this regard, one might select a planting medium or mixture of elements based upon those products and methods that have been proven to function properly under green roof conditions. Among those employed for such purposes, a 50-50 mixture of Stalite-Permatill rotary kiln lightweight aggregate – an amorphous silicate particulate material created from heat-expanded slate – and sandy clay loam may be the most appropriate choice of planting medium. At a weight of 48 to 65 lb per cubic foot (representing the range between unsaturated and saturated media) – far less than that of loam (~80-120 lb/ft^3) – Stalite-Permatill aggregate also possesses a good water holding capacity with lower absorption and higher water release than similar products, and will provide permanent purchase for those plants installed (Friedrich 2008). Of the utmost importance is that this type of planting medium be selected and installed using the proper precautionary measures. To ensure optimal performance, designers should always consult with manufacturers (www.permatill.com), contractors and soil scientists before proceeding in such endeavors.

At this point in the discussion, one final product warrants description. The G-Sky vine container, marketed and manufactured by G-Sky Inc. (a US subsidiary of Eco Innovations Inc., a Canadian corporation based in British Columbia which can be accessed at www.g-sky.com), has recently been introduced as a standardized method of growing climbing plans upon extant building facades. The G-Sky vine container provides an alternative to large container-based growing programs by instituting a series of smaller planting units – each fitted with an individual steel-framed trellis element (figure 4.24) – to be installed en masse for the purposes of creating a

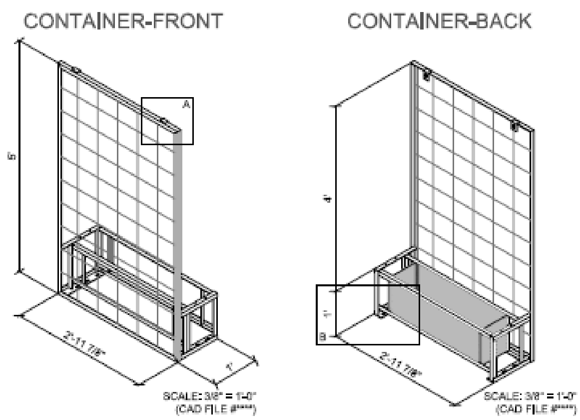


Figure 4.24. Diagram of the G-Sky Vine Container unit [Online Image] www.g-sky.com. Accessed July 24, 2008

large-scale vegetated surface comprised of numerous climbing plants or espaliered trees. The motivation behind this product is clear. First and foremost, it may guarantee quicker vegetative coverage by breaking up the planting program such that a single planting need only cloak a small vertical surface rather than a much larger one. Secondly, by isolating species to an individual unit, a wide variety of climbing plants may be utilized within a single composition with little risk of competition, thus enabling a veritable mosaic of flowering climbers and resplendent seasonal foliage. This facet may also allow for greater maintenance flexibility as individual planting containers may be switched out seasonally for the purposes of propagating tender annual vines often valued for their ornamental qualities. Finally, unruly or inappropriate plant selections can also be easily removed if necessary, though the small volume of the plant containers may offer some assurance that climbing plants may maintain a manageable size relative to the trellis elements meant to carry them.

Containers are held within a skeletal steel frame and are constructed from perforated stainless steel sheets lined on the interior of the container by a polypropylene fabric bag. Having made a name for themselves as a supplier of green roof materials and accessories, the structured soil recommended by G-Sky as a planting medium is similar to that which may be applied in the context of G-Sky rooftop applications. In this scheme, a 1” layer of lava mulch is placed atop a 7” layer of roof soil with a final 1 in layer of expanded obsidian placed at the bottom of the

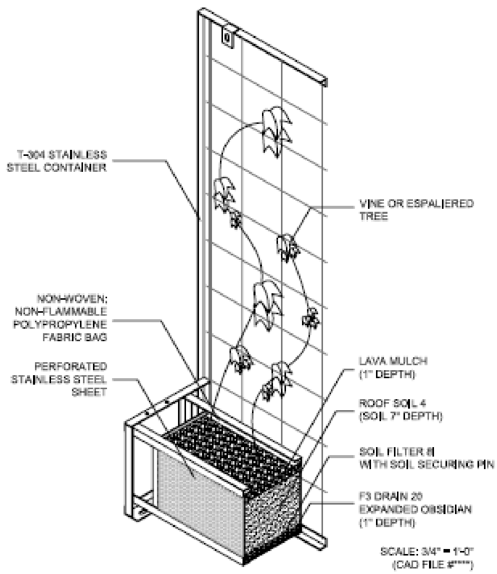


Figure 4.25. Planting detail for G-Sky Vine Container [Online Image] www.g-sky.com/greenwalls/ G-Sky%20Vine%20Container.pdf Accessed July 24, 2007

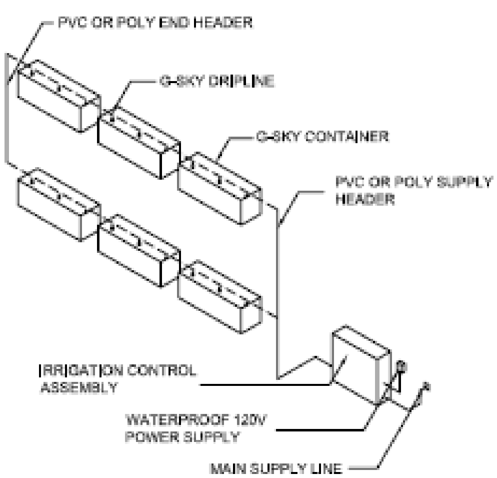


Figure 4.26. Irrigation detail for G-Sky Vine Container [Online Image] www.g-sky.com/greenwalls/ G-sky%20Vine%20Container %20Spec%20v1%201.pdf. Accessed July 24, 2007

container for drainage (figure 4.25). Irrigation is supplied via a basic dripline system engineered specifically for use with the G-Sky vine container and can be regulated by an automatic controller (figure 4.26).

Overall, the G-Sky vine container is a well-conceived option for the purposes of façade greening. However, certain facets of the product may restrict its potential use in some situations. In both drawings and applications, it would appear as though the preferred mounting scheme involves an extensive series of steel I-beam supports extending horizontally from the wall at standard 5 ft vertical intervals corresponding to the height of the individual trellis units. Flat stock grating or equivalent material may span the space between I-beam extensions to create a floor meant to support the weight of individuals traversing this catwalk for the purposes of plant maintenance. However, where G-Sky vine container units are applied as a series of vertical panels mounted atop one another this mounting procedure generates a corresponding series of tightly-spaced structural levels that may prove awkward in large-scale façade greening schemes. Although additional trellis frames (sans container) may be applied atop vine container units, coverage may be limited by restricted planting medium at the base. Therefore, additional levels of vine containers – and their attendant support mechanisms – must be installed to continue coverage upwards. Additionally, when compared to other modular trellis products – particularly the Greenscreen trellis panels mentioned earlier – the single layer of vertical vine supports appear to be an inferior mechanism for the provision of a neat, planar vegetated surface. Instead we might identify in photographs of the G-Sky vine container a more shrub-like, leggy appearance of climbing plants, which may be desirable in some cases, but otherwise must be maintained with a greater frequency than might be the case with similar products. As a final point of criticism, the standard size and rigid construction of the individual units dictate that façade-greening considerations must conform to the seemingly inflexible dimensions of the units themselves, effectually limiting design options to an arrangement of routine rectangular forms.

As a possible solution, G-Sky might consider offering individual vine container units of variable height and width along with other customizable options to provide greater design flexibility and less cumbersome support and maintenance operations. And while the preceding paragraph may seem an indictment of the G-Sky vine container, it nonetheless remains a highly useful product for the purposes of façade greening. Furthermore, like all of the specialized elements previously discussed – products and methods developed specifically for the purposes of façade greening – its marketability highlights the degree to which vertical gardening has been accepted as a feasible and worthwhile practice by both manufacturers and designers.

It is clear then, that the profile of façade greening applications has increased dramatically as the result of recently available technologies and an enhanced global awareness regarding the aesthetic and environmental advantages of pursuing such schemes. However, many of the most visible and celebrated vertical gardening projects eschew the façade greening technique altogether in favor of the living wall approach alluded to earlier in this chapter. Recalling the prior distinction drawn between these techniques, for the purposes of exploring the living wall method in greater detail, it will be informative to cite Randy Sharp once more at length:

> Living Walls (also called biowalls, "mur" [sic] vegetal, or vertical gardens) are composed of pre-vegetated panels or integrated fabric systems that are affixed to a structural wall or frame. Modular panels can be comprised of polypropylene plastic containers, geotextiles, irrigation, and growing medium and vegetation. This system supports a great diversity of plant species, including a mixture of groundcovers, ferns, low shrubs, perennial flowers, and edible plants. Living walls perform well in full sun, shade, and interior applications, and can be used in both tropical and temperate locations.
>
> Due to the diversity and density of plant life, living walls require more intensive maintenance (regular water, nutrients, fertilizer) than green façades (2007).

Forgiving any redundancy in this quotation, it nonetheless provides a detailed basis by which to introduce several projects and methods that utilize the living wall approach to spectacular effect. One may immediately recognize the primary differences – both structural and plant-specific – between the living wall method and those façade greening projects which rely exclusively upon the growth habits of climbing plants. Furthermore, in the mention of the *mur vegetal* we might also identify the first true luminary within the still-nascent discipline of vertical gardening: the botanist Patrick Blanc, who has pioneered the living wall strategy and emerged as its most illustrious practitioner.

A self-professed "monomaniac" (quoted in Rozenman 2005), Blanc has feverishly dedicated himself since childhood to the study of tropical flora. Captivated by the international flower exhibitions he attended during his youth, Blanc's obsession soon led him to the lush jungles of Malaysia and Thailand at the age of nineteen. In this setting he would encounter a fantastic cornucopia of exotic plants unlike anything he might have come across in his native France. Recalling Verne's vivid descriptions, Blanc was able to experience the true realm of the vertical. Plants could be found draped downward from all manner of branches and cliff faces and, like Roberto Burle Marx nearly a half-century earlier, Blanc quickly became enamored with the “idea of finding plants where you least expect them” (ibid.). Following his passion, Blanc studied tropical botany upon his return to France, eventually earning a doctorate for his work with philodendrons. As a researcher for the prestigious *Centre National de la Recherche Scientifique* (CNRS), the young Msr. Blanc spent years participating in numerous scientific expeditions across the globe, observing the wondrous variations of vertical plant growth perched high atop platform laboratories set within the forest canopies of Asia, South America, and the African continent. In this towering ecosystem one may encounter a vast assortment of plants which, unlike their relatives affixed upon the forest floor below, possess the abilities to grow in negligible amounts of earth under highly adverse conditions provided that they might locate necessary nourishment and support from non-traditional sources such as the decaying organic matter often found nestled amongst moist tree and rock crevices. Many of these unique species are of the epiphyte or lithophyte variety, “non-parasitic plants including mosses, some orchids and ferns, and many bromeliads [that] are adapted to use trees and other large plants as a host or support without harming them” (Hill 2001). Epiphytes often utilize aerial root systems for support and as a means of collecting moisture from the surrounding air, whereas certain lithophytes such as lichens and some orchid species grow on rocks and stones with little or no soil necessary for survival.

Seizing upon these unique plant characteristics, the first seeds of Blanc’s groundbreaking living wall system – or *mur vegetal* (translated in English to mean “verdant wall”) – were sewn. However, the problem of providing nourishment and support to plants in an artificial environment persisted. Fortunately, Msr. Blanc was no stranger to the practices of hydroponic growth – whereby it is possible to cultivate plants without soil in an inert medium designed to provide both support and a conduit by which water-based nutrient solutions might be delivered. Experimenting with various materials and structures throughout the 1980s in the hope of creating an inexpensive vertical hydroponic system, Blanc finally settled upon a viable configuration and in 1994 his innovative new vertical gardening system was unveiled to the public at the third annual garden festival at Chaumont-sur-Loire to instant acclaim – so much so that it has became a permanent installation at the festival to this day.

Visitors were amazed by the alien wall configurations of both exotic and familiar species which generated “an awe-inspiring three-dimensional space” and a “new spatial awareness by drawing the eye to plants in mid-air and challenging the usual tendency to look down at flowers in a garden” (Hill 2001). And while this level of praise may certainly be warranted on the basis of aesthetics alone (figure 4.27), witnesses may also delight over the structural simplicity of this seemingly inconceivable approach to gardening. For although the striking appearance of Blanc’s compositions allude to a masterful botanical understanding in terms of species arrangement, based upon the intrinsic qualities and environmental requirements, the support and nutrient delivery systems are straightforward.

The elements are easily understood and, at a cumulative thickness of approximately 13 mm (approximately ½ in.), pose very little imposition structurally when applied either indoor or outdoor. A double-layered section of non-woven polyamide felt is applied to a thin, rigid PVC panel which is in turn anchored to a steel support frame that can be set in a freestanding manner or offset from an existing structure by a small distance (as little as ¼ in.) to minimize the possibility of building surface decay. The initial spread of synthetic felt is cut at various junctures to provide pockets in which plants may be inserted and stapled securely to the PVC layer. Over the ensuing months, the root systems of the individual plants will ultimately take hold upon the secondary spread of felt – which in combination with the exterior layer provides

Figure 4.27. Marches Des Halles Plant Wall in Avignon, FRA
(Leenhardt and Lambertini 2007: 118)

the capillary absorptive qualities necessary to facilitate the diffusion of nutrient solution from drip lines installed about the upper recesses of the structure. Furthermore, by providing the required nourishment in sufficient quantities, the carefully calibrated automatic drip delivery system eliminates competition between plants that might otherwise exist in native environments. This facet of the design allows for larger and more vigorous species to thrive without the threat of overwhelming more tender plant varieties, thus lessening the demand for maintenance and/or replanting measures.

All of this, to remind the reader, is carried out without the use of soil, thus eradicating much of the weight and soil-compatibility concerns that might otherwise be generated by traditional planting media. A lightweight, soil-free planting strategy dictates that the designer is able to load the structure with as much vegetative material as it might possibly support or, in this case, fit spatially within a given area – with up to 30 mature plants growing within a single square meter in some instances. Moreover, the harmonious and easily-propagated coexistence of such a wide variety of vegetation allows for innumerable plant combinations. In some cases, upwards of 500 species have been used in a single endeavor, an incomprehensible level of biodiversity within a small – and above all, vertical – area relative to the enormous urban environs in which they are often situated.

In the hands of a genuine floraphile such as Patrick Blanc, an intimate understanding of plant selection and growth habits authorizes wildly innovative design gestures that may elevate the discussion of such vertical compositions beyond the specialized realms of landscape or architecture to a place within the more illustrious sphere of contemporary art. One need only glance over the seemingly indecipherable diagrams that map out individual species placement within a given installation to understand the high conceptual nature of this work (figure 4.28).

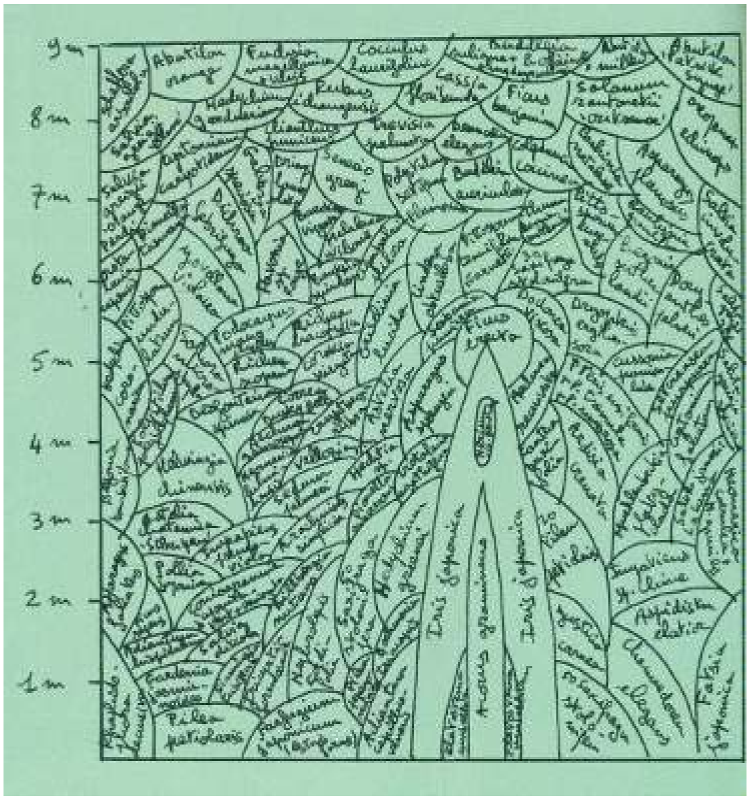


Figure 4.28. Planting plan by Patrick Blanc for interior *mur vegetel* at Dimanche residence in Paris, FRA (reprinted in Hoffman 2006: 160)

Moreover, the work of Patrick Blanc uses plant media to speak about the medium itself (plants) and the fantastic possibilities – familiar and unfamiliar, known and unknown – that they may offer both aesthetically and environmentally. In this sense, Blanc's compositions may be placed within a larger artistic tradition that harkens back to those Modernist artists who made paint and the act of painting their subject rather than any discernable image such gestures might have afforded. Blanc could easily have composed his *mur vegetal* to resemble some recognizable object, scene or slogan. More importantly, he does not. In his work, plants are allowed to express themselves, both individually and collectively, and in their faint whisper one might extract a powerful sentiment regarding the nature of environmental control in these sensitive times; an epoch in which issues of ecology and environment might be placed on equal footing with those of politics and economics and when disregard for such factors can generate potentially catastrophic results.

All proselytizing aside, in an era where beauty is often celebrated in the most ephemeral sense, one must acquiesce to the fact that – regardless of theoretical implications – these works are simply gorgeous to behold. Conversely, the marketability and viability of the *mur vegetal* ensures that if Msr. Blanc were to eschew certain commissions, in all likelihood a dilettante of lesser ability might step in to do the job.

For this reason, Blanc's remarkable method remains under exclusive patent and his decision to stay unincorporated for the time being reinforces his insistence that he remains, foremost, a botanist and professor rather than a garden designer (Rozenman 2005). However, one could not imagine turning down the parade of architectural and design royalty that have sought Msr. Blanc's services over the years. He has worked with such contemporary architectural giants as Jean Nouvel, Edouard Francois, and Renzo Piano, the former partnership having yielded the iconic visions afforded by Paris' recently completed Musee de Quai Branly (figure 4.29) and Foundation Cartier.

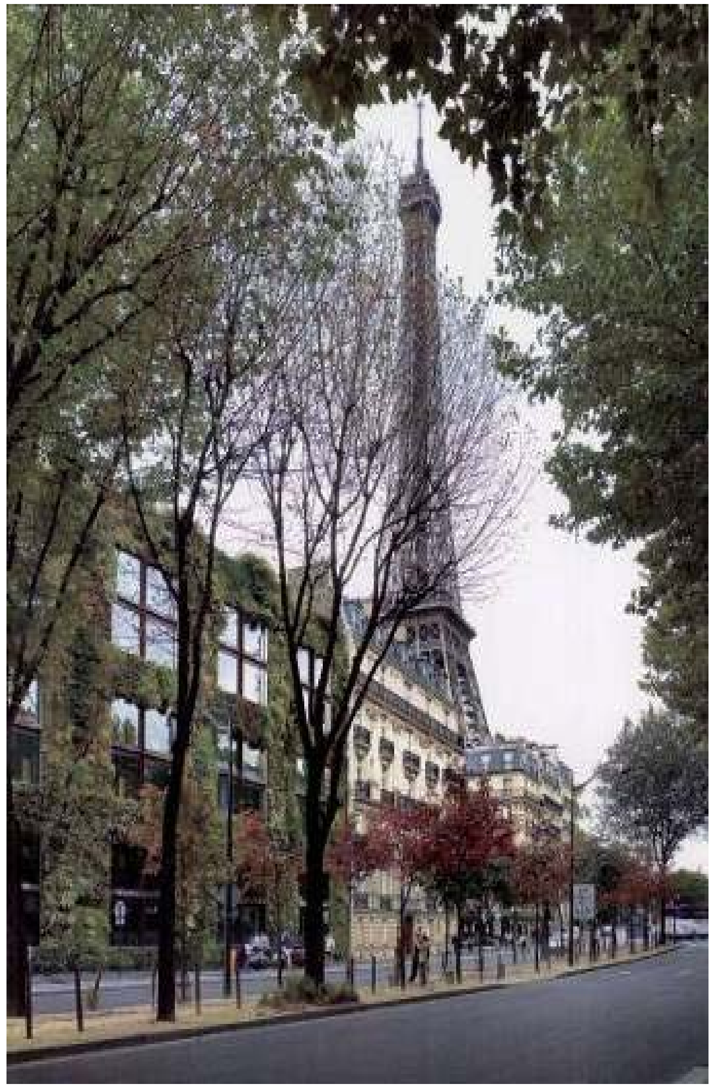


Figure 4.29. Musee de Quai Branly, Paris, FRA (Leenhardt and Lambertini 2007: 171)

Incidentally, the collaboration with Francois employs a design scheme more in step with the practice of façade greening – by which horizontally-planted climbing plants are affixed to an attendant support structure – than those works traditionally put forth by Blanc. At La Defense in

Figure 4.30. Chimenee Vegetale at La Defense in Paris, FRA (Leenhardt and Lambertini 2007: 57)

Paris, the duo was charged with the task of obscuring a sixty-foot tower providing ventilation for an underground parking garage. Turning the structure into what ultimately amounts to an enormous flower pot, the tower was affixed with chestnut wood stakes protruding from planting basins which encircle the cylindrical structure at various levels. Growing upwards from the basins, an exotic array of various moonflower species, climbing plants of the *Convolvulaceae* family, were installed to provide an innovative example of "urban camouflaging" (Leenhardt and Lambertini 2007: 55). Furthermore, the structural elements meant to provide support for climbing plants provide a degree of visual interest as they protrude at random from the tower. The result is a spiky vegetative sculpture – or *chimenee vegetale*, as it is commonly referred to – that not only hides an otherwise unsightly mechanical element but creates a delightful new aesthetic object within the urban landscape (figure 4.30). While this may be a relatively simple design scheme when compared to Blanc's *mur vegeteaux*, this example highlights not only the versatility of the designer but also the level of flexibility and creativity demanded by all vertical gardening projects where pre-existing physical conditions are present and unavoidable.

With the exception of Blanc's mur vegeteaux, living wall methods rely upon unique substrate configurations as a general means of vertical vegetative propagation. One technique

Figure 4.31. Wind adapted canopy structure with climbing plants situated in elevated basins. Designed by West 8 for San Juan, Puerto Rico (Liat and Margolis 2007: 29)

in particular warrants individual mention for the inventive strategies employed in an ambitious new building endeavor in Amsterdam. While Holland-based landscape architect Adriaan Geuze and his colleagues at West 8 have experimented with projects that might best be categorized within the realm of façade greening – employing steel cable and elevated planter apparatuses for the spread of climbing plants in their wind adapted canopy structure proposal for San Juan, Puerto Rico (figure 4.31) – it is another Dutch design team, Copijn Landscape Architects, who have developed an alternative living wall strategy that is worthy of discussion alongside the work of Patrick Blanc.

At the Sportplaza Mercator, an athletic complex located on the western edge of the Dutch capital in the sprawling Rembrandtpark, the Copijn-patented Wonderwall method has been employed to incredible effect as a means of merging the newly built structure with its surrounding environs, creating a “hybrid architecture, almost entirely covered by a layer of plants” (Leenhardt and Lambertini 2007: 207). The system employs a modular series of elements, each comprised of three component layers. To quote Leenhardt and Lambertini, the system is erected from:

> . . . a steel mesh that is anchored to the building, a shielding plate attached to the inside of the mesh and a thin external pane. This outside layer consists of a metal frame and a felt-covered plastic panel with regularly placed slots where plants in containers are inserted.

> An automated irrigation system is built into the plant walls allowing plants to grow in nutrient enriched water, hydroponically, without further care. (ibid.)

As the description above illustrates, the Wonderwall system employed at the Sportsplaza Mercator functions in a manner similar to that produced by Patrick Blanc. However, the modular characteristic of this particular method does create a degree of distinction between these respective approaches. Photographs reveal the regularized dimensions of individual panels and their attendant plantings – seemingly shelved within the layered structure at regular intervals – generating a geometric, grid-like appearance that agrees with the contemporary architectural character of the complex (figure 4.32). This standard setup is rigid in design when compared with the far more flexible approach adopted by Blanc, which allows for a free-flowing, amorphous presentation of vegetation within the confines of its borders. Criticism aside, the combination of textures and colors generated by individual plants stationed about the entire surface of the building – save for

Figure 4.32. Close up view of Wonderwall system by Copijn Landscape Architects for Sportzplaza Mercator in Amsterdam, NED (Leenhardt and Lambertini 2007: 212)

sections of curtain glass walls to permit light and visibility – creates a highly unique exterior that magnificently echoes its verdant surroundings (figure 4.33).

Figure 4.33. View of Sportzplaza Mercator and surrounding vegetation. Curiously, this athletic complex also houses a Kentucky Fried Chicken on its premises. Conflict of interest, perhaps? Only the Dutch know for sure. (Leenhardt and Lambertini 2007: 206).

Thus far in the discussion of the living wall approach to vertical gardening, this thesis has introduced two highly-specific systems that in many ways represent the cutting edge of living wall technologies. Both systems remain the exclusive property of their respective designers and, for this reason, may not be an option for would-be vertical gardeners seeking out publicly-available techniques. However, several manufacturers have developed their own living wall schemes that may be easily applied in both new and extant building schemes. Many of these methods make use of traditional soil-based planting apparatii set at 90º orientations as a means of creating vertical plant surfaces where applied.

With apologies to other manufacturers, for the purposes of brevity it will be adequate to discuss one individual product – the G-Sky Green Wall Panel – as a means of shedding light upon an entire approach to the living wall method of vertical gardening, as many systems now available utilize nearly identical tactics and materials to create the desired effect. Developed by the same company that has given the world the G-Sky Vine Container, the G-Sky Green Wall Panel system makes use of 1 x 1 ft. modular planting units that can be arranged to create a living cladding for walls both indoor and outdoor. The modular panels (figure 4.34) are made of an ultraviolet-resistant, non-flammable Polypropylene. Each panel contains a growing medium of natural peat block encased in a non-woven, non-corrosive, non-flammable fabric inserted within the Polypropylene module to ensure a compact and stable vertical substrate. At a depth of approximately 3 in., the provided planting medium is engineered to accommodate 13 or 25 established plants that are cultivated in situ at G-Sky growing facilities for eventual distribution. Plants are selected by the manufacturer based upon their

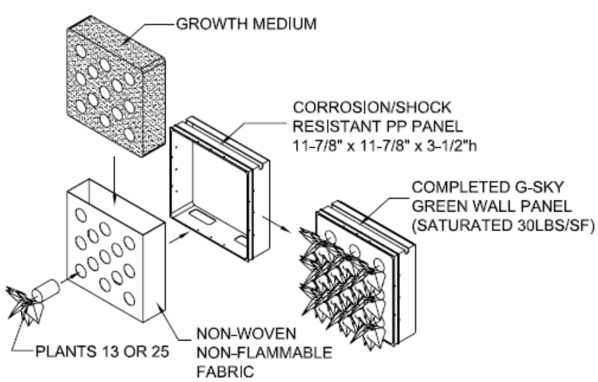


Figure 4.34. G-Sky Green Wall panel detail [Online Image] www.G-Sky.com. Downloaded June 26, 2008

growing abilities and the individual environmental conditions present at the project site. Typical plantings are comprised of Sedum and fern varieties that generate a profile somewhere between 3-8 in. to create “a dense carpet of living green material” (Liat and Margolis 2007: 150).

The panels themselves are mounted upon a stainless steel framework designed specifically for the support of G-Sky Green Wall Panels (figure 4.35), which are essentially hooked over the support frame to provide stability. This framework can be easily anchored to concrete, masonry, or other acceptable structures capable of bearing the cumulative weight of the system, which amounts to approximately 30 lbs per square foot for a single panel under saturated conditions plus the weight of the framework and attendant G-Sky GWP Drip Irrigation System (figure 4.36) developed specifically for use with the G-Sky Green Wall Panel.

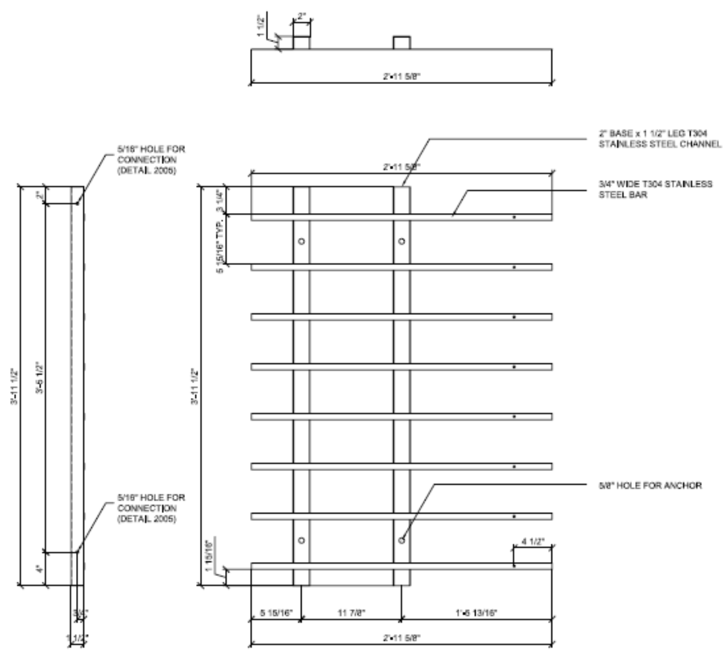


Figure 4.35. G-Sky stainless steel wall support for 12 panels [Online Image] www.G-Sky.com. Downloaded June 26, 2008.

Applications of the G-Sky Green Wall Panel have been numerous over recent years, with examples ranging from the first living wall constructed in North America by Sharp and Diamond Landscape Architecture, Inc (of which Randy Sharp is a principal) for the Vancouver Aquarium (figure 4.37) in Vancouver, Canada to the forecourt wall installation at the W Hotel Midtown in

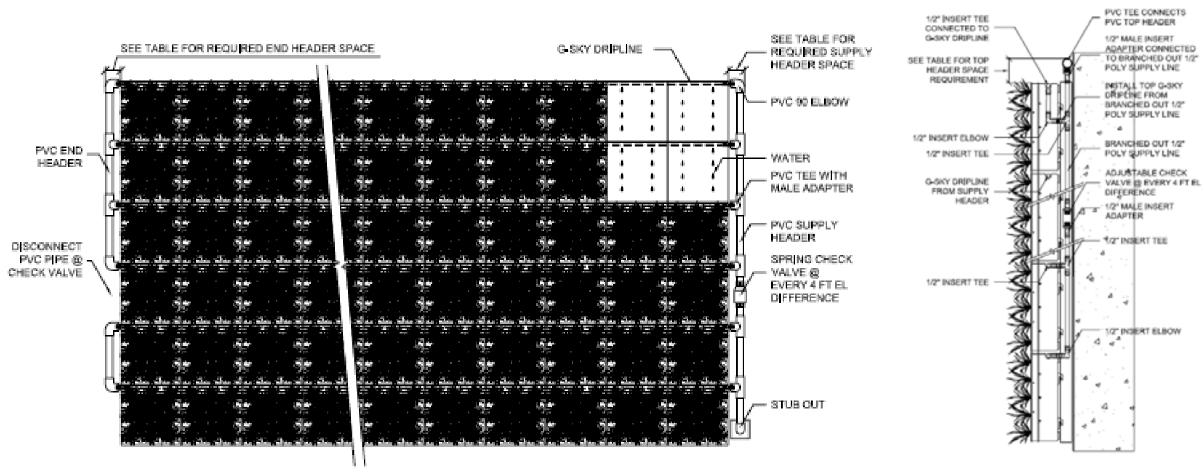


Figure 4.36. G-Sky Green Wall Panel irrigation system details [Online Image] www.G-Sky.com. Downloaded June 26, 2008

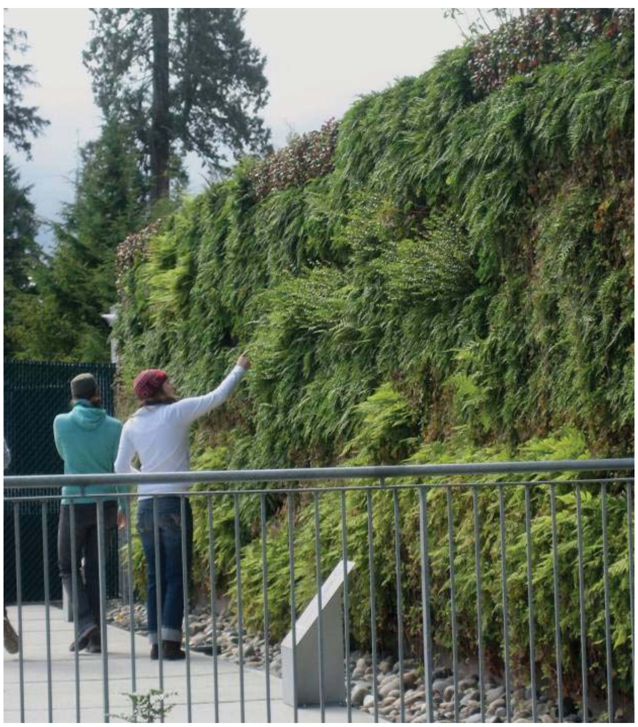


Figure 4.37. Living wall built by Sharp and Diamond Landscape Architects at Vancouver Aquarium [Online Image] http://www.greenroofs.org/baltimore_files/awardsimg2008/hiresimgs/VanAquarium_PeopleTouchWall.jpg Accessed August 10, 2008

Atlanta, GA (not pictured). And while G-Sky manufacture their products for specific use with elements isolated within their individual catalogue of options, other products such as the ELT Easy Green Wall (www.eltlivingwalls.com) make use of comparable systems to similar effect.

In summation, vertical gardening strategies are developing and adapting at a rate equivalent to the creative applications devised by those who seek their aesthetic and environmental benefits as a means of improving the built landscape. Aside from those already discussed, innovative vertical gardening gestures such as those devised by

Heather Ackroyd and Dan Harvey for temporary cladding surfaces in germinating grass seed set upon a clay substrate (figure 4.38) certainly occupy a position on the author's radar. However, their ephemeral characteristics and limited function make any further mention unnecessary for the purposes of this thesis. Far from denying their spectacular visual qualities, the focus must remain upon those primary methods of vertical gardening – the façade greening and living wall approaches, respectively – that may potentially factor in future design schemes.

Figure 4.38. Grass interior at Dilston Grove, a deconsecrated church in London, UK
(Liat and Margolis 2007: 38)

CHAPTER 5

THE TALE OF TWO PARKING DECKS: VERTICAL GARDENING IN ACTION

Having covered the wide range of material- and product-based approaches to vertical gardening currently available to designers for the propagation and support of climbing plants and other species, it now will serve the purposes of this thesis to take these measures and apply them in a real world context. By analyzing specific applications – in this case, a pair of extant parking structures in Athens, GA – the potential for vertical gardening can now be examined in an expanded manner that may then be utilized beyond the particular circumstances of this chapter.

While the previous chapter highlighted the various methods by which vertical gardening endeavors might be realized, no standardized formula exists for selecting the proper strategy from one project to the next. Each individual scenario will demand careful consideration of individual site conditions and a high degree of collaboration between a multidisciplinary team of professionals. This latter point warrants further elaboration, for it is the case that vertical gardening projects have yet to be "claimed," so to speak, by any specific discipline in the manner often typical of the persistent territorialism between allied professionals in architecture, landscape architecture, and site or structural engineering. One must consider this facet of vertical gardening in a positive light, for it opens the door to a widened array of design strategies and relevant philosophies that may engender an enhanced level of communication between associated disciplines that may otherwise prove to be a detriment in its absence.

The preceding examples from Chapter 4 help to illustrate this premise. With little exception, each can be categorized as a cooperative effort combining the expert knowledge of a diverse selection of individuals towards achieving the goals and benefits of the modernized practice of vertical gardening. In light of the disparate aesthetic, structural and horticultural elements that are involved in the realization of such schemes, it becomes difficult – and unwise – to proceed in any other manner.

These difficulties become especially pertinent with regards to many of the structural considerations present in nearly every vertical gardening scenario – particularly when one is proposing a potential addition to an existing edifice. A landscape architect would be required to consult with structural engineers and other professionals were he or she to advance any proposal beyond a certain stage. For this reason, exact specifications have been eschewed in some cases in favor of more generic descriptions. Nonetheless, the recommendations put forth in this chapter might be considered comprehensive (in the relative sense) and serve as a basic guide towards the implementation of vertical gardening measures at the specific sites addressed here in this chapter and in those future situations where they may be considered productive.

Site selection was not a difficult procedure. The level of development and density in downtown Athens, GA and on the University of Georgia campus makes the above-ground parking structure a necessary inclusion. In these areas, space comes at a high premium and both witness a tremendous influx of automobiles during regular work hours and special events such as football games and festivals. Topography might also be considered a factor in this equation. The rolling hills of Athens are not especially conducive to surface parking and it would seem that those efforts to generate it have been fraught with extensive grading and construction efforts. Furthermore, the general character of both town and campus remain the end-product of nearly two hundred years of history – a quality which many are quick to identify and defend when it becomes threatened by obtrusive development within the overall scheme. A large swath of asphalt does not often meet the criteria of such individuals, and yet, the demand for parking has rarely been greater as both settings continue to expand in scale and function.

As this thesis has constantly stressed, parking structures may not be the ideal addition to a historic town or bucolic campus, but they are necessary to accommodate auto accessibility and, moreover, far superior to surface or satellite parking alternatives. In recent decades both the University of Georgia and Athens-Clarke County have sanctioned the construction of multiple above-ground facilities in and around their immediate environs as a means of conserving land while concurrently addressing an increased demand for automobile parking. Of these new projects, two in particular tend to stand out in terms of their physical prominence within their respective settings: the North Campus Parking Deck at the University of Georgia and the College Avenue Parking Deck in downtown Athens. Each facility functions as a chief repository for vehicular traffic and both exert a tremendous presence within their surrounding landscapes. As areas of high automobile concentration, these facilities might be considered point sources for exhaust emissions and particulate matter. As large and impervious structures occupying areas that might have otherwise been vegetated, they most certainly contribute to increased stormwater runoff and any existent heat island issues within the greater region. When considering these factors in concert with their high degree of visibility, each facility represents an ideal candidate for ecological, environmental, and aesthetic improvement via the integration of vertical gardening strategies.

However, there exist a unique set of issues in either case that must be addressed in order to assure the effectiveness of each scheme. For this reason, the thesis will approach each facility from an individual standpoint, beginning with the North Campus Parking Deck, as a means of demonstrating the degree of customized structural and horticultural application that must go into each and every vertical gardening endeavor.

Any successful strategy must strike a balance between providing the advantages of vertical gardening and maintaining the principal functions of the extant structure. It follows then, that for the purposes of vertical gardening applications on both the North Campus Parking Deck and the College Avenue Parking Deck, a realistic minimum standard of approximately 30-40% vegetative coverage, or about one-third of the vertical surface, will be set for each individual façade with which this exercise is concerned. Due to the relative scale of each structure, the introduction of such an expansive quantity of vegetative biomass will undoubtedly have a positive effect upon building operations and outlying areas despite the possibility that sections of each structure may remain bare for certain functional or aesthetic purposes.

North Campus Parking Deck

Perhaps the most striking characteristic of the North Campus Parking Deck is its size. Even amongst the massive institutional structures that occupy the University of Georgia campus, it remains a behemoth. However, as it is located in proximity to the older and smaller-scaled section of the campus, much of which currently functions in an administrative and support capacity, the mass of the facility is further magnified by its modest surroundings. Nestled between Jackson Street and East Campus Drive – just east of the former Lamar Dodd School of Art Facility – the North Campus Parking Deck occupies a narrow, eastward-sloping site that is accessible from the twin north-south thoroughfares bordering it on either side (figure 5.1). Because of the nature of the parcel the facility is a long, vertical structure meant to store a maximum of 1157 automobiles amongst its seven main levels. The hill upon which the structure

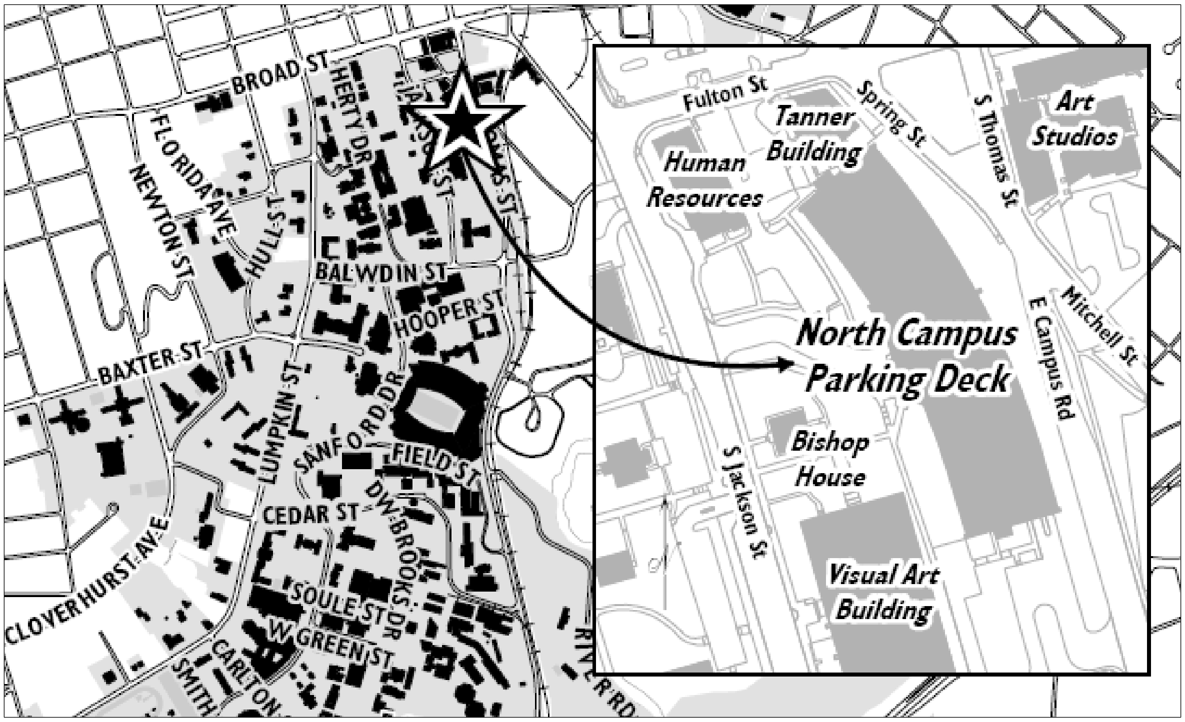


Figure 5.1. Map locating the North Campus Parking Deck on the University of Georgia Campus [Online Image] www.uga.edu/soc/department/PDF/NorthCampusDeck.pdf Accessed September 25, 2008

is situated makes it necessary that two, and sometimes three parking floors (for there is also a slight downward slope to the south), are located beneath ground level as one approaches the facility from Jackson Street. Therefore, the west-facing façade appears to be shorter than the east-facing façade, where the entirety of the structure's height is exposed in full as one views it from East Campus Drive (figure 5.2).

From a dimensional standpoint, the physical structure occupies an area of approximately 60,200 square feet. Plans for the facility reveal that it has been laid out as a concentric series of chords laid out via radii originating from a central point located a considerable distance west of the structure itself (figure 5.3). The largest of the chords occurs at the easternmost façade, with a length of 530'-10". The facility tapers towards the innermost chord of the western façade and possesses a lesser north-south length of about 450 feet. The minor north and south facades

Figure 5.2. Northeast end of North Campus Parking Deck (Photograph by Nicholas Petty)

maintain a uniform width of 112 feet – with no curvature present - and in this sense we might view the footprint of the facility as almost macaroni-like (for lack of a better description) in its overall shape.

Considering the facility in terms of its height, the facility fluctuates in elevation depending upon the vantage point of the viewer. Looking eastward towards the west-facing façade of the parking edifice, the height of the structure ranges – as a result of topographical changes – from 44 feet at the northern half of the building to 54 feet at the southern end. Similar conditions are present on the eastern façade of the structure. In this case, height discrepancies are even greater due to the aforementioned downward-sloping nature of the site to the south and east. Here one may encounter varying structural heights from 64 to 74 feet as one proceeds southwards along the lowest ramped parking level towards the East Campus Drive access. By these calculations, the eastern façade of the structure possesses a surface area of nearly 35,000 square feet. The less-prominent western façade measures in at approximately 21,000 square feet, discounting the vertical surface area of the extruding stair and elevator facilities located just south of the main Jackson Street entrance. For the purposes of examining those surfaces suitable for a vertical gardening approach, the author has similarly disregarded the north and south facades which

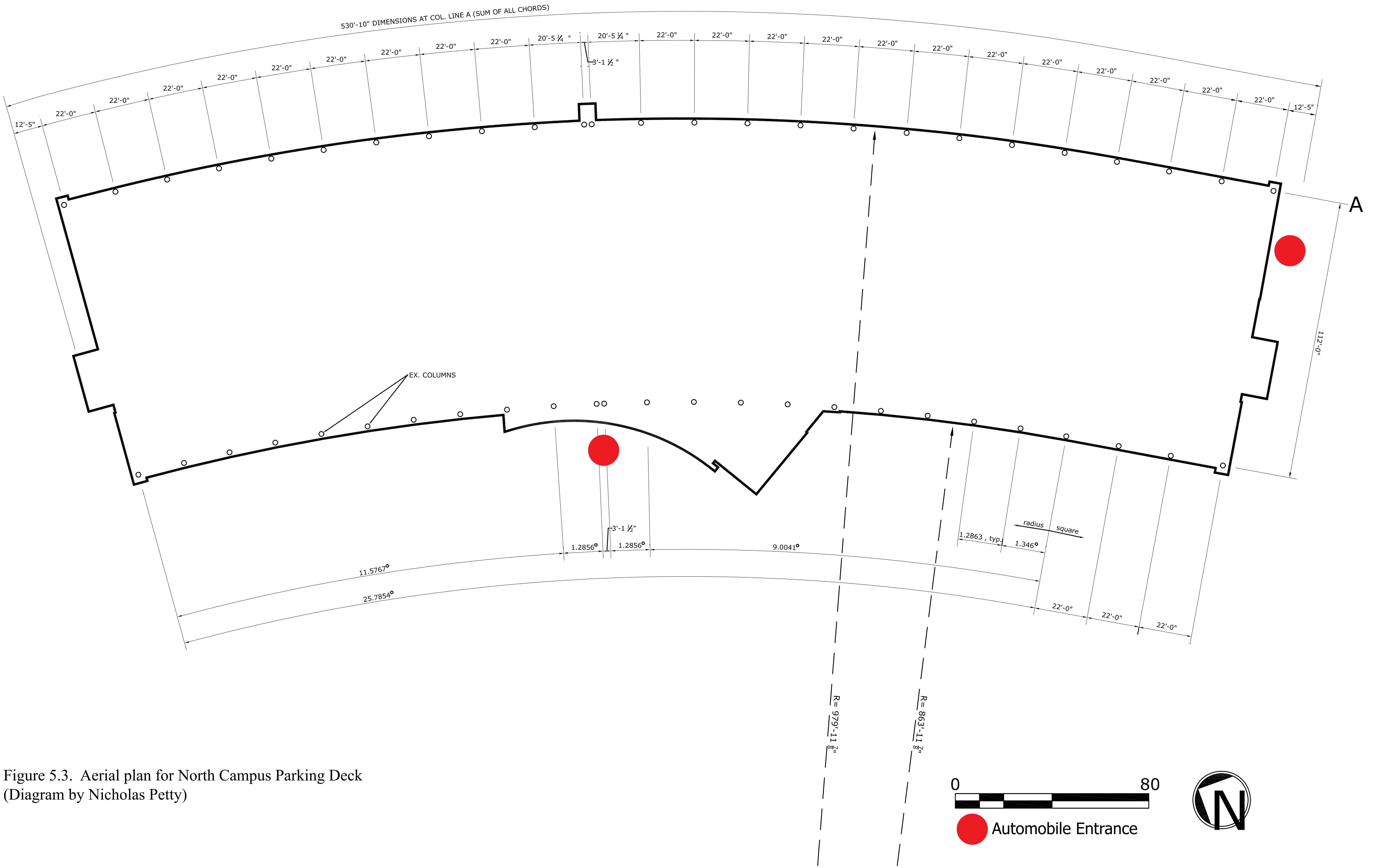


Figure 5.3. Aerial plan for North Campus Parking Deck
(Diagram by Nicholas Petty)

house additional staircase facilities. The motivation behind this decision is primarily aesthetic – but it is also true that structural and horticultural issues give the designer reason to leave these particular areas bare for the time being.

With the exception of that area put aside for vehicular access at the western entrance of the facility, the north and south ends of the structure are the only surrounding sections of the site which have been paved with impervious surfaces. Otherwise, the majority of the North Campus Parking Deck remains bordered on all edges by natural soil. These unpaved areas have been planted to a limited degree with a variety of trees, shrubs, and vegetative groundcover that lessen the harsh angles and surfaces of this enormous structure, while simultaneously obscuring a sizeable fraction of its imposing height (figures 5.4).

Figure 5.4. Existing vegetation on eastern side of North Campus Parking Deck
(Photograph by Nicholas Petty)

While the scale, function, and visibility of the North Campus Parking Deck factored prominently in the selection of this particular site, the primary impetus guiding the author's decision to work with this facility concerned a particular element of the structure's outward physical appearance. The primary structural elements (figure 5.5, *letters corresponding*) of this particular parking deck are relatively simple, forming a basic skeleton of platforms (H), ramps (C) and support columns (D) of post-tensioned concrete for the explicit task of housing over one thousand automobiles among the various parking levels generated by this framework. However, given the tremendous size of the structure, it would seem that the civil engineering team from Walter P. Moore and Associates – working in conjunction with consulting architects from Stanley Beaman & Sears – made the executive decision to manipulate the appearance of the structure using a series of decorative architectural features. By applying a sheath of aluminum grillework (G) to the long outer façades of the facility, the design enables the geometrical alignment of the grillework – a continuous grid of roughly 5” x 5” squares – to break up the monotonous scale and appearance of the principal concrete construction. It might be said that this grillework has no function aside from enhancing the aesthetic character of the structure. Horizontal steel cables (not pictured) spanning the distance between columns have been set in place to provide a barrier between vehicles and the edge of the parking platform and it is therefore unlikely that the grillework has been installed as a safety element. To add an additional degree of flair, aluminum fins (B) have been installed vertically towards the north and south ends of the grillework at intervals corresponding to the support columns while an off-center architectural tower (I) interrupts the continuous horizontal span of the structure. The program also features a series of aluminum bands (A) mounted towards the lower reaches of the architectural grillework to add an additional decorative element. The grillework itself is affixed

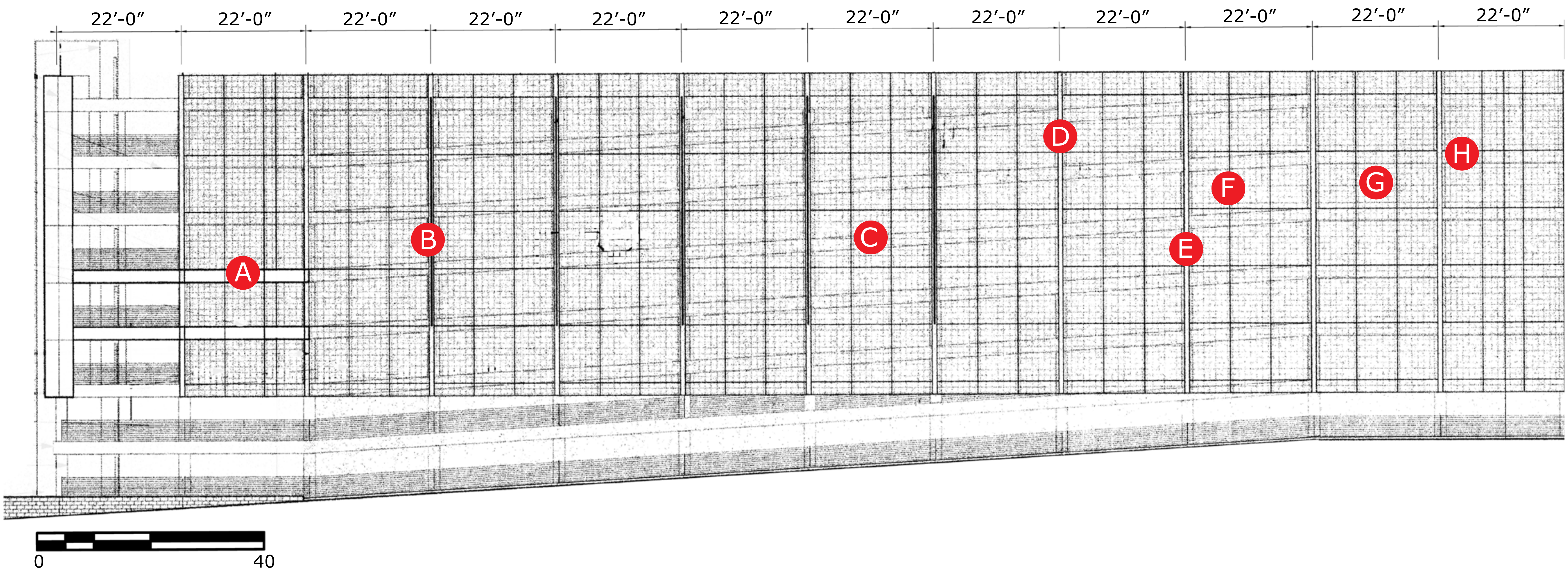


Figure 5.5. Existing structural configuration for eastern facade of North Campus Parking Deck (Diagram by Nicholas Petty)

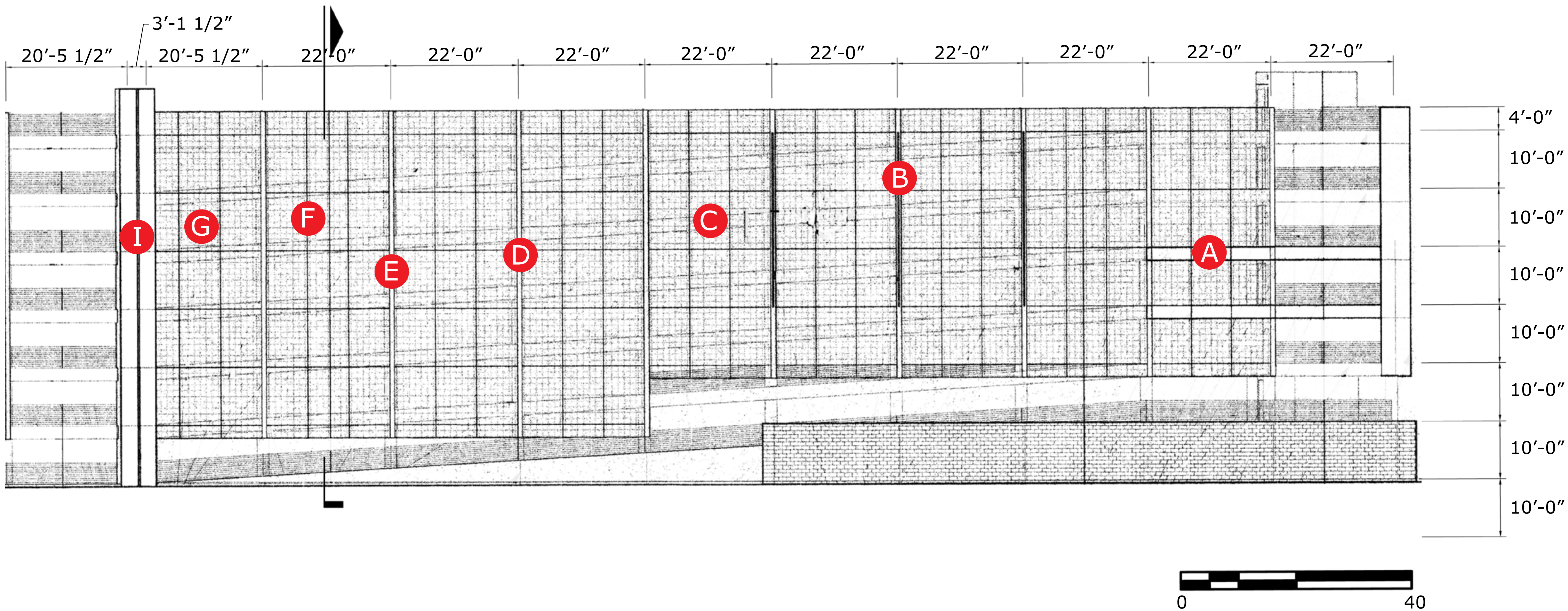


Figure 5.5. (Continued)

to the main structure as a series of sections, each comprised of adjoining sub-units possessing an individual height of 10” and a width of 6’-8 2/3”. These units are attached to one another both vertically and horizontally via a series of primary (E) and secondary support channels (F) spaced evenly from the centerline of the concrete columns set at staged intervals of 22’ on the eastern façade.

When considered from a distance, the aluminum grillework setup is reminiscent of the crisscrossing pattern characteristic of those steel trellis systems discussed in the Chapter 4 that have been used to support climbing plants in certain façade greening projects. To the author’s chagrin, the profile of the extant grillework (figure 5.6) – measuring 5” from back to front – makes it less than ideal for such purposes. The finished aluminum surface and dimensional character of the grillework could not be expected to provide adequate purchase for most climbing species. It is also unclear as to whether or not the grillework and attendant support systems possess the load-bearing capacity to maintain climbing plants under adverse conditions. Furthermore, when considered as a whole, the grillework creates a constant and vast vertical surface across the face of the parking structure. Were the grillework otherwise passable in a support capacity, one

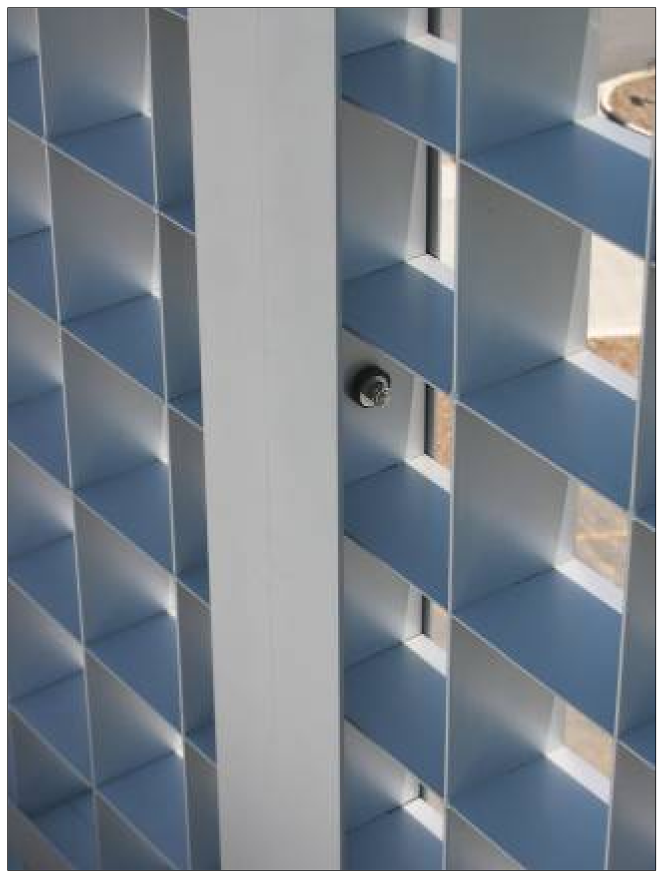


Figure 5.6. Close-up of aluminum grillework (Photograph by Nicholas Petty)

might have been able to grow climbing vegetation to the highest reaches of the facility merely by providing a means by which to deliver plants from the surrounding soil to the lower levels of the grillework. However, vertical gardening – and façade greening, in particular – is very much concerned with enhancing the level of control that the prospective gardener has over plant species as they develop. In light of this consideration, the continuous aspect of the North Campus Parking Deck façade would make management of plant growth a difficult task that might only be accomplished via rigorous maintenance if one were to seek an orderly appearance of vegetation about the exterior of the structure. For this reason, it becomes necessary to implement a series of offset support structures as a means of isolating climbers from the grillework. Doing so will allow for easier plant management and propagation, while simultaneously granting an additional degree of design leeway with regards to improving the aesthetic character of the structure through a controlled program.

While a barrier of vegetation can serve as an excellent windbreak – thereby lessening the effects of seasonal gusts – it is also true that without an impenetrable vertical surface behind it to capture that air, this barrier cannot possibly provide the heating and cooling effects available under closed structural circumstances. Shading during summer months may be present in all cases via the introduction of a vegetated façade over those openings where sunlight might otherwise penetrate and warm heat-absorptive surfaces, but it is also the case that many above-ground parking structures rely upon sunlight to illuminate their inner confines during daylight hours. This factor all but eliminates the potential for “green-all” measures. Under such a scenario, the facility might then have to rely upon artificial lighting to provide the degree of visibility necessary for vehicular operation and safety, a costly measure in terms of both installation and energy requirements. During colder months, concerns might be lessened under façade greening scenarios if deciduous vegetation is installed on the surface; an aspect which would allow sunlight to penetrate and warm the inner structure.

In the specific case of the North Campus Parking Deck, meeting the self-imposed coverage standard of one-third should not prove excessively difficult on either the eastern or western façades of the facility. In fact, there is already a well-conceived precedent for mounting the support elements necessary to successfully integrate vertical gardening strategies upon this particular parking structure. The author is speaking in reference to the aluminum grillework already present on the façade. In essence, applying the appropriate vertical gardening measures becomes a matter of creating a secondary architectural layer of modular trellis panels employing a similar support approach not unlike that already utilized to stabilize and bear the load of the existing grillework.

As it currently stands, the aluminum grillework is mounted upon the exterior of the main structure via a series of 4” x 4” stainless steel tubes – with a wall thickness of 3/16” – extending outwards from the post-tensioned concrete platforms at a distance of 10” from the edge of the structure. The steel tubing has been welded to a series of ½” thick steel plates, which are in turn anchored to the outer lip of the parking platform via a series of galvanized steel bolts. The dimensions of these plates vary depending on the type of connection that is made between the main structure and the architectural facade. Where the connection is made with the primary vertical support channels located parallel to each column, the plate is of a 1’ x 1’ variety (figure 5.7). Where secondary support connections are made with the corresponding T-shaped steel support channels linking individual aluminum grillework units, the steel plates have been sized at a lesser dimension of 6” x 12”. These plates are buffered by plastic shims of equivalent dimensions and thickness to compensate for the curvature of the aluminum grillework about the

Figure 5.7. 1' x 1' steel plate connections between aluminum grillework and post-tensioned concrete platform (Photograph by Nicholas Petty)

overall façade of the structure. The center of each steel plate/tube combination is oriented 8 in below the upper edge of the post-tensioned concrete platforms. All elevated post-tensioned concrete platforms and ramps possess an individual height of 2’-3” at their outer section – thus leaving 1’-7” remaining below the center point of the steel plate and plastic shim arrangement at the upper portion. Between each series of connections, the distance measures a constant 10’ corresponding to the individual stories of the structure. At the upper and lower recesses of the aluminum grillework, custom grillework units of various heights have been fabricated to maintain even horizontal edges at the top and bottom extremes of the overall configuration. Additionally, the height of the aluminum grillwork varies at two separate levels in coordination with the descent of the lowermost ramp southward from 56’ to 66’. Figure 5.8 illustrates the basic sectional layout of the aluminum grillework façade and its attendant connections and may serve as a reference for the next stage of discussion.

The existent aluminum grillework mounted upon the main structural components of the parking facility bears a striking resemblance to many of the modern trellis systems discussed in Chapter 4. However, despite its initial appearance, this is a purely decorative measure that is of little use from a support standpoint. To go even further, this feature may present a considerable encumbrance for those efforts seeking to realize a viable design scenario. This aspect dictates that any new addition for the purposes of supporting applied vegetation must be offset to an even greater distance than the grillework has already been set with respect to the main building frame. Considering that the aluminum units are stationed 10” from the concrete platform upon which they are anchored and possess a profile of 5”, it reasons that any proposed vegetative support mechanisms must extend a minimum of 18” from its vertical base to protect against the interference of climbing plants.

This is an instance where façade greening measures utilizing climbing plants appear to be the solution. Whatever type of application is installed will be viewed from both the inside and outside of the facility. Living walls, unfortunately, are essentially one-sided. Furthermore, because living wall systems are composed of opaque materials, such a system would restrict sunlight and air circulation on a year-round basis. And while this might be advantageous under certain seasonal conditions, it would simultaneously offer little in terms of visual compensation besides a glimpse of the odd irrigation mechanisms that would otherwise be obscured under more common applications of this method.

Furthermore, because of the distance by which any vertical gardening measure must be stationed and the relative scarcity of potentially load-bearing vertical surfaces upon which to attach structural members, it is necessary that all devices be as low in weight as possible. The shearing strength of anchoring devices tends to decrease the further the main weight of the support structures are set relative to their vertical base. Therefore, a high-strength connection to the anchoring surface and a sturdy horizontal extension from that base (much like that provided to bolster the existent aluminum grillework) becomes critical. With regards to the lack of surface upon which supports might be attached – a condition generated by the distance between parking levels – this challenge requires that structures are able to span a minimum vertical distance of ten feet between upper and lower supports and that these additions do not interfere with those elements which are already in place. For this reason, the author has chosen to pursue a vegetative support strategy that utilizes Greenscreen modular trellis panels as a means of creating a secondary vegetative skin upon the structure. Working with individual panels of 10’ in height, 4’ in width, and a profile of 3”, it becomes possible to create a series of unified trellis surfaces that will span the distance between individual support columns and the lower and upper reaches of the aluminum grillework, the design scheme of which will be dictated by those very same ordering architectural features.

Figure 5.9 illustrates, in section view, a hypothetical suggestion for how this might be accomplished if it were proven to be structurally feasible. A series of 1’ x 1’ x ½” steel plates could be welded to 4” x 4” square steel tubing – of approximately 1’-9” in length – which might then extend outwards from the post-tensioned concrete parking platforms. Working with the rectangular sub-sections delineated by the main grillework support channels, these steel arms will be set approximately 1’ to the inside of the main aluminum grillework supports such that the full apparatus (made up of a conglomerate of individual trellis units) spans a distance of 20’ between concrete support columns. A third horizontal support will be centered evenly between the two outer extensions so that a total of three steel tubes protrude between adjacent columns, making their way through the 5” x 5” spaces in the aluminum grillework at each platform level. From this point, a perpendicularly aligned, three-sided steel channel beam can then be bolted to the outer ends of the rectangular steel tubes to span the distance between support extensions. It should be noted that a single welded unit comprised of the aforementioned elements might have been superior in terms of overall strength but, as a result of existing conditions (i.e. the

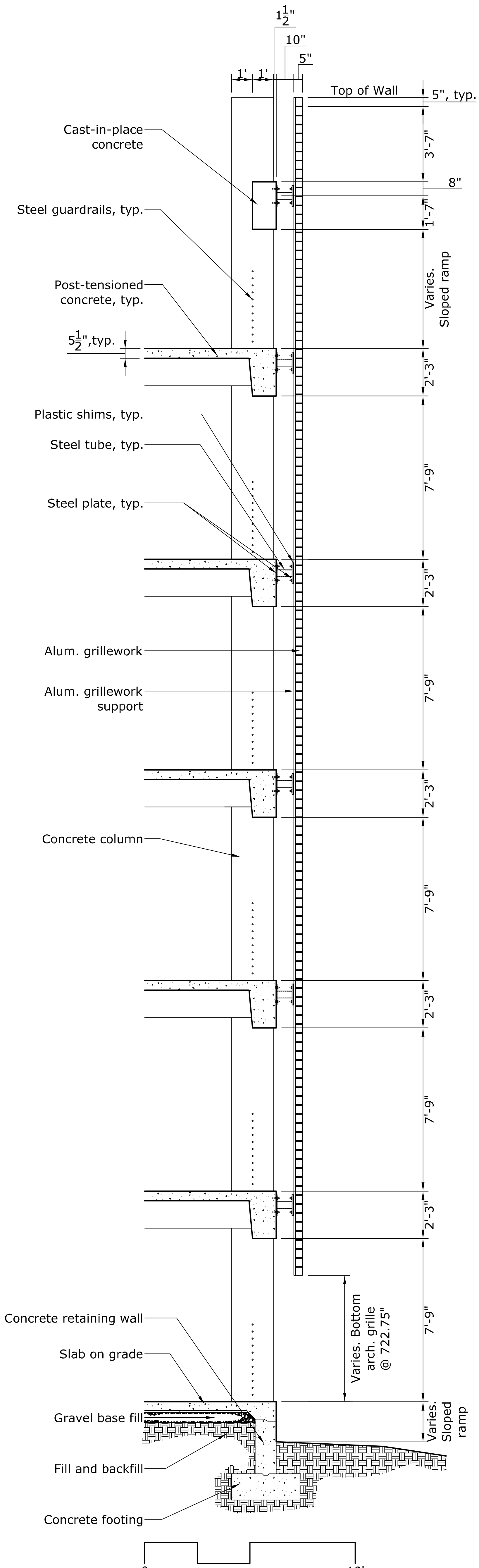


Figure 5.8. Section view of existing structural configuration for eastern facade of North Campus Parking Deck (Diagram by Nicholas Petty)

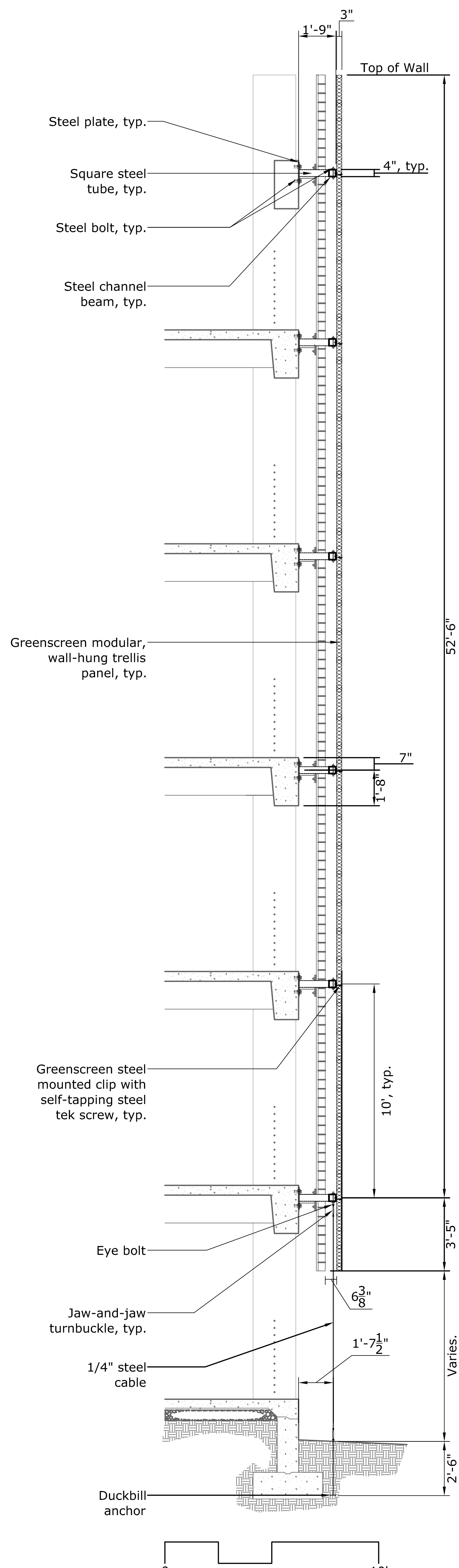


Figure 5.9. Section view of proposed structural additions for eastern facade of North Campus Parking Deck (Section by Nicholas Petty)

aluminum grillework), installation of such a structural addition would prove impossible unless welding operations were conducted on site.

With the steel channel beam fixed firmly around the steel tube supports, a series of Greenscreen steel mounted clips can be installed along the outer lengths of the channel beams using self-tapping tek screws provided by the manufacturer for just such a purpose. Mounting clips could be placed at 1-2 ft intervals along the 20 ft wide channel beam as a means of providing upper and lower support for the stacked individual modular trellis units. Where the sides of individual panels meet edge-to-edge, factory-applied Greenscreen Cage Assembly Clips or in-field Greenscreen Flex "C" Ring devices can be used to join panels together – thus creating a cohesive assemblage for climbing plant propagation. For maintenance purposes, Greenscreen-manufactured Steel Channel Trim (figure 5.10) at the outer edges of the greater trellis framework can keep climbers from branching beyond the strict borders of the geometric layout. However, at the bottom end of the structure, one might use a Steel Edge Trim (figure 5.11) in place of a Channel Trim to allow plants trellis access from beneath. As Greenscreen modular trellis units can be customized at intervals of 2", matching the height of the overall modular trellis grouping to the dimensions of the aluminum grillework, which these structural additions mimic and enhance, should not be difficult.

Figures 5.10 & 5.11. Greenscreen Steel Channel Trim (top) and Steel Edge Trim (bottom). (Greenscreen "Accessories," 2006:1)

The natural soil conditions presents around the base of the structure provide the optimal planting medium for vegetation. Unfortunately, this makes it the case that plants must span the vertical distance between the ground where they are rooted and the lower recesses of the trellis panels. This distance ranges between 10’ and 20’ along the eastern face of the structure as dictated by the slope of the lower parking levels aluminum grillework as one progresses southward. Though Greenscreen panels can be customized to fit the angle of descent where the topography follows the slope of the site, such an approach may be both costly and cumbersome – particularly when there are other options available that may serve necessary function but also add further variety to the overall design.

It might be helpful to recall the examples from the previous chapter at MFO Park in Zurich, Switzerland and the Swiss Re facility in Munich, Germany. In both cases, climbing plants were distributed amongst the more substantial trellis arrangements above via a system of stainless steel cables set in the ground below. Fundamentally speaking, the situation at the North Campus is no different from these examples. Referring once more to figure 5.9, in order to bridge the vertical gap between ground level and the supplementary façade comprised of Greenscreen modular trellis units, a series of vertical cables are an advisable option in those areas beneath the vegetative support structures. These cables must possess a diameter of at least 1/2 in and can be anchored in the ground using a 2’-6” high duckbill or manta-ray anchor, such as those made available at Foresight Products, LLC (www.earthanchor.com). These devices may be installed by driving the unit into the ground and setting its lower aspect perpendicular to the stake such that the weight of the soil above prevents pullout. These anchors possess a maximum pullout strength of approximately 3,000 lbs and should provide the adequate grounding for those steel cables which will be extended from their apex.

When using steel cable as a vehicle for climbing plants, the constant tension exerted by plant weight and hardier stems can lead to slackening or damage to the cable. To protect against such concerns and to maintain a taught line upwards, the cable connection adjacent to the Greenscreen trellis system might include a device that would allow for retensioning in those instances where it might be required. In figure 5.9, the design calls for the use of a jaw-and-jaw turnbuckle installed at the bottom portion of the lowermost steel tube support to provide this function.

Looking at the overall configuration in elevation view (figure 5.12, *letters corresponding*), it becomes possible to identify the main structural components – Greenscreen trellis panels (A) and steel cables (B) – of the vertical gardening strategies described thus far in both text and section drawing. It also illustrates the design scheme which the author has envisioned for the eastern façade of the North Campus Parking Deck. Making use of the columnar pattern of the main framework, the author has broken up the façade into "sections," of which there are a total of 23 in all. Using the slightly off-center architectural tower as a design point, three sections of the façade on either side of the tower will be vegetated followed by a regular program of alternating vegetated and non-vegetated sections (figures 5.13 & 5.14). This pattern shall cease when it reaches those sections of the façade which are not covered by the grillework or ornamented with aluminum bands.

Before moving on to a description of the western façade and those vertical gardening measures that might be recommended, a few details remain – some of which might considered relevant to all projects. This design must rely upon the growth habits of the climbing plants alone to provide the desired level of coverage. Considering that the height of the structure varies between 64 and 74 ft, the climbing plant palette available to the designer is limited to those few

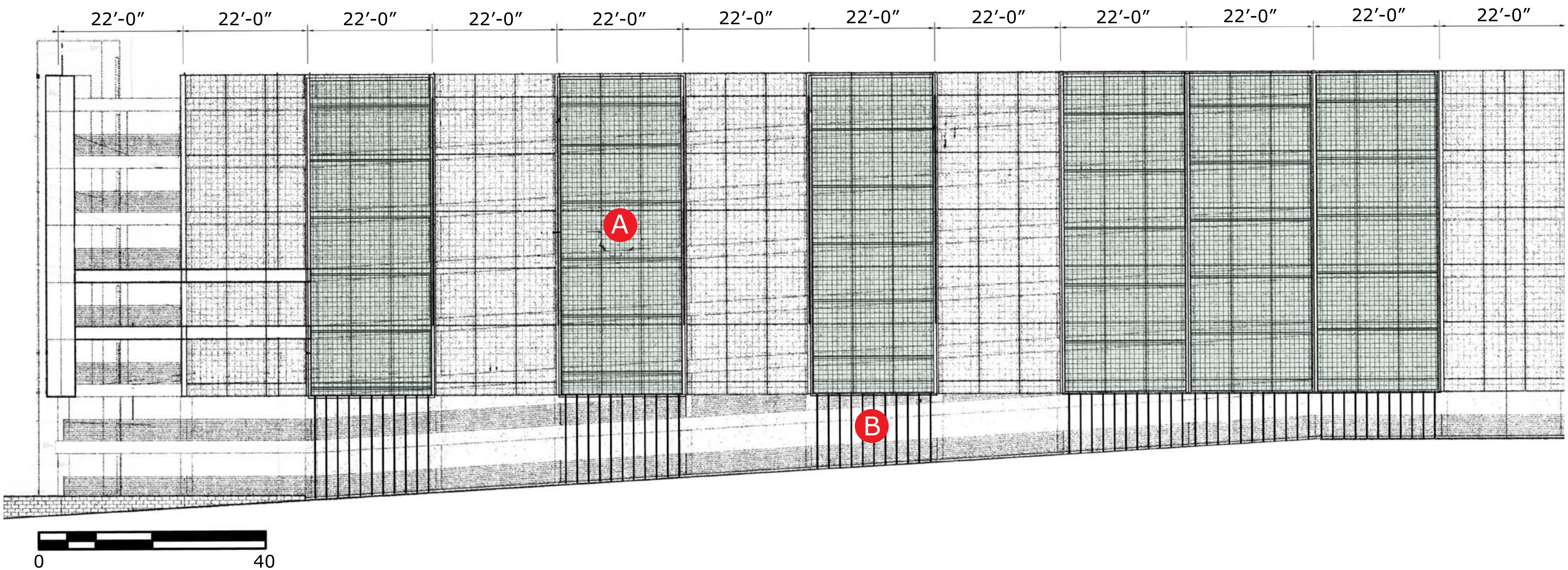


Figure 5.12. Proposed structural configuration for eastern facade of North Campus Parking Deck (Diagram by Nicholas Petty)

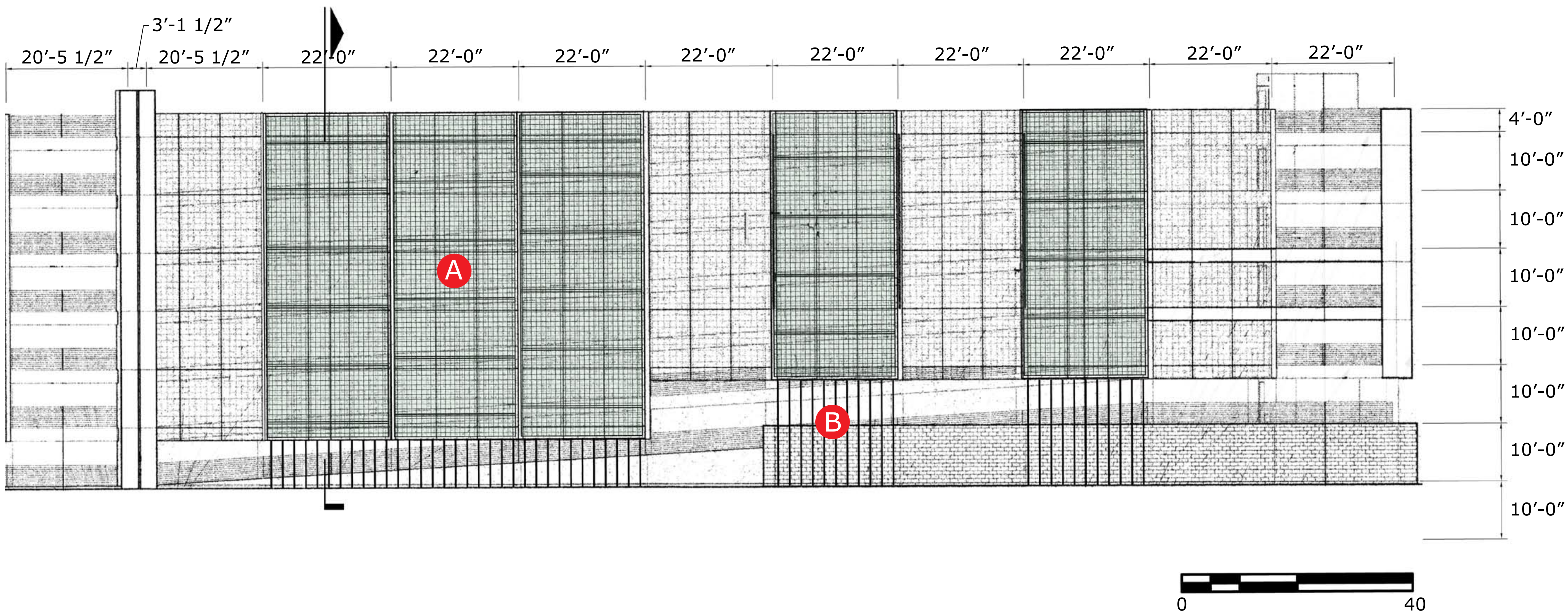


Figure 5.12. (Continued)

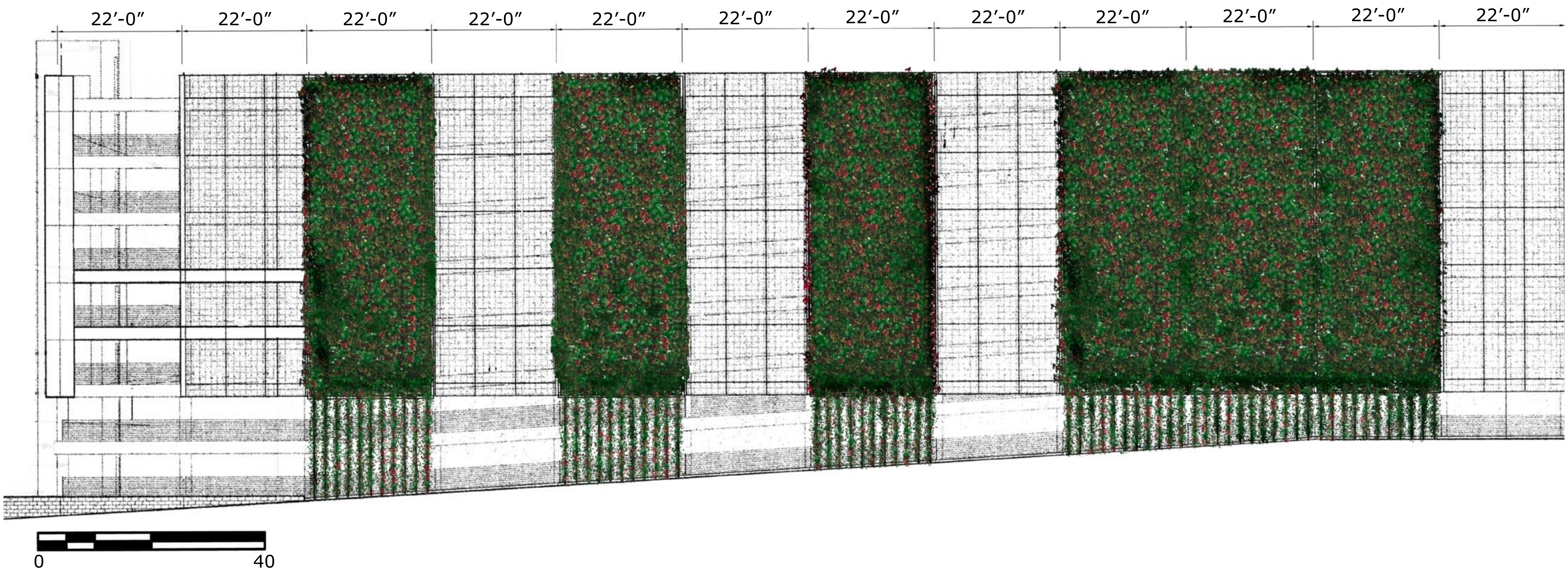


Figure 5.13. Structural and vegetative overlay for eastern facade of North Campus Parking Deck (Diagram by Nicholas Petty)

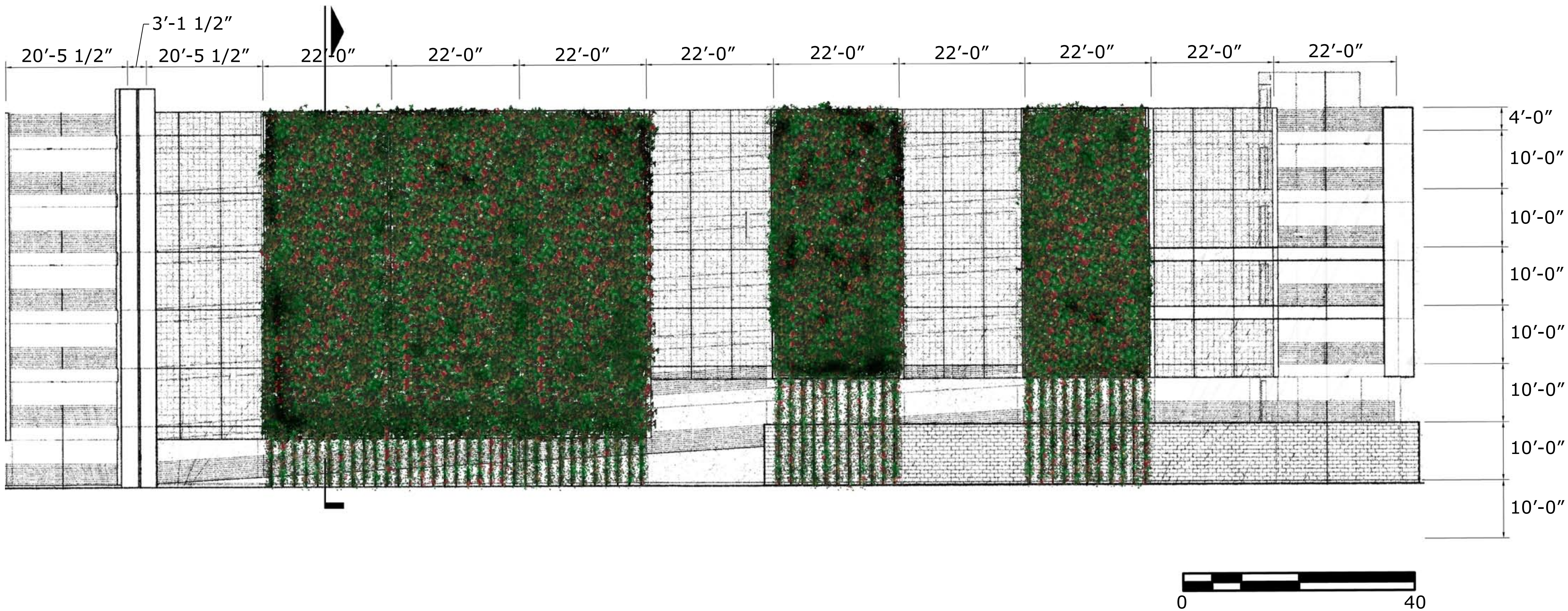


Figure 5.13. (Continued)

Figure 5.14. Photoshop rendering of North Campus Parking Deck after proposed structural and vegetative additions (Nicholas Petty)

climbing plants that possess the capacity to span such large distances vertically. While the southeastern United States does boast a considerable array of large climbers, this geographical zone is broken up into separate regions which delineate the hardiness of plants within a given area. This presents a degree of difficulty in the task of plant selection. Athens is specifically located in zone 7B, a sub-region within a more general plant hardiness zone. However, many plant guides often tend to avoid reference to sub-regions and one must thereby assume that a plant that is said to flourish in a particular hardiness zone might do so. Such guides may do the vertical gardener a great disservice, as climatic differences between sub-regions can eliminate the possibility of utilizing certain plants.

With regards to the North Campus Parking Deck, the author had supposed that, based upon information supplied by certain horticultural guides, *Parthenocissus tricuspidata* would have been an obvious plant option on the eastern facade. Thomas suggests that this vigorous clinging vine is hardy from zones 4 through 8 (1999) while Dunnett and Kingsbury record that it may grow to heights of 60-70 ft (2001). This would seem to fit the criteria for use. Furthermore, it maintains a lively ruby hue in the fall months that might introduce a startling visual presence on campus during the University of Georgia football campaign – one that might have received a great deal of attention from visitors and the media given the scale of the structure and its proximity to Sanford Stadium. Though *Parthenocissus tricuspidata* is known to grow in environments as nearby as Atlanta, GA, it is unfortunately the case that this climber does not exhibit the same characteristics a mere 60 miles east in the slightly warmer climate of Athens (Smalley, *pers. comm.*). In light of this reference, one might conclude that the only way to decide upon potential plant selections is via a detailed and highly specific understanding of the horticultural particularities of the locale in which one plans to operate. With that in mind, based upon personal observation and that supplemental information provided by horticultural text – however dubious some may be – plant options are restricted to a handful of species able to provide the necessary coverage along the eastern façade of North Campus Parking Deck. The most likely candidate for propagation upon the eastern façade is Virginia Creeper (*Parthenocissus quinquefolia*), a vigorous climber native to the southeast United States which can reach heights of 50' or more. However, there is little precedent for this type of application. Some reports suggest that heightened CO_2 levels from automobile exhaust may affect the growth habits of vines growing within the vicinity of a CO_2 point source (Williamson 2008) – though, in all likelihood, this effect would be marginal at best. Without going into too much horticultural detail here, one may refer to Appendix A which provides a detailed list of those climbing plants appropriate to the Athens region along with some attendant characteristics that must be considered for the purposes of appropriately selecting plants for specific façade greening application.

Finally, there is the all-important matter of providing water for those plants that will be grown at the base of the structure. Because of the vast swath of impervious surface generated by any above-ground parking facility, there will be a considerable amount of runoff when precipitation is present. At the North Campus Parking Deck, water is currently channeled into regularly positioned storm drains on the roof where it travels downward to the ground. To the best of the author's knowledge, this water is not stored and/or utilized in any further capacity; it is merely collected and discharged away from the site. This effect may lead to erosion and groundwater recharge issues. If façade greening applications were to be undertaken at the facility, the bulk of this water might be put to alternative use for irrigation purposes. Doing so may become a simple matter of eliminating a few odd parking spaces below the uppermost parking level in order to implement a series of cisterns (figure 5.15) to store water to be distributed amongst the lower reaches of the facility. While calculations regarding the volume of water that might be collected at the facility are not within the purview of this thesis, it might be assumed that – with the proper rainwater catchment strategies in place – the North Campus Parking Deck may provide on-site irrigation that will ensure the vitality of any introduced vegetation on or around the structure.

In general, the relatively brief discussions with regards to plant selection and rainwater catchment are applicable in most – if not all – vertical gardening scenarios. Not surprisingly, the western façade of the North Campus Parking Deck is comprised of many of the same elements made familiar through a discussion of the eastern façade. However, owing to the topography of the site upon which the facility is situated and the overall design of the structure, this particular

Figure 5.15. Proposed cistern addition beneath roof level at North Campus Parking Deck (Photoshop Rendering by Nicholas Petty)

face of the parking deck presents a slightly different set of challenges than its counterpart. For one, the height of this side is of a lesser height than the eastern façade. Here the two lowermost levels of the parking structure are situated underground, whereas on the east side they are all exposed. When viewed from Jackson Street, the height of the edifice is set at 44 ft and 54 ft, respectively – the difference of which is determined by the descending terrain towards the southern end of the structure (where a set of stairs have been installed for pedestrian use). It is also the case that because the western façade is laid out along a minor chord relative to the eastern front, the distance between support elements is of a slightly lesser distance at most junctures. This aspect has already been illustrated to some degree in figure 5.3. Finally, the parking platforms on this side of the structure are entirely level; all ramps are thus confined to the eastern section of the elongated facility. Whereas custom-spaced and/or sized elements may be necessary for cladding the existing and proposed outer surface of the structure where the platform slants (so as to maintain a constant line at both the top and bottom), it becomes possible to work with a more uniform configuration upon this alternate façade.

Tthe western façade (Figure 5.16, *letters corresponding*) features a greater number of additional elements which may also be addressed in a vertical gardening context than the eastern face of the structure. The same type of aluminum grillework (B) is present in a similar alignment relative to the concrete support columns (E). Similarly, primary support channels (F) make the necessary connections between the main structure and grillework, while secondary support channels (C) secure the linkage between the grillework panels themselves. Incidentally, no aluminum fins have been included in this scheme. Nonetheless, aluminum bands (A) – a limited presence on the eastern façade – do here make their way along the entire lower length of the aluminum grillework, an aspect which must be dealt with accordingly for successful integration of vertical gardening strategies. Referring to those additional elements unique to the western façade, this particular face of the structure features a central vehicular entryway accessible from Jackson Street (H). Adjacent to this entrance there is a small brick-clad storefront area with a narrow window, behind which one may find a small parking services office. Just south of the entrance one encounters a stairway and elevator facility (I) granting access to the upper and lower levels of the structure. Architecturally speaking, this aspect of the structure interrupts the basic concave curvature of the western face of the structure, extending outwards from the main face of the facility.

As previously alluded, the architectural grillework mentioned above begins at the base of the third parking level relative to the street. Beneath this decorative element, brick masonry has

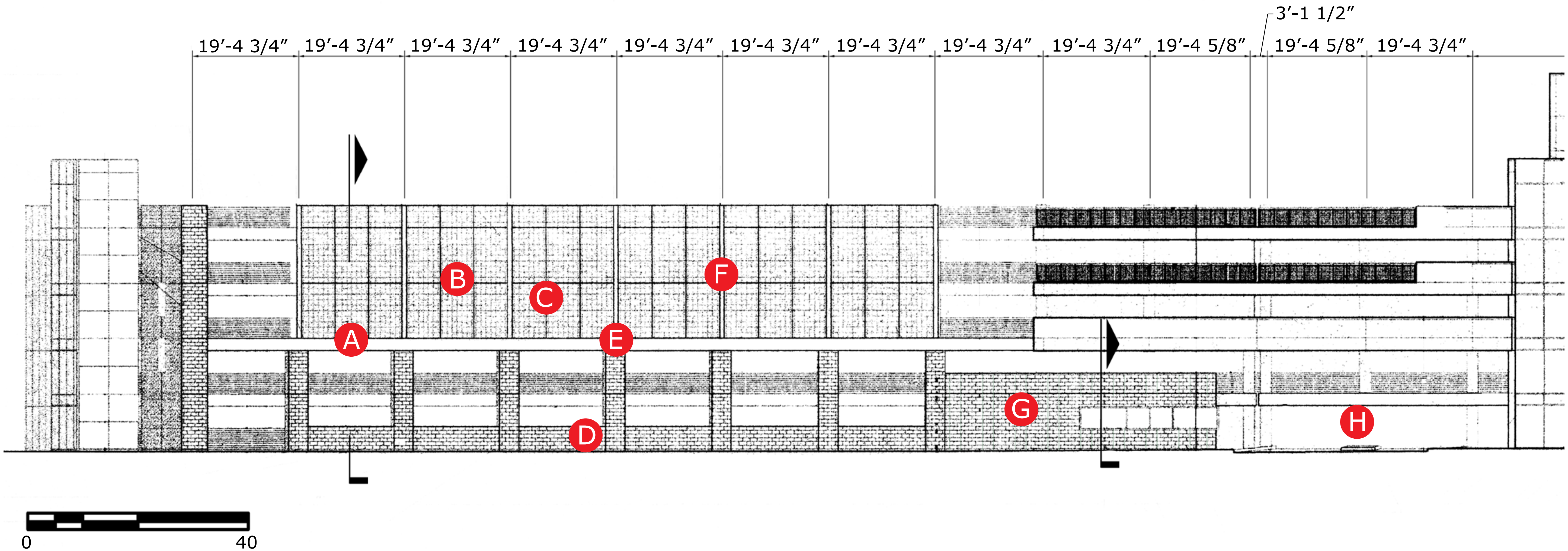


Figure 5.16. Existing structural configuration for western facade of North Campus Parking Deck (Diagram by Nicholas Petty)

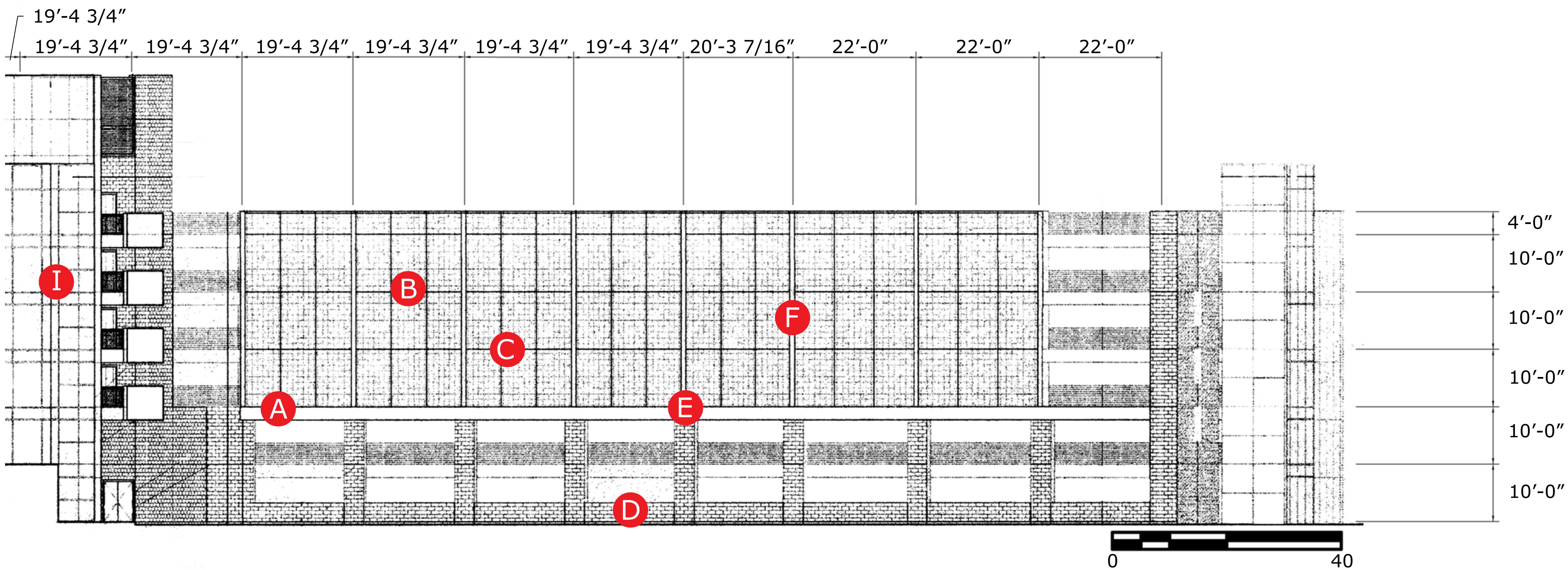


Figure 5.16. (Continued)

Figure 5.17. Existing structural configuration of Northwest end of North Campus Parking Deck (Photograph by Nicholas Petty)

been applied around the exterior of the concrete support columns, effectively creating the appearance of a rectangular brick support that is in keeping with the appearance put forth by the storefront. Additionally, where the structure meets ground level, a low wall (D) has been constructed in lieu of the typical steel cable barriers employed at upper levels (figure 5.17). Despite the aforementioned differences between respective facades, façade greening applications may proceed in much the same way as on the eastern face of the facility. Once more, the vertical surfaces upon which one might attach any type of support member are restricted to the 2’-3” high parking platforms. An existing series of horizontally-spaced steel tube and plate connections of similar dimensions and relative placement as those found on the eastern facade have been installed to connect with the main support channels of the aluminum grillework (figure 5.18). However, at ground level, the low wall – comprised of an inner concrete masonry unit and additionally clad with a shallow brick veneer on the outer face – does offer an additional surface where one might anchor support elements for the purposes of façade greening. One must also observe the presence of the aluminum banding about the bottom of the aluminum grillework. This element is of particular consequence because it extends from the outer edge of the grillework – already offset from the main structure at a distance of 1’-3” - an additional 7-1/2”. Therefore, to avoid the encroachment of climbing plants upon these extant architectural elements, any vegetative support structures that may here be applied must be set away from the wall at a greater distance than would have been the case had this feature been absent.

Similar to the eastern façade, the proposed vertical gardening scheme will utilize the support properties of the Greenscreen modular trellis for the purposes of applying façade greening measures. Figure 5.20 (*letters corresponding*) illustrates in elevation view the structural additions to be applied. Before a comprehensive description can be provided of this modular trellis arrangement (A), a second type of structure must be noted that has been included about the brick façade of the storefront office area (B). This configuration displays the minor framework of a living wall system composed of G-Sky green wall panels and shall be discussed in greater detail shortly. Nonetheless, at this present juncture – and for the sake of continuity – the focus must remain upon the main vegetative body of this new supplementary façade system: the application of a series of Greenscreen modular trellis structures along the length of the façade.

With regards to reinforcing an applied trellis system, similar support surfaces identified on the eastern façade – stacked post-tensioned concrete parking platforms with an additional lower concrete/brick wall configuration can be taken advantage of for the purposes of façade greening. Likewise, the strategy is to integrate a series of interconnected trellis modules beyond the outer boundary of the aluminum grillework in much the same manner as had been recommended for the opposite face of the structure (figure 5.19). Once more, this may be accomplished using regularly-spaced 4" x 4" rectangular steel tubing extended through the spaces of the grillwork. When affixed to the platform via welded steel plates bolted to the concrete platform, it becomes possible to create a network of suspended support beams at each level, capable of bearing a portion of the future weight generated by climbing plants and modular

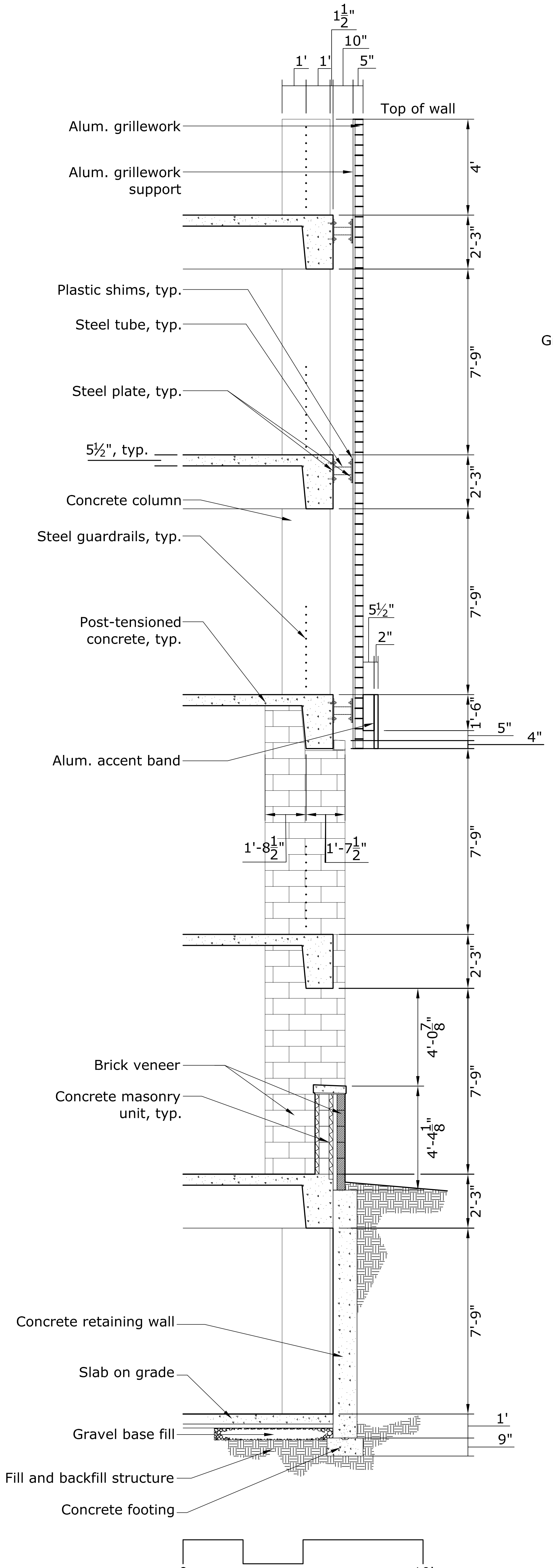


Figure 5.18. Section view of existing structural configuration for eastern facade of North Campus Parking Deck (Diagram by Nicholas Petty)

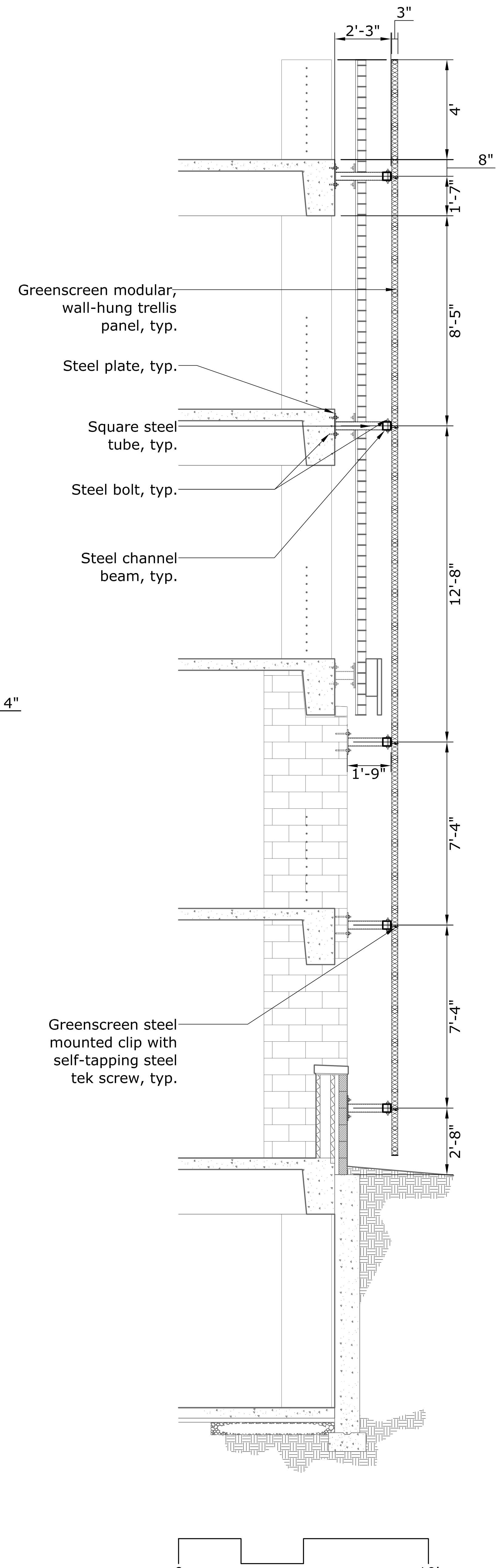


Figure 5.19. Section view of proposed structural additions for eastern facade of North Campus Parking Deck (Diagram by Nicholas Petty)

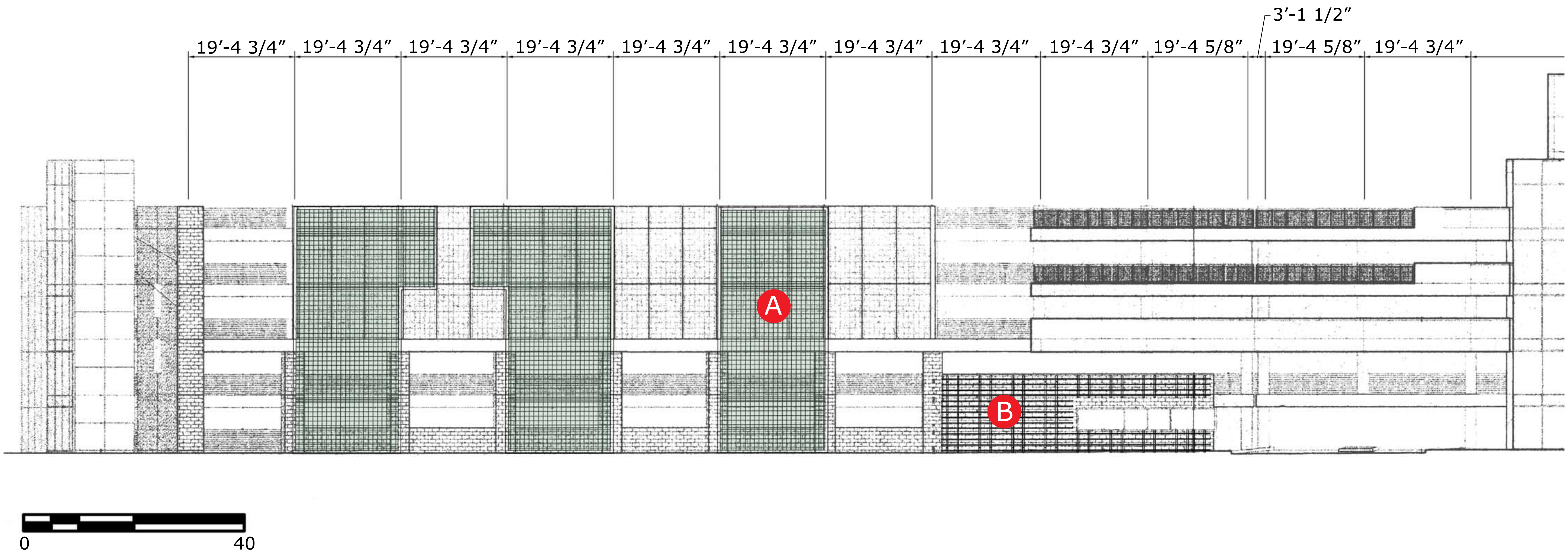


Figure 5.20. Proposed structural configuration for western facade of North Campus Parking Deck (Diagram by Nicholas Petty)

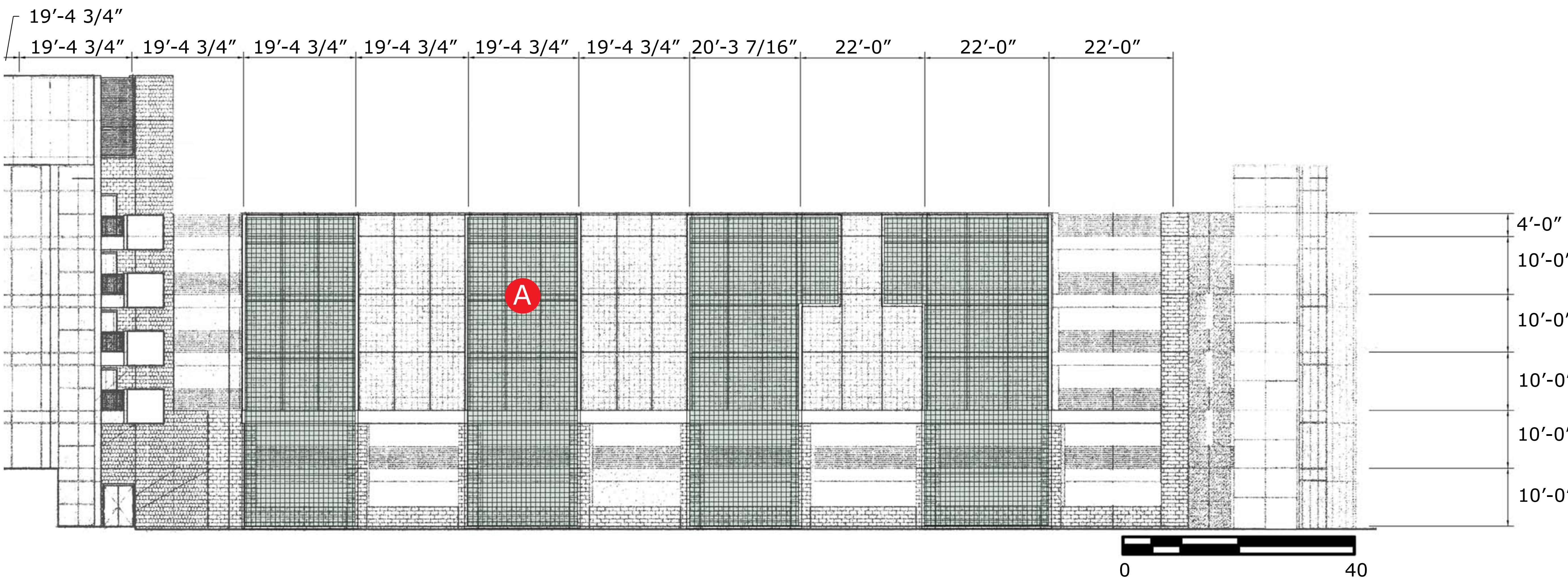


Figure 5.20. (Continued)

trellis units. Steel channel beams will span the distance between trellis groupings. These groupings will be composed of individual modular units attached at side-to-side and top-to-bottom intersections via factory-applied Greenscreen Cage Assembly Clips or in-field Greenscreen Flex “C” Ring devices. Turning once more to the section diagram, because of the alternating profile of the main exterior – a factor made so by the brick veneer about the lower concrete support columns – the horizontal extension of the supports towards the bottom of the support system is approximately 6” less than at the upper portion. For this reason, the upper steel tube support devices must be offset from their vertical anchoring by 2’-3” with an additional 3” of additional separation supplied by the profile width of the Greenscreen modular trellis units. Accordingly, the lower steel tube supports that can be fixed along the brick-veneered support column need only extend a distance of 1’-9”. In both cases, an additional 7-1/2” offset is necessary to compensate for the structural imposition generated by the aluminum bands so that a buffer zone of approximately 4-1/2” might remain between any extant architectural element and the newly-introduced support trellises for climbing plants.

On the eastern façade of the North Campus Parking Deck, vertically-oriented steel cables were positioned at the base of the structure on the eastern façade as a means of providing a conduit by which climbing plants might access the lower reaches of the applied Greenscreen modular trellis groups. This measure has been discarded on the western façade in favor of a continuous arrangement of modular trellis units, vertically spanning the distance between the topmost reaches of the aluminum grillework and ground level below, with a small space left at the bottom for rooted plants. The reasoning behind this gesture is primarily aesthetic. Doing so creates a continuous vertical façade that can be examined up-close by passersby, making it possible for the individual to understand an otherwise unfamiliar scene; allowing them access to its inner workings should they care to explore. Where cables have been intermittently positioned at the lower reaches of the trellis structure on the opposite face of the facility, these elements will be more or less obscured by pre-existing vegetation and the crest of a the hillside. In this regard, there is little opportunity for close-quarters observation of either plants or structural components. Furthermore, when compared with the neat and orderly display of climbing plants proliferated amongst the truly three-dimensional confines of the Greenscreen modular trellis unit, the dissemination of climbing plants along a suspended vertical steel cable can look somewhat unkempt under even modest scrutiny. Under such conditions (where aesthetic appearance is a priority), a higher level of maintenance may therefore be necessary – a Herculean effort, perhaps, when considering the breadth of the structure in question.

Design-wise, the author has decided to continue the basic strategy of echoing the pre-existent architectural lines of the main structure and its decorative architectural features, adding both pattern and variety to an otherwise uninterrupted façade arrangement. At either terminal end of the aluminum grillework, upside-down L-shaped trellis groupings mirror one another to emphasize the north-south span of the structure. Apart from these minor flourishes, single trellis groupings that occupy alternating grillework sections between concrete support columns provide the rest of the coverage – breaking up the length of the structure from end-to-end and thereby making it far less imposing upon approach (figures 5.21 & 5.22).

With regards to plant selection, the lesser height of the western façade does seem to allow for a broader level of horticultural options than on the eastern façade which is limited by the scant number of plants that are able to scale such an elevation within the greater Athens climate. With rare exception, 50’ represents a considerable distance for any climbing plant species to ascend. Therefore, one should rely upon those few plants that have the ability to approach such

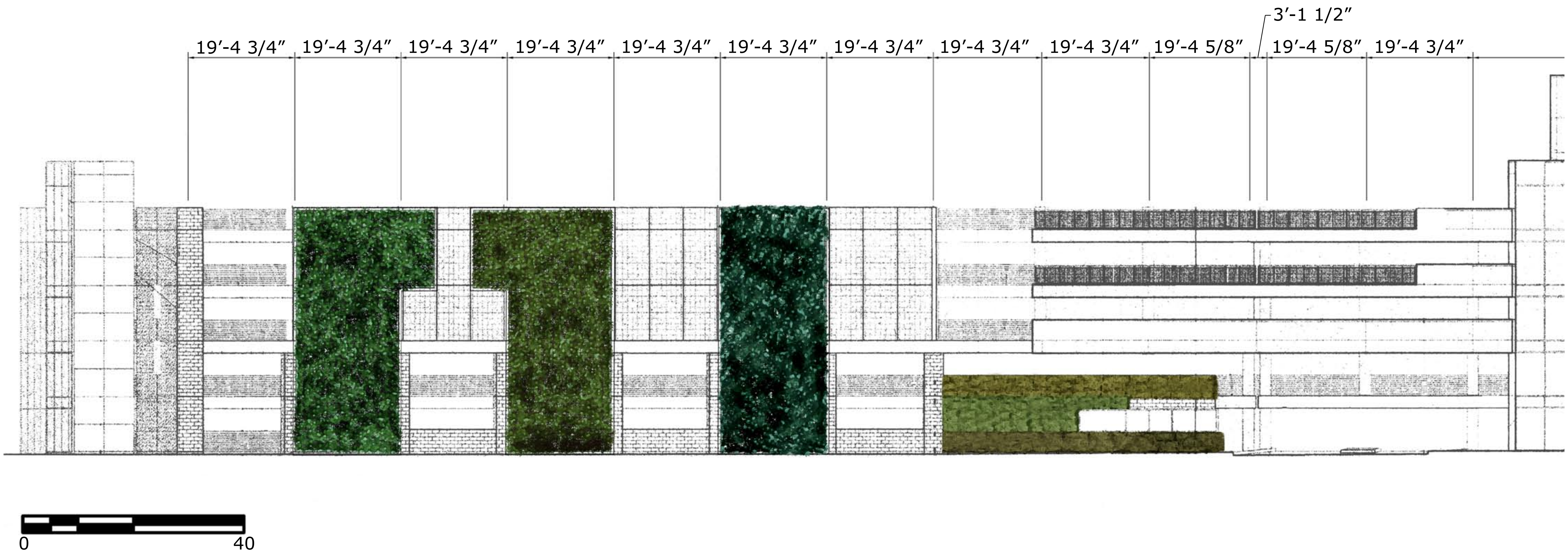


Figure 5.21. Structural and vegetative overlay for western facade of North Campus Parking Deck (Diagram by Nicholas Petty)

Figure 5.21. (Continued)

Figure 5.22. Photoshop rendering illustrating proposed structural and vegetated additions to Northwest end of North Campus Parking Deck (Rendering by Nicholas Petty)

such heights. Among those plants suitable for such purposes in Athens, GA, one might select such climbers as: Akebia (*Akebia quinata*), Trumpet Creeper (*Campsis radicans*), Cross Vine (*Bignonia capreolata*), English Ivy (*Hedera helix*) and the previously referenced Virginia Creeper (*Parthenocissus quinquefolia*). These climbing species can be applied upon individual trellis groupings at the western façade to create a diverse showcase of climbing species for would-be passersby (For more detailed information on particular species, the reader may also refer to Appendix A). From a horticultural standpoint, the greatest difference between respective façades will most likely be a matter of the length of time it might take to achieve complete vegetative coverage of those vertical surfaces upon which this effect may be desired. In either case, a period of somewhere between 8 to 14 years might be necessary before any vertical gardening schemes might be wholly realized, though even a less-than-mature vegetative presence can produce tangible benefits – particularly in light of the tremendous scale of the North Campus Parking Deck.

Façade greening endeavors can take a substantial period of time to yield full results, but the development of these strategies can be of considerable interest to practitioners for monitoring purposes. In the meantime, it might be possible to rely upon additional vertical gardening practices which can be immediately realized as a means of providing instant vertical coverage and reinforcing the ultimate vegetative appearance of the entire structure. The brick storefront façade which flanks the Jackson Street entrance to the north may not be the most prominent feature from a distance, but it might be considered among the most important aspects of the facility overall. Because the majority of automobile traffic tends to pass through this particular area – often requiring motorists to idle in line or stop to gain access to the deck – it reasons that specific attention should be paid to the surrounding façade as it may be subject to scrutiny on a regular basis.

The bare-brick storefront façade adjacent to the western entrance presents a prime opportunity to implement a living wall approach. As the previous chapter makes clear, many living wall systems remain the exclusive intellectual property of the designer(s) who originally conceived them. In this sense, they cannot be realistically recommended in any design scheme without consent or collaboration with these individuals. Unless one is determined or qualified to design and build a new living wall system – which the author is certainly not – then one must rely upon the limited number of modular living wall systems manufactured and marketed for public use. The G-Sky Green Wall Panel is one product that fits these criteria and – with that in mind – it now falls upon this discussion to elaborate upon the manner by which this living wall product might be applied to the extant storefront façade in question.

Referring to figure 5.23, one can begin to grasp the existent structural configuration of the storefront system. Beginning at ground level, there is a facade of 15’ in cumulative height that extends from the base of a stepped juncture between an underground concrete retaining wall and the post-tensioned concrete parking platform upon which automobiles will first enter the facility from Jackson Street. This wall possesses an outer brick veneer with a horizontal profile of 4” that is reinforced to the inside by a stacked concrete masonry unit of corresponding height and a thickness of approximately 10”. A portion of this wall is interrupted at its 4’ mark (relative to the ground) by an aluminum storefront window system containing a series of glass panels with a total height of 4’ from the lower base of the aluminum sill to its opposite member. Above this window system, the brick veneer ascends an additional 7’, with a successive post-tensioned concrete platform and concrete masonry unit providing the necessary structural backing. It should be identified that for much of this isolated storefront facade, there is no window system present. Where this is the case, one is presented with a continuous vertical brick surface. However, for the purposes of providing a detailed visual representation of how G-Sky Green Wall Panels might be affixed to the aforementioned wall, it is necessary to work with that section of the edifice that presents the greatest variable presence. The assumption then follows that, where windows are not present, vegetative coverage will continue uninterrupted to the topmost edge of the storefront wall.

Applying the modular G-Sky Green Wall Panels is a relatively simple process. Each panel has a uniform dimension of 11-7/8” at each side with a standard depth of 3-1/2” from back-to-front when oriented vertically. As the storefront façade in question has dimensions of

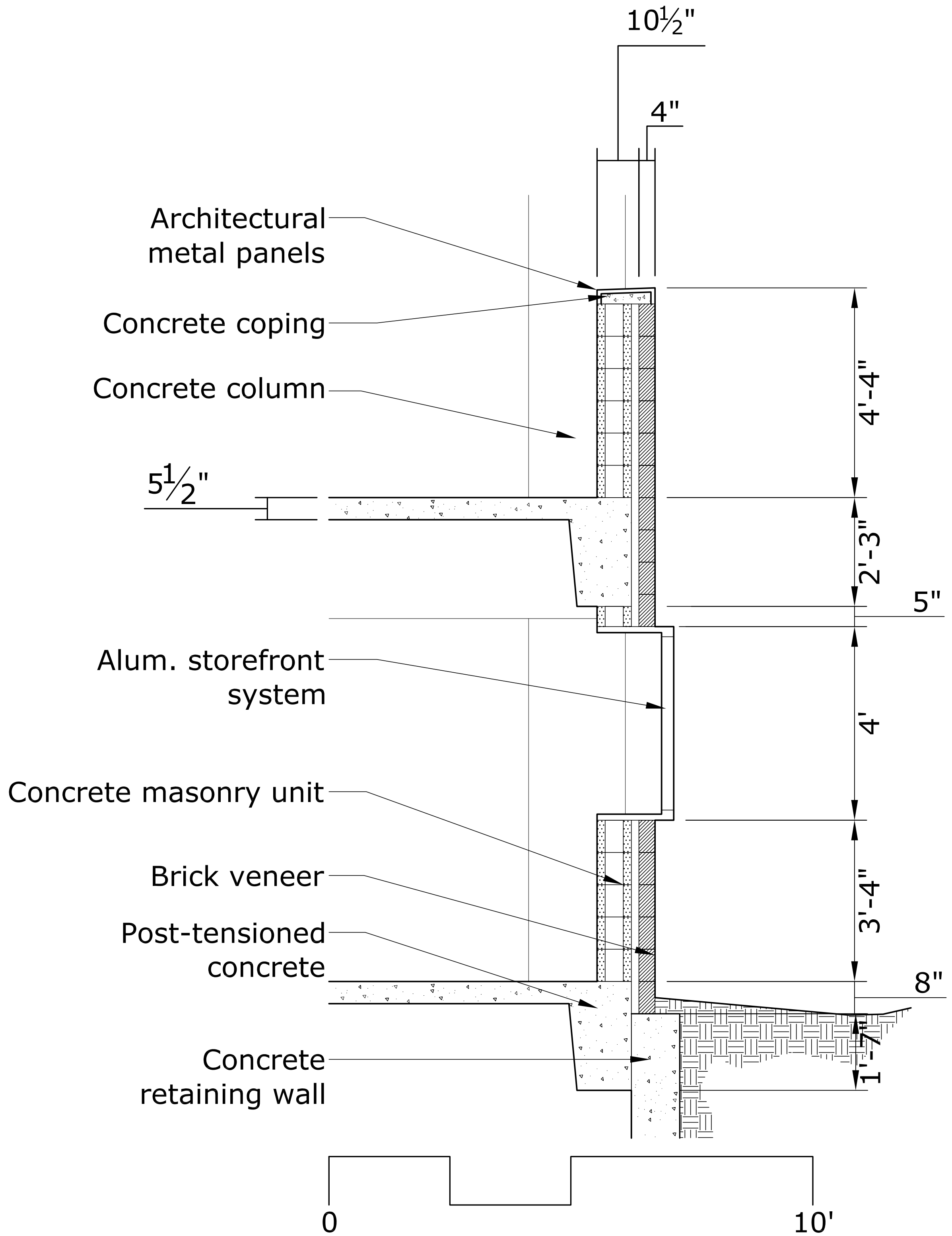


Figure 5.23. Section view of existing storefront configuration on western facade of Noth Campus Parking Deck (Diagram by Nicholas Petty)

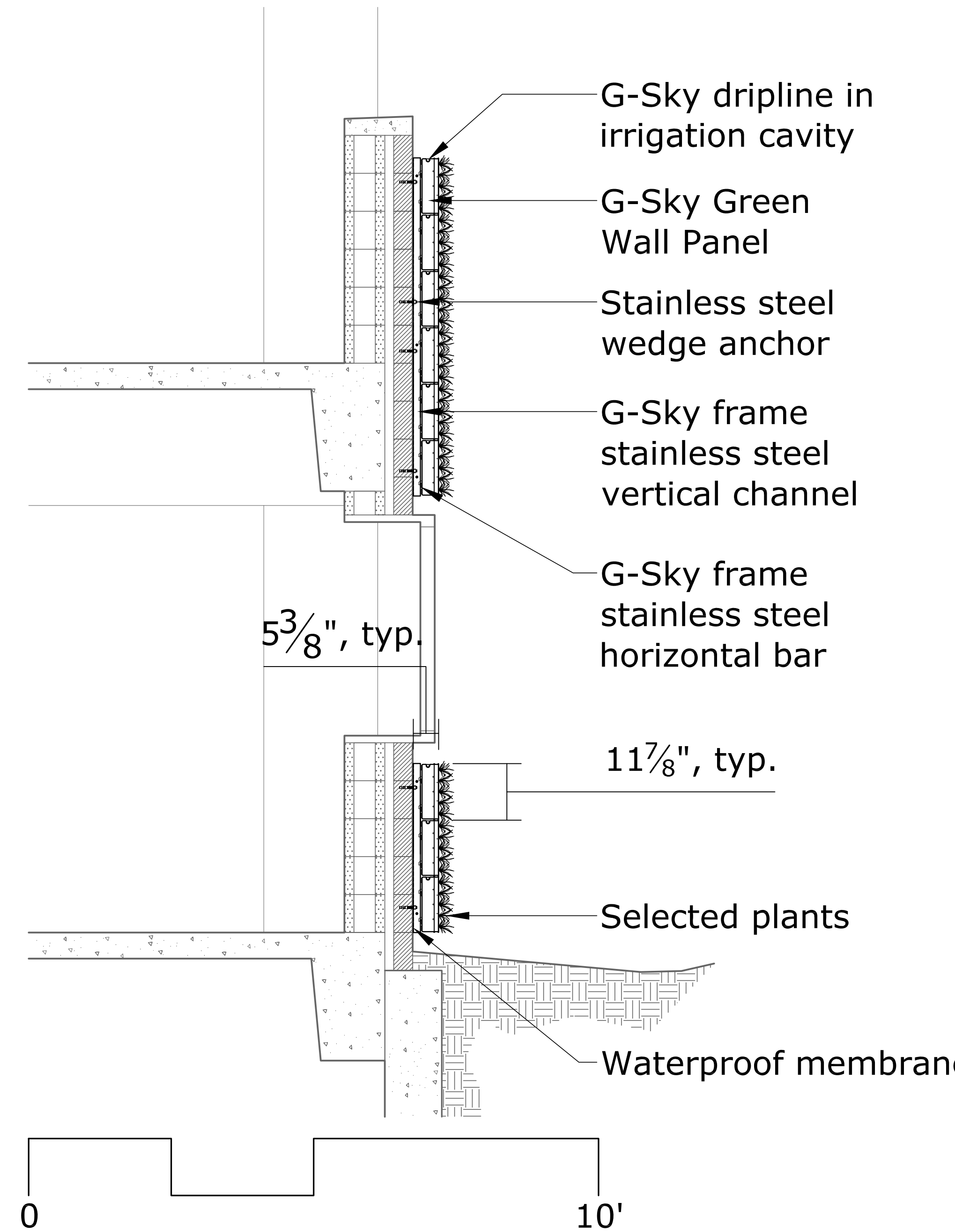


Figure 5.24. Section view of proposed storefront additions for western facade of North Campus Parking Deck (Diagram by Nicholas Petty)

15’ x 50’, any configuration of the approximately 1’ square panels should fit nicely. Furthermore, the continuous brick and concrete wall with which this application must function provides an ideal surface for integrating this type of strategy. G-Sky Green Wall Panels can be hung from rows of specially manufactured horizontal steel bar arrangements. The horizontal members themselves are mounted upon a series of vertical stainless steel channels – also provided by the manufacturer – that can be anchored to the surface of the wall using stainless steel wedge anchors. Figure 5.24 demonstrates, in section view, how this structural configuration might be set up with regards to the storefront office façade of the North Campus Parking Deck. Essentially, structural elements generate a fixed system of shelves upon which G-Sky Green Wall Panels may be positioned next to another to create a continuous surface of vertically-oriented plant material (figure 5.25). These shelves – and the attendant Green Wall

Figure 5.25. Photoshop rendering illustrating proposed G-Sky Wall Panel additions to North Campus Parking Deck storefront (Rendering by Nicholas Petty)

Panels which occupy them – can then be effortlessly mounted around the perimeter of the windows and signage features which adorn the exterior of the storefront.

To go one step further, such a configuration could be completed in a relatively short time span. G-Sky Green Wall Panels are pre-grown by the manufacturer, with plant selection pre-determined by G-Sky staff according to the climate in which they will reside. Due to a required plant propagation period of a few months time – a necessary stage so that the manufacturer may prepare vegetated panels for installation – one can determine the required number of panels beforehand and arrange structural and irrigational elements accordingly. Therefore, the entire system itself might be operational within days of the Green Wall Panels arriving on-site. Whereas full vegetative coverage will take years to accomplish under façade greening programs, a living wall system such as that proposed in this application can be installed over a matter of months with more or less instantaneous effects. It is true that this arrangement of G-Sky Green Wall Panels might only comprise a minor fraction of the total hypothetical biomass to be introduced as part of an overall vertical gardening scheme. However, the utilization of such a quickly-achieved approach might serve as a pleasant preview towards a much broader program – one which will manifest over time through the realization of the large-scale façade greening efforts mentioned earlier.

Having laid out the physical components of the proposed vertical gardening scheme for both the eastern and western facades of the North Campus Deck, it now becomes possible to gauge precisely how much vegetation may potentially be applied to the outer façade of the facility. No vertical gardening strategies have been pursued on the north and south ends of the structure. These two ends – as well as the stair/elevator node on the western façade – possess an aesthetic character that remains attractive to the designer and brings an additional element of variety to the overall scene. Had this omission severely compromised the amount of vegetation that might otherwise have been introduced onto the structure or enhanced the physical appearance of the design, it might have been included in the general scheme. However, because it does neither of these things, it has not been considered a factor. With reference to those areas that continue to be the object of this application's focus, one may now look at the some quantitative information derived from this exercise.

The east façade of the structure maintains a vertical surface area of approximately 35,000 square feet from end to end. If the façade greening plan put forward in this application were to achieve the maximum level of vegetative coverage using the structures specified, it would potentially introduce upwards of 16,000 square feet of vegetation to the eastern-facing exterior of the structure. Percentage-wise, this would mean that approximately 47% of the façade would be enveloped in climbing plants, a figure in excess of the thesis' stated goal of approximately one-third total coverage. Moving to the western façade, one finds a vertical surface area of about 21,000 square feet. With both façade greening and living wall measures in place and at full growth, one can anticipate a sum of over 8,000 square feet of introduced vegetation – a coverage figure of slightly above 38%. In total, proposed vertical gardening measures would establish nearly 25,000 square feet of new vegetation on the exterior of the structure, more than one-third of the total horizontal surface area of the structure itself. Realistically speaking, 60-70 feet is about as high as even the most vigorous climbing plants may reach in this particular plant hardiness zone. However, the author's contention is that the proposed efforts would be successful in the long run if proper conditions were maintained.

College Avenue Parking Deck

the presence of natural soil around the base of the North Campus Parking Deck enabled planting strategies that might otherwise have been absent in a more urban setting. Because the site of the structure was largely undeveloped prior to construction – and constructed in an area set aside purely for the function of providing automobile storage – there were fewer constraints in place to obstruct façade greening effort. However, many modern parking structures in towns and cities across the globe have been, or are being, constructed in environments where they must maximize parking within extremely tight quarters while simultaneously minimizing the impact upon urban character where it has been previously established. As one may recall from Chapter 3, extensive measures have been taken over recent decades to provide parking facilities that are compatible with their surroundings in both use and appearance; providing necessary services without disrupting the quality of life. The College Avenue Parking Deck in downtown Athens, GA is one example of this type of effort and shall henceforth be the subject of a second exercise to help determine the manner and degree to which vertical gardening measures might be applied to extant parking structures.

Located at the southwestern corner of College Avenue and Washington Street (figure 5.26) in the heart of the Athens' bustling downtown corridor, this facility represents a far more modest endeavor when compared with the colossal scale and parking capacity of the University of Georgia's North Campus Parking Deck. Designed by the Atlanta-based architectural firm of Pieper O'Brien Herr Architects, this municipally-funded project was approved for construction in November 1989 and houses approximately 370 spaces for automobile storage among seven stacked levels. Whereas the North Campus of the University of Georgia holds little in the way of

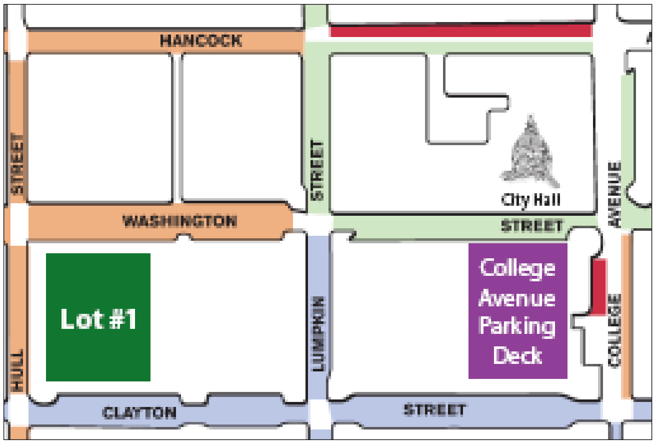


Figure 5.26. Map displaying location of College Avenue Parking Deck in downtown Athens, GA [Online Image] www.downtownathensga.com/ images/ParkingMapColor.pdf. Accessed Sept. 30, 2008

street or surface parking for staff, faculty, and students on the campus proper – thus necessitating the massive North Campus Parking Deck – downtown Athens does provide a great deal of street parking along many of its main thoroughfares. However, any individual familiar with the parking situation in this area is also aware that the amount of street parking available may often be limited under certain conditions. It reasons to believe that this may have also been the case in the late 1980s and, most likely, the primary impetus.

Architecturally-speaking, the designers of this facility had a much longer list of considerations to deal with than those responsible for the previous parking structure discussed. The lot upon which the edifice had been designated for construction is located on prime real estate in a section of Athens that is already dense with prior development. This factor dictated that architects would be encouraged to build upwards, thereby minimizing the footprint of the structure. While this is certainly a practical and logical gesture, it also meant that the parking facility would assume an increased level of structural visibility within the surrounding landscape. As it stands, the facility maintains a maximum height from base to top of approximately 77’-6” feet, though this measurement changes with the topography of the surrounding street. Generally speaking, each parking level – of which there are seven (including the roof level) – is separated vertically by a distance of 9’6”. The lowermost office level located along the street adds an additional 12’ to the height of the structure while a 3’6” wall has been installed at the uppermost parking level. Thus, the average height of the structure is much closer to 72’-6” overall, nonetheless dwarfing many of those edifices located in its immediate vicinity.

By all accounts, the citizenry of Athens does not take the physical appearance of new construction lightly. Given the proximity of the proposed facility to the character-laden historical structures that border the site – among them the cherished storefronts of Clayton Street and the lavishly ornamented City Hall just yards away – it is clear that any potential design scenarios would ultimately have to approach this particular project with an enhanced sense of aesthetic sensitivity.

From an overall standpoint, the design efforts undertaken at the ACC facility might be considered a success with regards to the manner in which the designers addressed the inherent concerns associated with construction. At street level, office, retail, and pedestrian spaces were included in the final plan – particularly along College Avenue – so as to maintain an acceptable relationship with the adjacent streetscape elements. A considerable degree of architectural detail was also included upon those outer facades which feature most prominently in one’s view of the structure, though little attention seems to have been paid to the western and southern faces of the facility. One must assume that the reasons for this gesture were primarily economic. Because the neglected sides of the College Avenue Parking Deck are flanked by existing buildings and offer no immediate access to either pedestrians or motorists, the costs associated with adorning these facades were probably not worth the action. And while these upper regions are actually quite visible as one approaches the parking deck from the west and from the south, the design efforts undertaken on the primary street facades remain commendable given the functional nature of the structure.

Aesthetic praise aside, the College Avenue Parking Deck nonetheless presents an excellent opportunity for the application of vertical gardening programs. The reintroduction of vegetation in urban environments can vastly improve the visual character of a given locale and can have a profound effect upon the physical and mental well-being of its inhabitants. The reasons for pursuing a vertical gardening strategy at this particular site are numerous. Its physical mass and prominence guarantee that any efforts will be recognized by the public and may thereby serve as a reference for future construction and a potential source of civic pride as the town continues to address issues of sustainability and ecological responsibility. With regards to these latter concerns, the facility is situated in a congested urban setting and acts as a concentration point for automobiles and the attendant exhaust and particulate matter that they inevitably expel into the atmosphere. And while the city certainly did not recently clear an existing forest or natural area in order to construct this particular project, it is still the case that the facility introduces a high volume of impervious surfaces to a section of downtown that has already seen its fair share of development at the expense of any vegetative presence. Therefore, it is apparent that the very existence of this particular structure – regardless of the less-agreeable parking alternatives that were eschewed in favor of this above-ground option – provides a deleterious contribution to the overall downtown environment. The author has been on the uppermost level of the structure on cloudless days and can report that it is considerably warmer at this elevation than in similarly open areas on the ground. This may be due, in part, to the heat-absorptive concrete surface that remains exposed at the highest level. Despite the unscientific nature of this observation, it would be difficult to deny that whatever heat island effect is present within Athens is surely exacerbated by structures such as the one in question, particularly when existing in lieu of natural vegetation which might otherwise help regulate the climate.

Before moving on to a detailed description of the extant structural and architectural framework upon which any vertical gardening strategy might be applied at this facility, one final aspect of the external site (i.e. not of the structure itself) conditions must be mentioned that will undoubtedly affect any recommendation. Space is certainly at a premium within this section of Athens. City officials and citizens alike would hope to maximize the storage capacity of any above-ground parking structure erected within this highly-used area. The City of Athens, it can be said, has done an excellent job over recent decades of implementing street trees along its main downtown thoroughfares. However, it has only allocated specifically sized and spaced planting pits for the propagation of that all-important tree canopy that grants shade in the summer, alleviating many of the harsh urban conditions present in an environment where the majority of surfaces are paved or developed. This is precisely the case in the immediate area surrounding the College Avenue Parking Deck. For although street trees and small planters are present along the outer edge of the sidewalk, at the immediate juncture between the horizontally-flat walking surface and the vertical plane of the parking edifice there is negligible space for plantings of any size. Moreover, were one to desire the propagation of climbing plants, storefront windows and awnings obstruct any path upon which such species might ascend from a ground level base. In the previous application there was an abundance of natural soil surrounding the North Campus Parking Deck that made it possible to install climbers in an ideal planting medium with few apparent obstacles. This is anything but the case at the College Avenue Parking Deck. How then might one achieve a vertical gardening program, particularly one employing the principles of façade greening, under such adverse conditions? To answer this essential question, it becomes necessary to examine the architectural and structural layout of the College Avenue Parking Deck so that other options may be put forward in the absence of tenable natural soil.

Observing the facility in plan view (figure 5.27), the structure – which occupies a footprint of 18,300 square feet – adheres to the boundaries of the site maintained by adjacent buildings, sidewalks, and streets already in place prior to construction. In this sense, it possesses a more or less rectangular shape. Nonetheless, certain architectural liberties have been taken to create visual interest and break up the general architectural form of a potentially monotonous structure. To reinforce the street corner and provide a small plaza for pedestrians at the sidewalk junction where a tobacco store is present, the east and north façades are terminated short of where they might have otherwise intersected to create an approximately 16’ x 16’ square recess. Where the main stairway and elevator facilities are located on the east façade adjacent to the College Avenue automobile entrance, a 13’-10” wide architectural turret with a curved outer element extends 20’-1” from the main façade. Ignoring those dimensional deviations produced by the architectural elements mentioned above, the facility maintains basic dimensions approaching 144’ x 125’,

Speaking in elevational terms, the eastern and northern facades of the College Avenue Parking Deck are the “public face,” of the structure (figure 5.28, *letters corresponding*). Entry and exit from the parking facility is provided at College Avenue (A) with a secondary exit available on Washington Street. Given its two-way character, College Avenue tends to be accessed more often than its counterpart by both vehicles and pedestrians alike. For the most part, the architectural program for the facility remains constant on either side, but the slightly longer eastern face – the *de facto* center of activity at the site – also includes the previously referenced stairway and elevator facility that interrupt the otherwise consistent layout of the façade. Because stair access must be provided to the topmost platform of the structure (elevator service ceases at the previous floor), the enclosing turret (B) rises above all other structural

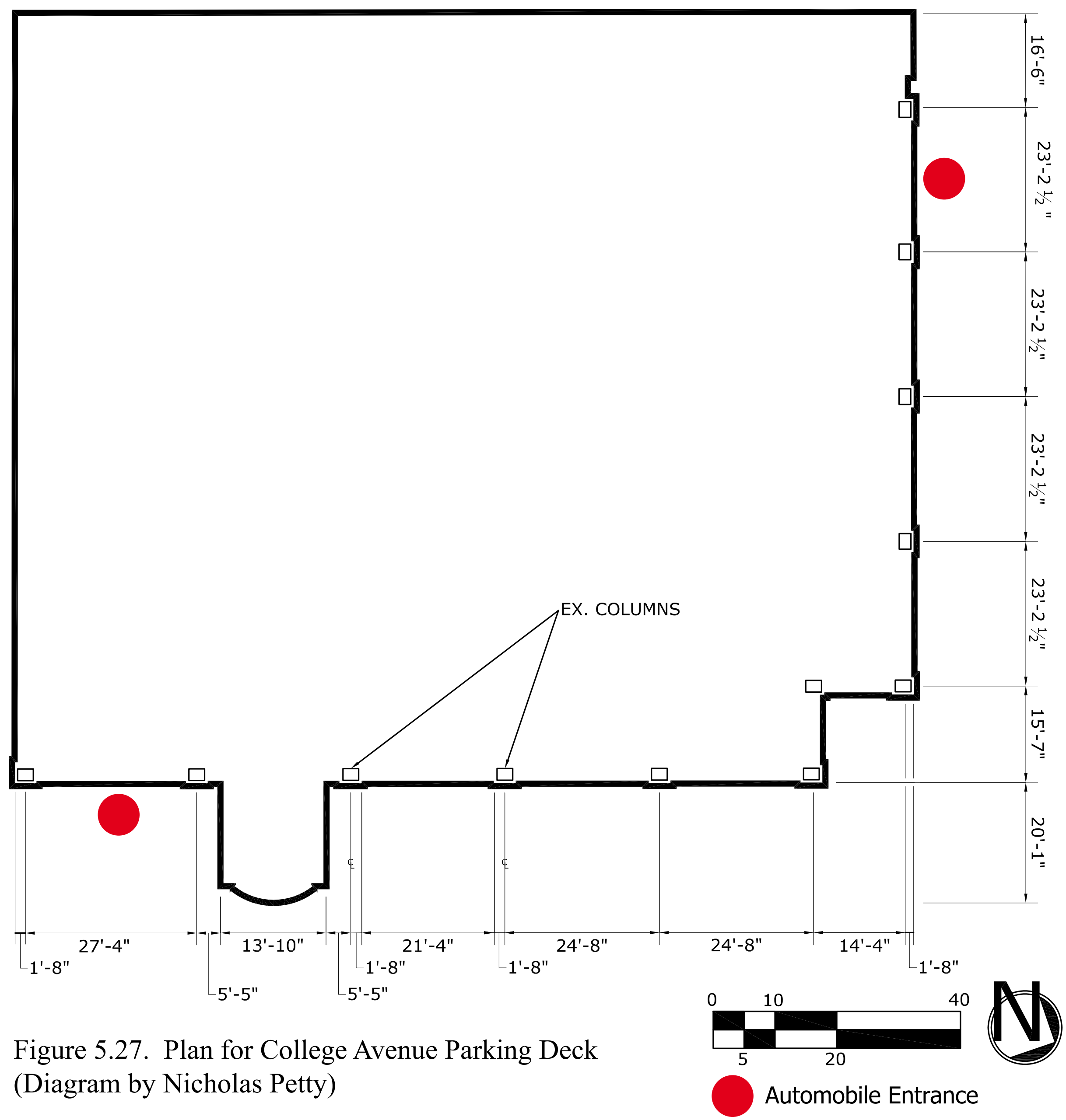


Figure 5.27. Plan for College Avenue Parking Deck
(Diagram by Nicholas Petty)

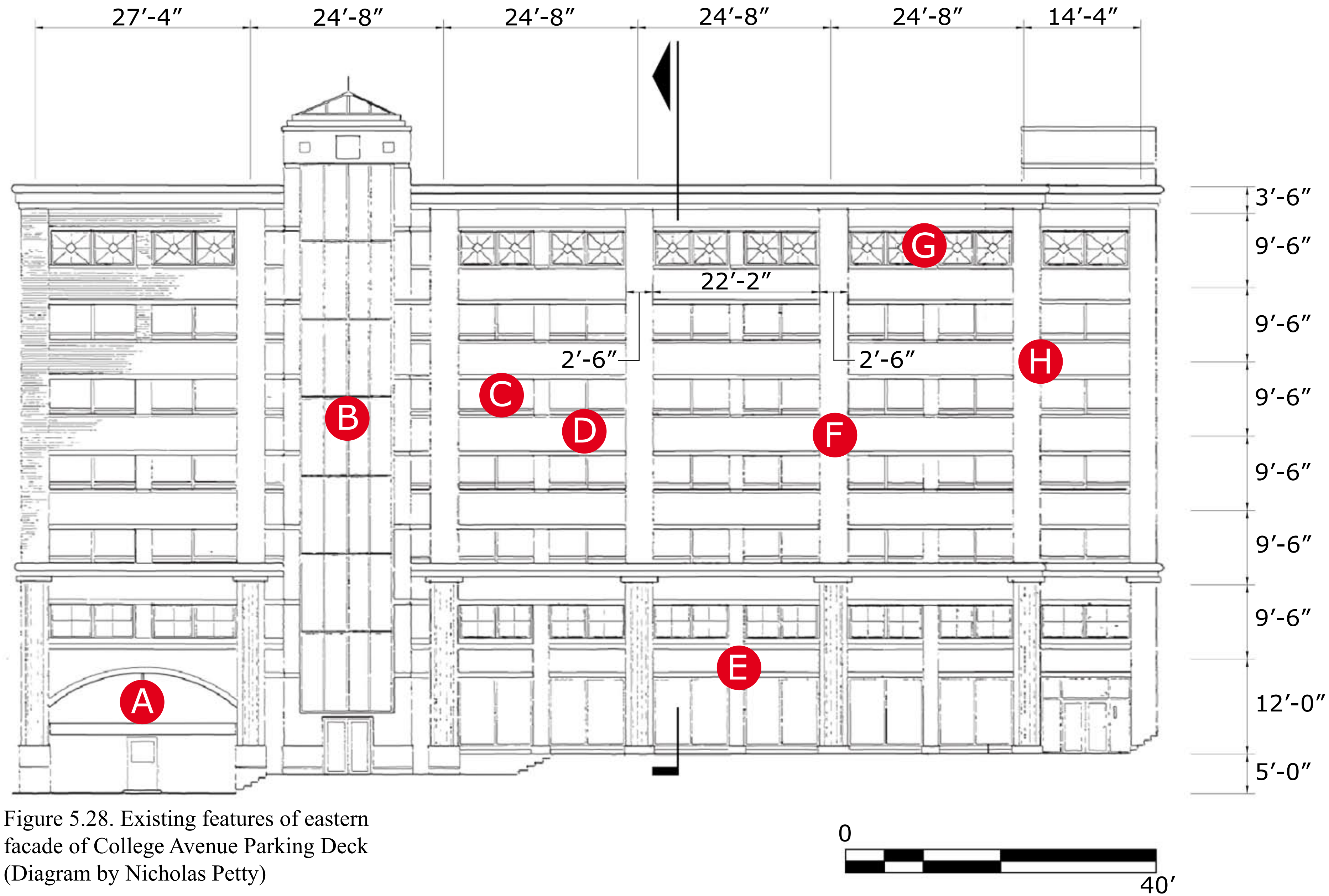


Figure 5.28. Existing features of eastern facade of College Avenue Parking Deck (Diagram by Nicholas Petty)

elements, serving as the main focal point along the eastern façade. The height of the turret might prove visually overwhelming if not for a series of reinforced concrete columns (F) ascending at regular intervals about the eastern and western facades. These 30” x 30” square columns deliver the primary structural support for the entire facility and dictate the appearance of the structure when viewed from the street. Where the façade of the structure attempts to mimic the aesthetic character of the surrounding commercial area at ground level, decorative columns have been installed about the north and east sides of the structure. The actual load-bearing columns extend unseen towards the base of the facility, which also includes a concrete veneer and glass storefront installation (E).

The first true parking level is elevated one story up from street level so as to allow for office and commercial use on the ground. Vehicles must, upon entry, travel upwards via ramp to find a place for storage. However, this first parking level is unique in that only about half of it is set aside for parking. The other portion houses the machinery which serves office level functions. Hence, the real concentration of automobiles begins at the second parking level and at this point a transition occurs – both structurally and architecturally – between the decorative base of the structure and the more functional upper parking strata above. Much of the detail observed at ground level seems to have been implemented to mollify the aesthetic appetites of pedestrians and, in this sense, the facility does not immediately announce itself as a parking structure. Nonetheless, as the function of the facility shifts to accommodate parking needs alone, many of the decorative architectural elements visible at the first two levels are abandoned in favor of a more stripped-down appearance. Because the actual parking levels are only visible from an outlying vantage point, it would seem that the designers and, more likely, those funding the project made the executive decision to waste little effort disguising the function of the structure from a distance. The underlying motivation is obvious: aesthetically appealing or not, parking is a necessary service.

Be that as it may, architects did not discard any type of aesthetic program altogether. In fact, efforts were made to express some degree of continuity between the street-oriented base levels and the more functional upper section. For one thing, the design maintains a tan brick-veneer throughout the upper north and east façades on those horizontal wall units (D) installed between concrete supports at each individual parking level. As section drawings will later illustrate, masonry is a decidedly ornamental gesture, for it has been installed upon concrete wall sections providing the true security barrier. These barricades only comprise approximately half the vertical span between parking platforms. The rest of the façade plane remains open for the purposes of providing the inner structure with natural light and ventilation (C). This aspect represents a vital (and non-negotiable) addition made necessary by the impervious monolithic construction of the southern and western faces of the structure which allow neither in any capacity. At the sixth parking level located just beneath the exposed roof, the staggered openings into the structure have been ornamented with stainless steel grills that accentuate the penthouse level (G). These grill units are painted a ghastly teal color that is repeated upon steel railings positioned just above the wall elements present at each level. It is fair to say that the hue of these elements severely disrupts the visual character of the entire structure, overwhelming the otherwise muted tone of the facility. Finally, there is the inverted corner where the two primary façades intersect (H). From a distance, this aspect of the structure lessens the angular harshness that might have been prevalent had the eastern and northern sides of the structures terminated at a sharp corner.

Figure 5.29. View of College Avenue Parking Deck from College Avenue
(Photograph by Nicholas Petty)

Architectural flourishes aside, photographs suggest (figure 5.29) that the College Avenue Parking Deck may not be the most attractive structure in Athens, GA. It remains rather featureless, capable of generating only the slightest level of visual interest beyond its enormous scale. Additionally, those elements which do tend to catch the eye – the steel railing and grill features, for example – do not necessarily generate a positive effect. The College Avenue Parking Deck may not rouse too many objections in light of its functional nature, but the implementation of vertical gardening strategies can dramatically enhance the visual character of the facility. From an environmental and ecological standpoint, this particular facility can only be viewed as a burden under the relevant criteria (though one must allow that it remains a vastly superior alternative to surface parking options). However, recalling the myriad aesthetic, environmental, and ecological services that can be provided via the application of vertical gardening strategies, it follows that all aspects of this particular edifice can be improved through the integration of vertical gardening measures.

At a structural level, one of the primary obstacles confronting vertical gardening efforts at the College Avenue Parking Deck concerns a need to bypass the two lowermost levels of the overall structure in the absence of a proper planting medium or viable surface upon which to begin propagating plants. The soil issue might not have presented a problem were this an instance where a living wall strategy might have been viable. However, the skeletal, grid-like nature of that section of the structure devoted to vehicular parking seems to dictate that the integration of living wall systems might be supremely difficult considering the intricate arrangement of structural and irrigation mechanisms that might have become necessary. To be sure, these types of systems are best applied *en masse* and become considerably more complex when used to cover a series of small areas rather than a continuous vertical surface. Furthermore, the living wall approach uses plants as one might apply paint or a masonry veneer: one must mount vegetation and its attendant support mechanisms precisely and completely in those areas where the design requires it. And though this strategy may generate immediate results, it may also present a serious hindrance in those cases where structural height is a contributing factor; for this method must be applied and, potentially, re-applied at considerable expense and personal risk. Façade greening, on the other hand, harnesses the innate characteristics of climbing plants to carry out the desired program via natural processes. Vegetative coverage can be accomplished through planting appropriate climbers at the base of a surface and letting them pursue their upward mission – provided, that one supplies the proper support and control mechanisms to ensure optimum dissemination.

Returning once more to the issue of delivering plants to the upper strata of a facility devoid of sufficient natural soil about its base, it will be useful to recall the Harbor Day School example provided in Chapter 4. Relying upon elevated fiberglass planters anchored to the outer recesses of the gymnasium complex, designers were able to provide a comprehensive level of vegetative coverage to the upper portion of the structure. This effort not only concealed the edifice from afar amongst the neighboring tree canopy, it also fostered an enhanced degree of visual complexity and ecological improvement to the site. Given the success of this project, it is conceivable that similar measures might be taken at the College Avenue Parking Deck. Recognizing that there is already a transitional line between the street-level façade and the second parking floor, any façade greening measures should begin at this point to reduce the height to which climbing plants might be required to ascend. Due to the structural and architectural configuration of the parking floors and support columns, continuous coverage from top-to-bottom might only be possible – and advisable – in limited application. Otherwise, the vertical integration of vegetation must be pursued on a level-to level-basis where anchoring support may be present.

Figure 5.30 (*letters corresponding*) displays the proposed structural configuration for the eastern wall of the facility. Each of these aspects will be explained at greater length via section drawings (figure 5.31 & 5.32) and description but, for the moment, it will suffice to identify them as they relate to one another in elevation. As it should become apparent, with an organizing architectural program already in place, the existing forms of the structure have been maintained. This is not to say that the addition of a vertically-oriented vegetative presence about the surface of the College Avenue Parking Deck will not dramatically alter the physical appearance of the structure. What will become manifest via this design scheme will most likely

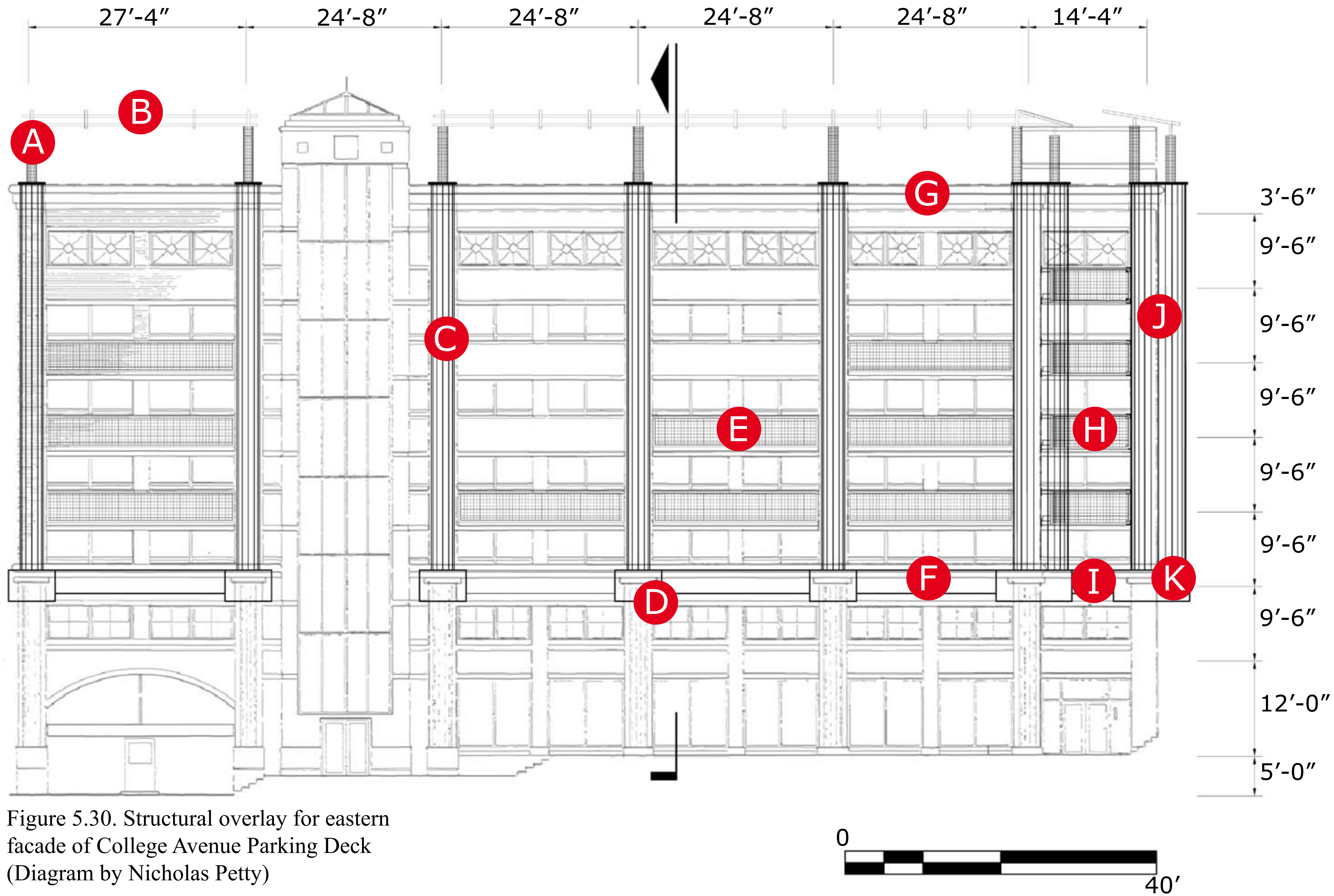


Figure 5.30. Structural overlay for eastern facade of College Avenue Parking Deck (Diagram by Nicholas Petty)

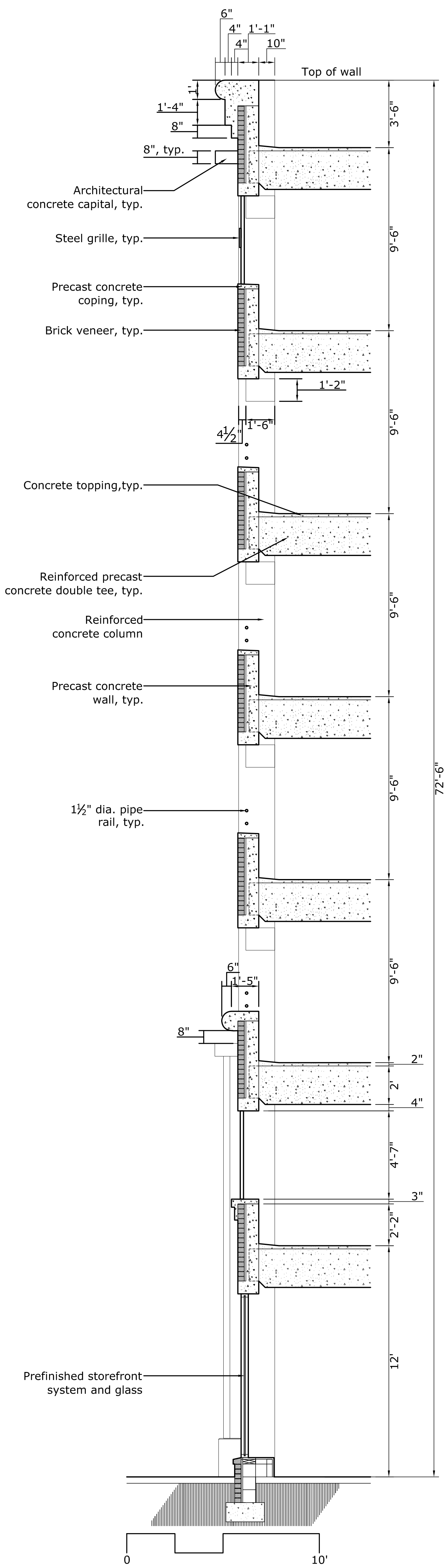


Figure 5.31. Section view of existing structural configuration for eastern facade of College Avenue Parking Deck (Diagram by Nicholas Petty)

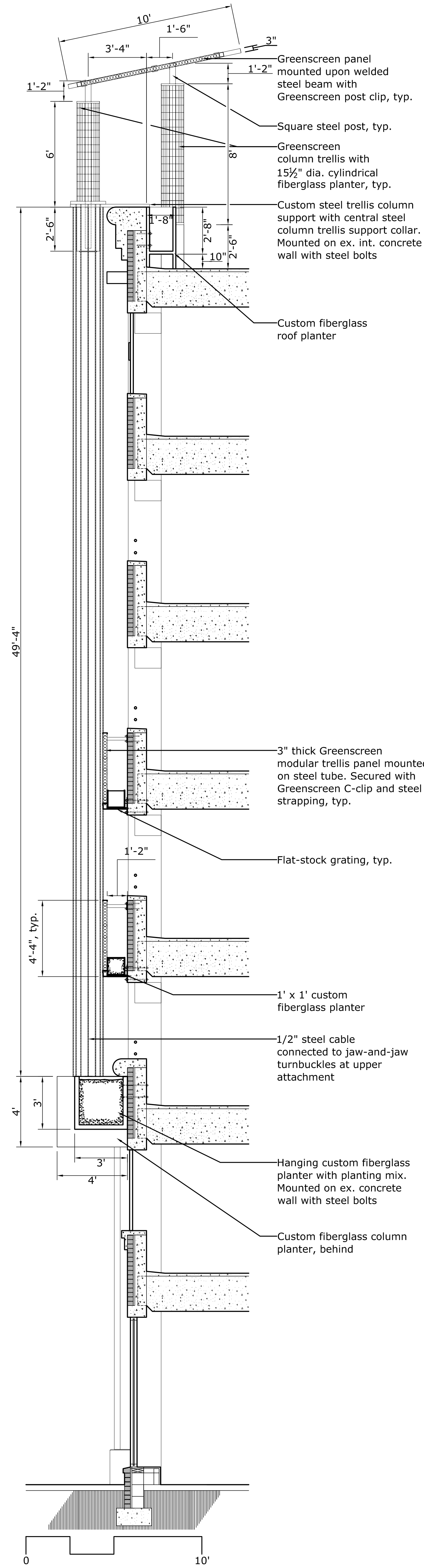


Figure 5.32. Section view of proposed structural additions for eastern facade of College Avenue Parking Deck (Diagram by Nicholas Petty)

be both familiar and unfamiliar to the viewer in terms of overall vision, offering an enhanced degree of visual interest and ecological functionality while simultaneously preserving the general characteristics of the structure in its current state. Beginning at the second parking level above the street façade of the structure, one can observe that a series of structural additions have been mounted upon the exterior for the purposes of façade greening. At the base of each vertically-spanning concrete column, a series of fiberglass column planters (D) have been installed that will serve as the planting base for climbers. These plants will be free to scale the upper reaches of the facility via cylindrical “columns” composed of upright stainless steel cables (C) anchored at the base of the column planters. The cables will terminate at the roof of the structure where they will be affixed at their upper section via stainless steel hoops. These hoops will be part of a custom steel support unit (not labeled) anchored to the inside of the topmost wall. The appearance of this columnar steel cable configuration will create the illusion that the column planters have been suspended from the upper attachment like gigantic hanging pots, though it will be the case that proper support for the column planters will be provided at their immediate position on the lower façade for both safety and stability.

In terms of potential plant selection for these structural members, any plant installed at the base of this columnar configuration will have to span a sizeable vertical distance of approximately 50’. Once more it is possible to rely upon those plants proposed for the North Campus Parking Deck which are able to ascend to such heights (Virginia Creeper, Trumpet Creeper, etc.). In addition to those species referenced earlier, there is the curious option of Kudzu vine (*Pueraria lobata*) – often considered an invasive scourge in the southeast – for the purposes of ascending the steel cables provided from the base of the planter. The reader may wince at this suggestion, but this plant can be controlled under the given circumstances since it has nowhere to spread outside of the container provided. While this type of selection is not advised when planting in natural soil, in this case, it may be of use for façade greening purposes. The inclusion of such a climber in the overall scheme may come as a quite a surprise to pedestrians viewing the addition from the street – particularly if they are familiar with the ubiquitous kudzu-strangled roadside landscapes common throughout the southeast. However, this inclusion will challenge widespread conceptions of the plant and may suggest a revised, but cautious, use for an otherwise loathed climbing species.

Returning to structural matters, those custom steel supports that will hold the stainless steel hoops and steel cable columns in place are intended to have a load-bearing function though, as mentioned above, they will in no way contribute to the support for the column planters below. Extending outward from the structure at the center of each hoop will be a square steel collar supporting a series of Greenscreen Column Trellis units (A), thereby creating a supplementary level of ascending vegetation. These additional vertical units will not only continue the basic form of the steel cable columns below, they will also prop up the outer section of a proposed slanted pergola structure – the roof of which will be made up of Greenscreen modular trellis panels (B). The inner supports of this pergola structure, a second series of Greenscreen Column trellis units, will be anchored upon the reinforced concrete roof of the parking facility. At the base of each Column Trellis Unit, cylindrical planters will hold planting media in which a second level of climbers can be installed. There are a number of climbing species appropriate for providing coverage for this roofed structure, but it is suggested that they be evergreen in nature to provide a year-round function. Taking this factor into consideration, species such as Cross Vine (*Bignonia Capreolata*), Akebia (*Akebia quinata*), and Carolina Jessamine (*Gelsemium sempervirens*) may fit the bill. This vegetated pergola will ideally provide shade for vehicles parked along the eastern and northern walls of the roof level, the seventh parking level overall, in hopes of mitigating the release of emissions from automobiles at rest. The vertical presence of this rooftop configuration will also moderate the punctuated form of the tower structure housing stairway access to and from College Avenue, an otherwise isolated architectural feature that will ideally merge with the proposed upper additions.

At the lowest structural level where vertical gardening features first appear, it might be imagined that the column planters recommended above would impose a tremendous visual presence just above street level. To alleviate any potentially-awkward exterior forms generated by these elements, a series of elevated rectangular planters (F) have been proposed to span the distance between column planters. This will create a more consistent appearance along the transitional facade line located along the base of the second parking level. Whereas the column planters were installed to facilitate the upward growth of climbing plants, this alternate series of fiberglass planters provide the growing medium for cascading plants that will spill downward from the edges of their containers to add a pleasant textured aspect to the pedestrian streetscape below. The use of cascading plants represents a distinct sub-approach to façade greening that requires few of the structural mechanisms necessary to support the ascending habits of climbing plants. Though the level of potential vegetative coverage available under such schemes may be limited by the distances to which cascading plants are capable of descending, cascading species remains a valuable option in scenarios of modest vertical height. Additionally, cascading species can provide an interesting foil to the opposing upward growth of vines and other climbing species. With that in mind, a similar planting tactic has been utilized on the roof of the College Avenue Parking Deck as a means of integrating vegetation where architectural coping makes structural applications difficult. A series of custom fiberglass roof planters (G) have been included between the inner Greenscreen Column Trellis units anchored on the roof for the purposes of providing a cascading plant presence at the uppermost level of the structure. Working in conjunction with the vegetated pergola feature installed at the same level, the addition of cascading plants will accentuate the roofline and continue to break up the overall textural and chromatic monotony of the parking structure. Shore Juniper (*Juniperus conferta*) may be the most advisable choice for both applications which seek to produce such this type of effect. Its dense, evergreen quality, hardiness, and intrinsic ability to grow downwards to distances of 5’ or more make it one of the few authoritative selections for this type of scheme.

At the North Campus Parking Deck it was possible to create a series of continuous planar vegetative surfaces spanning the vertical distance between the base of the structure and its topmost levels. However, a potential “green-all” program was eschewed to allow for light and ventilation where it might otherwise have been eliminated. As documents from the initial construction review of the College Avenue Parking Deck reveal, ventilation was an issue at the facility from the onset (1989), in fact, the initial height of the walls at each parking level was modified from the original drawings to allow for greater airflow throughout the structure. Viewing the structure from the east and north, it would appear a relatively open facility but, because the southern and western facades are closed off to the elements, this means that all air circulation occurs at those openings which face the street proper. In light of this consideration, if the recommendations of this thesis are to be considered viable, any areas that are currently open must remain so. This constraint dictates that the remaining façade greening measures must be designed to cover only those exterior portions of the façade that are already closed off – essentially, any place where masonry is present. These sections are isolated from one another by both the steel cable columns mentioned earlier and the open recesses at each level which cannot be covered over. Therefore one must treat each of these quadrants as an individual unit where both the height and width of any vegetative addition is pre-determined by bounding elements both proposed and existing.

G-Sky Green Wall Panels might be applied using similar structural supports as those specified on the storefront area of the North Campus Parking Deck, but this approach might be problematic at elevated heights in terms of maintenance and installation. In theory, G-Sky's vine container module offers the best resolution to this design quandary, but the trellis component of this particular product seems a bit of an afterthought and may not possess the same qualities of comparable products currently available to designers. However, using the basic strategy behind the G-Sky vine container – the creation of small platforms upon which to set planters – it reasons that a custom apparatus might be constructed that would make use of Greenscreen modular trellis (E) units rather than those included in the G-Sky package. These modular units would create a superior support apparatus for climbing plants and might thereby provide a more orderly vegetated appearance than that put forth by the G-Sky vine container in similar functions. Furthermore, such a configuration would permit an individual to access plants at each successive parking level. Firstly, this method would allow for easier maintenance than in a living wall approach. Plants would be horizontally offset from the structure rather than vertically flush with the exterior surface and might be easily manipulated. Secondly, one gains the ability to rotate perennial or annual species – many of which exhibit appealing foliage, fruits, and flowers – on a seasonal basis, thus enhancing the aesthetic quality of vegetative additions. There are a considerable number of climbing plants which may be installed under this configuration. Among them are perennial climbers such as Trumpet Honeysuckle (*Lonicera sempervirens*) and Passion Vine (*Passifolora incarnate*) and annual species such as Love-in-a-Puff (*Cardiospermum* *halicacabum*), Moonvine (*Ipomoea alba*) and Cardinal Vine (*Ipomoea quamoclit x multifada*). And while there may be questions as to how well some climbing species might flourish in such a constrained planting medium, it stands that a small container may limit the height to which average climbers might grow, thus minimizing maintenance concerns that might have resulted were the plants allowed to mature upon an undersized vertical trellis arrangement.

While the diagrams referencing the primary elements of the vertical gardening scheme for the eastern façade of the College Avenue Parking Deck are unique to this particular side of the structure, a similar configuration will be present about the northern side of the structure and warrant no further description beyond that which will be supplied via renderings at a late juncture. Turning the focus now to the corner recess where these two sides intersect, one can observe an analogous strategy in place. At the corners, steel cable columns have been included once more. However, these columns possess a larger diameter overall and are only integrated in a 270º manner (J). This gesture reinforces the twin corners produced by the recessed junction and, in many ways, echo the prominent vertical presence of the stair tower. To provide an anchor for ascending cables and a medium for climbing plants, a custom fiberglass planter is necessary that will wrap around each corner at a 90º angle (K). Similarly, a container for cascading plants will also be mounted along the wall at this joint and will follow the 90º interior corner of the recessed area as a single unit (I).

Above this lowermost level of elevated planters where masonry walls are present, the author has chosen to deviate slightly with regards to the configuration of Greenscreen modular trellis units present on the primary facades. Using Greenscreen Crimp-to-Curve customization options, it will be possible to create a concave 90º curvature spanning between the corners of the recess (H), the length of which will be based upon a radius of approximately 16’ (the centerpoint of which is located at that juncture where the two facades would otherwise have terminated). Whereas the platforms upon which plant containers might have rested on the northern and eastern facades were able to remain flush with both the wall and the trellis module, in this case the plant containers must be positioned relative to the trellis module rather than the wall since they are now exclusive of one another. Therefore, the space behind the trellis units must be composed of flat stock grating or a similar horizontal element to support the weight of a human being for maintenance purposes if necessary. From a visual standpoint, this curved addition to the corner feature of the structure will soften the intersection and enhance the outward appearance of the corner plaza area where Washington Street and College Avenue coincide.

Figure 5.31 provides a section view through the eastern face of the structure as it currently exists while figure 5.32 contains most, if not all, of those additions proposed for the structure in question. Observing these drawings in concert with one another, one can attain a more precise idea as to what may be required structurally to carry out a façade greening program on the public-oriented exterior of the facility. Beginning at the second parking level where the transition occurs between the decorative street façade and the spartan upper parking façade, one can identify an elevated fiberglass planter positioned just beneath the lip of the concrete coping of the second floor parking level. These planters provide a growing medium for cascading shrubs and will extend 3’ from the wall and possess a vertical depth of an additional 3’. The length of these planters will be determined by that distance between the 4’x 4’ x 4’ column planters (located just behind the fiberglass planters in figure 5.32) centered just beneath the exposed base of each reinforced concrete support column.

With regards to planter weight and stability, fiberglass is the material of choice in both cases, offering a lightweight, high-strength alternative to concrete and other materials and can be easily customize by manufacturers prior to installation. The planting medium may also generate a tremendous load in this type of configuration. Because it comprises a majority of the volume of each planter, selecting a planting mixture that can provide optimal conditions for plant growth while minimizing the loading stress generated by its presence is critical. A 50-50 mixture of lightweight aggregate and sandy clay loam which can cut down the weight of the planting medium by approximately one half versus the weight of loam alone..

Ideally, the act of securing the elevated planters to the structure may be accomplished via the integration of a series of high strength steel bolts threaded through the back of each planter and the adjacent concrete/masonry wall behind it. Each planter will ideally use the strength of the wall to support itself, though additional securing mechanisms may be necessary underneath the planters to ensure their stability. In this instance, consultation with structural engineers or similar professionals may be necessary to ensure that adequate support is provided. For although measures may be taken to minimize the total weight of these elements, the elevated planters in question will nonetheless generate a substantial load that may endanger the safety of those below if proper measures are not taken to ensure their fixed position on the exterior of the facility.

As mentioned previously, the 1/2” vertical stainless steel cables that make up the faux columns running upwards to the roof of the structure are to be anchored at the base of the fiberglass column planters. Though the illusion may be present that these elements provide some degree of support for the planters at their base, to rely on this measure in any structural capacity would be ill-advised. Essentially, these decorative cable columns will be comprised of twelve cables per column, each set in a circular formation possessing a diameter of approximately 1’-9”. This configuration shall serve as both conduit and formal guide for the growth of large climbing plants rooted in the column planter below. Each series of cables will ascend nearly 50’ to the roof of the structure where they will attach individually to jaw-and-jaw turnbuckle retensioning mechanisms that will be secured, in turn, to a support extension fixed to the inside of the uppermost wall located at the roof of the facility.

The outer aspect of this support will be hoop-like in appearance, much like the rim of a basketball goal. The inner void of this circular support will contain an additional support arm that extends into the center of the hoop. Here a hollow square collar will be provided for the bolting of a 4”x 4” x 9’-8” stainless steel beam to its inner core. This vertical beam will provide the central vertical element for the aforementioned set of outer Greenscreen Column Trellis units, the height of which is composed of a 30” high cylindrical fiberglass planter with a diameter of 15’-1/2” and a 6’ high column trellis of the same width. The steel beam, which may also be secured at the base of the cylindrical planter for additional support, will extend an extra 1’-2” upwards from where the column trellis terminates. This vertical element can then be affixed by bolt to a diagonally-oriented 3” x 3” x 10’ steel beam that will secure a proposed series of Greenscreen modular trellis panels making up the horizontal “roof” of the upper pergola structure. Inner vertical supports – offset from the central vertical beams of the outer vertical supports by a distance of 4’-10” – will be provided by a secondary series of Greenscreen Column Trellis units (with central steel beams) of approximately 11-’8”. These column trellis pergola supports will be anchored at their base to the concrete parking platform below and should provide the majority of the stability necessary to make this design scheme successful. Beneath this pergola structure and between the inner Greenscreen Column Trellis units, fiberglass roof planters will be installed flush with the rooftop wall to provide the planting medium for cascading plants at the uppermost levels. These planters will be exactly 3’6” in height to correspond with the height of the adjacent wall and shall maintain a horizontal depth of 1’-8” to provide space for planting.

The final series of structures to be applied to the eastern and northern facades of the ACC parking facility are those elements discussed earlier that derive their inspiration from the G-Sky vine container units. Rather than relying upon a pre-manufactured product, the designer has concluded that a custom-built feature integrating Greenscreen modular trellis units will be superior in its ability to capture plants and create a more orderly planar vegetative surface. This can be done by mounting a welded three-sided 4” x 4” rectangular steel tube to the base of the exterior walls via stainless steel plates and bolting devices on those sections of the facade where such additions have been designated. On the underside of this steel tube, flat stock-grating can be affixed to create a platform upon which 1’x 1’ fiberglass planters may be inserted and potentially bolted to the grating below to keep them stationary. In terms of securing the 4’ high outer trellis system, the outer aspect of the rectangular steel tubing will provide the lower anchoring station for Greenscreen steel mounted clips. These devices will bear the downward load of the modular trellis units and those climbing plants cultivated in the fiberglass containers located just behind the vertical trellis. The additional act of fastening the modular trellis units at their upper ends for ensured stability and loading support will also be necessary. This may be accomplished via the addition of Greenscreen steel strapping units attached to the outer edges of the modular trellis units.

By comparison, the configuration of vertical gardening devices proposed on the northern and eastern facades of the College Avenue Parking Deck far exceed those applied at the North Campus Parking Deck in terms of complexity and the variety of approaches included in the overall scheme. It is the case that at this particular facility, there was clearly more to work with

– and more to necessarily work around – than in the previous example. It follows that though the existing layout of the structure certainly forced more rigorous structural considerations, in terms of physical appearances, the College Avenue Parking Deck may reap greater aesthetic benefits with regards to the vertical gardening additions put forward by this section of the application. Figures 5.33 and 5.34 illustrate how this may be the case.

Figure 5.33. Photoshop rendering of proposed structural and vegetative additions to eastern and northern facades of College Avenue Parking Deck
(Rendering by Nicholas Petty)

Nonetheless, any questions pertaining to the attractive or unattractive qualities of the proposed vegetative additions to the facility must be considered in a secondary manner. The primary function in all vertical gardening undertakings is the successful integration of vegetation into an area where it had heretofore been absent. Unless one were planning to cloak an architectural masterpiece in a vegetative skin – thereby obscuring its genius – one could assume

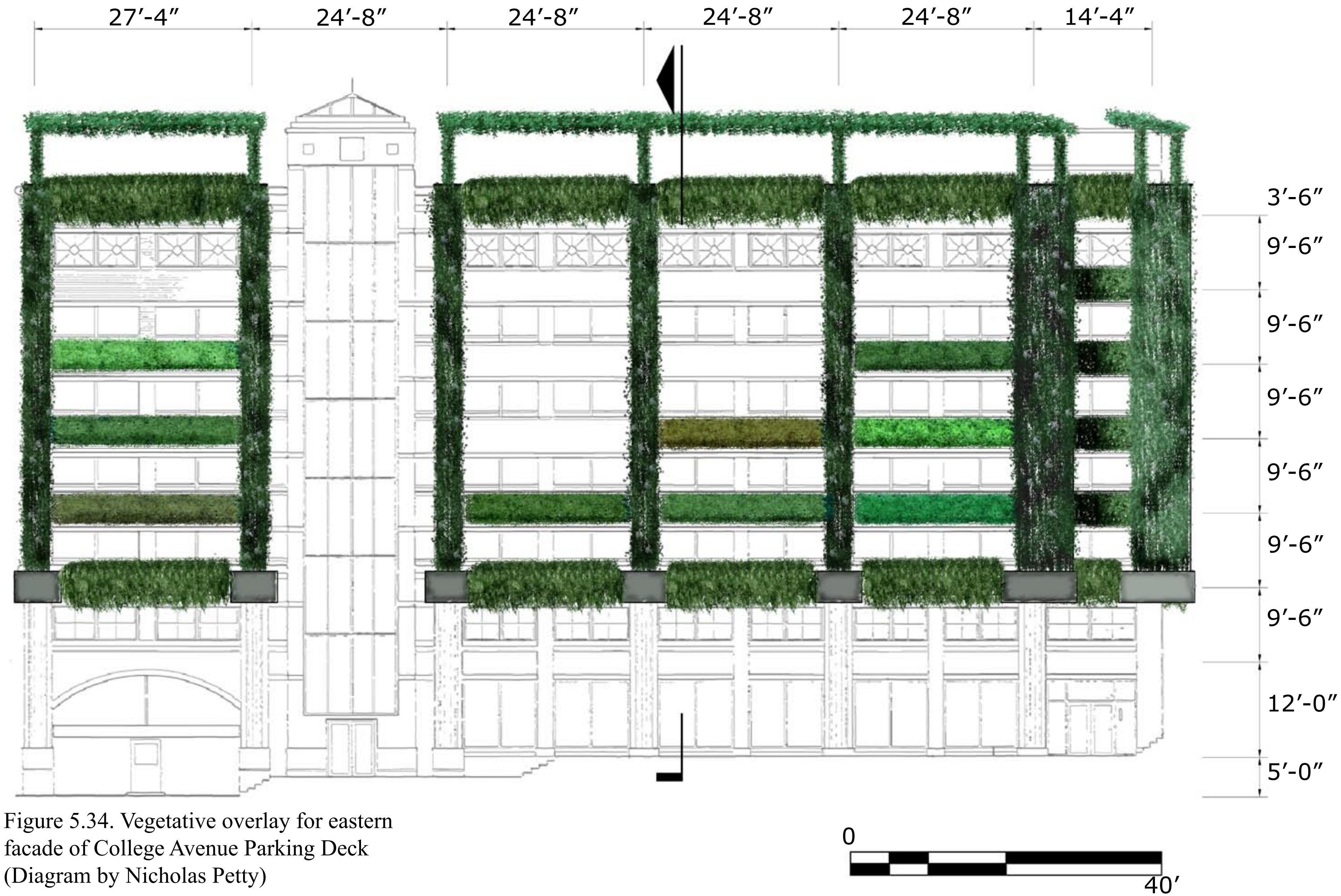


Figure 5.34. Vegetative overlay for eastern facade of College Avenue Parking Deck (Diagram by Nicholas Petty)

that, in all other cases, a well-conceived vertical gardening strategy will provide a marked degree of improvement to an existing structure. In this regard, one may also assume that given the bare, featureless western façade of the College Avenue Parking Deck (which represents anything but an architectural masterpiece), just about any addition to this banal concrete monolith will be a welcome gesture. Be that as it may, the uniformity of this face of the structure might be deemed a virtue as it pertains to the endeavor of vertical gardening. There are no windows, no doors, no architectural coping. It is quite literally a gigantic concrete wall and, in this respect, may also be considered a slam dunk from an applicational standpoint.

Perhaps the greatest issue present is the enormity of the surface itself. Figure 5.35 displays the overall dimensions of the façade and – as photographs suggest (figure 5.36) – with a vertical area approaching 11,000 square feet, it is an undeniably massive expanse of nothing. Fortunately, along the entire lower course of this wall there is a narrow gap between the structure and the low-lying building (figure 5.37) adjacent that, serves little purpose at the present. Currently, there is a depression in the ground that seems to have become a dumping ground for construction debris and garbage deposited by wind and callous acts of littering. This unknown, unmanaged and unused strip of earth might easily by filled in with a proper planting soil – if it is not already present beneath the detritus – to provide

Figure 5.36. View of western facade of College Avenue Parking Deck from Washington Street
(Photograph by Nicholas Petty)

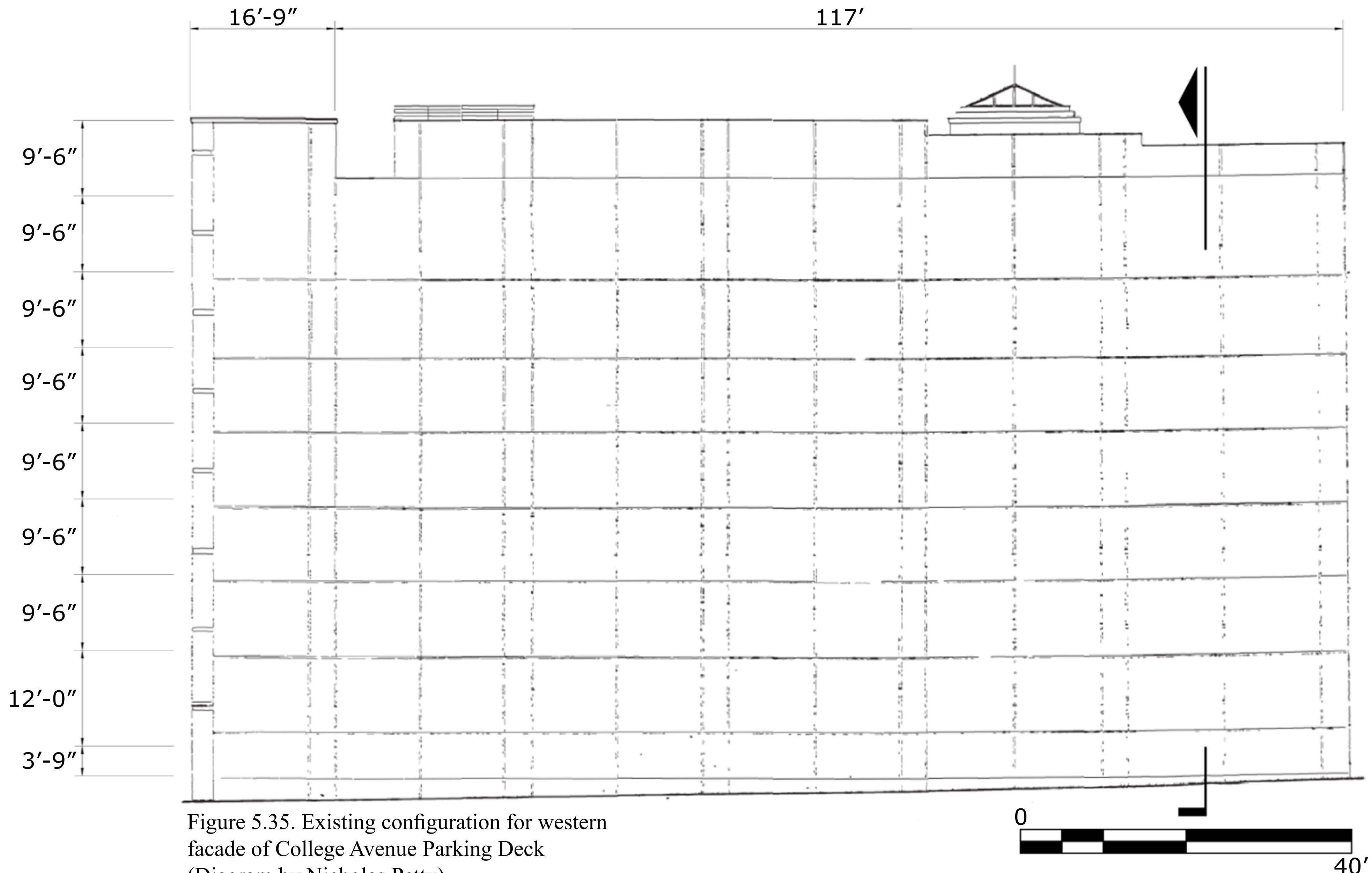


Figure 5.35. Existing configuration for western facade of College Avenue Parking Deck (Diagram by Nicholas Petty)

Figure 5.37. Alleyway between western facade of College Avenue Parking Deck and adjacent building as seen from roof (Photograph by Nicholas Petty)

natural purchase for climbing plants. Ideally, those plants installed would be of a large and vigorous variety and could be inserted in the ground as required to provide both vertical and horizontal coverage along the face of the western wall of the structure.

Providing structural support for vegetation under this scenario will not prove difficult given the current façade conditions. Greenscreen modular trellis panels can be applied about the entire face of the western wall to provide a medium for the dissemination of climbing plants. Figure 5.38 illustrates, in elevation, how this may be accomplished using a simple arrangement of product-specific elements. An interconnected series of 4’ x 10’ Greenscreen modular trellis (A) can be installed to create a continuous trellis surface which can blank the entire side of the facility. Greenscreen mounting clips (B) can be anchored at corresponding intervals via expansion anchors to provide the requisite support for the trellis units. This configuration is demonstrated to greater extent in section view (figure 5.39). The drawing details not only the overall layout of the proposed façade greening scheme, but also the specific support and

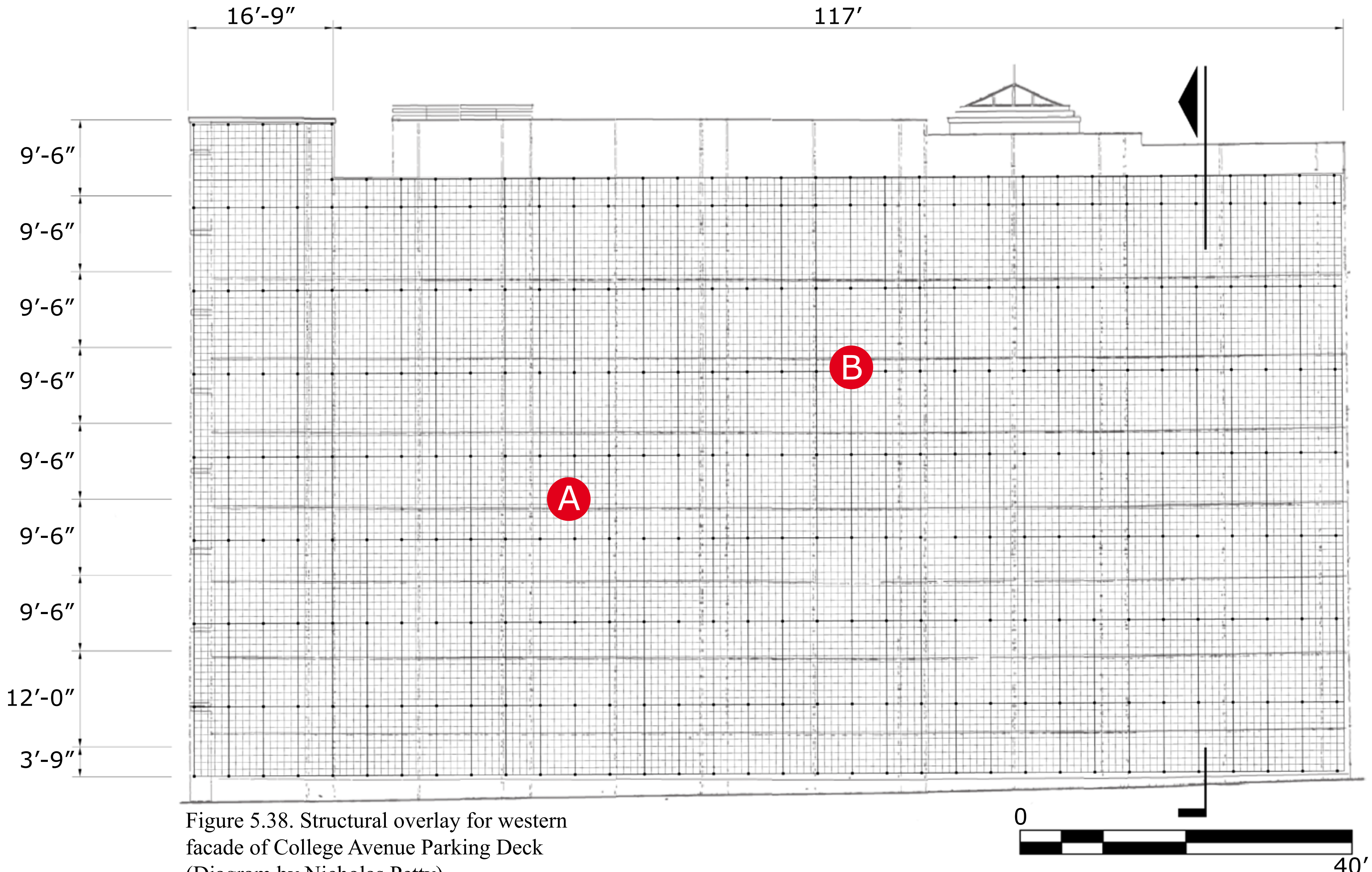


Figure 5.38. Structural overlay for western facade of College Avenue Parking Deck (Diagram by Nicholas Petty)

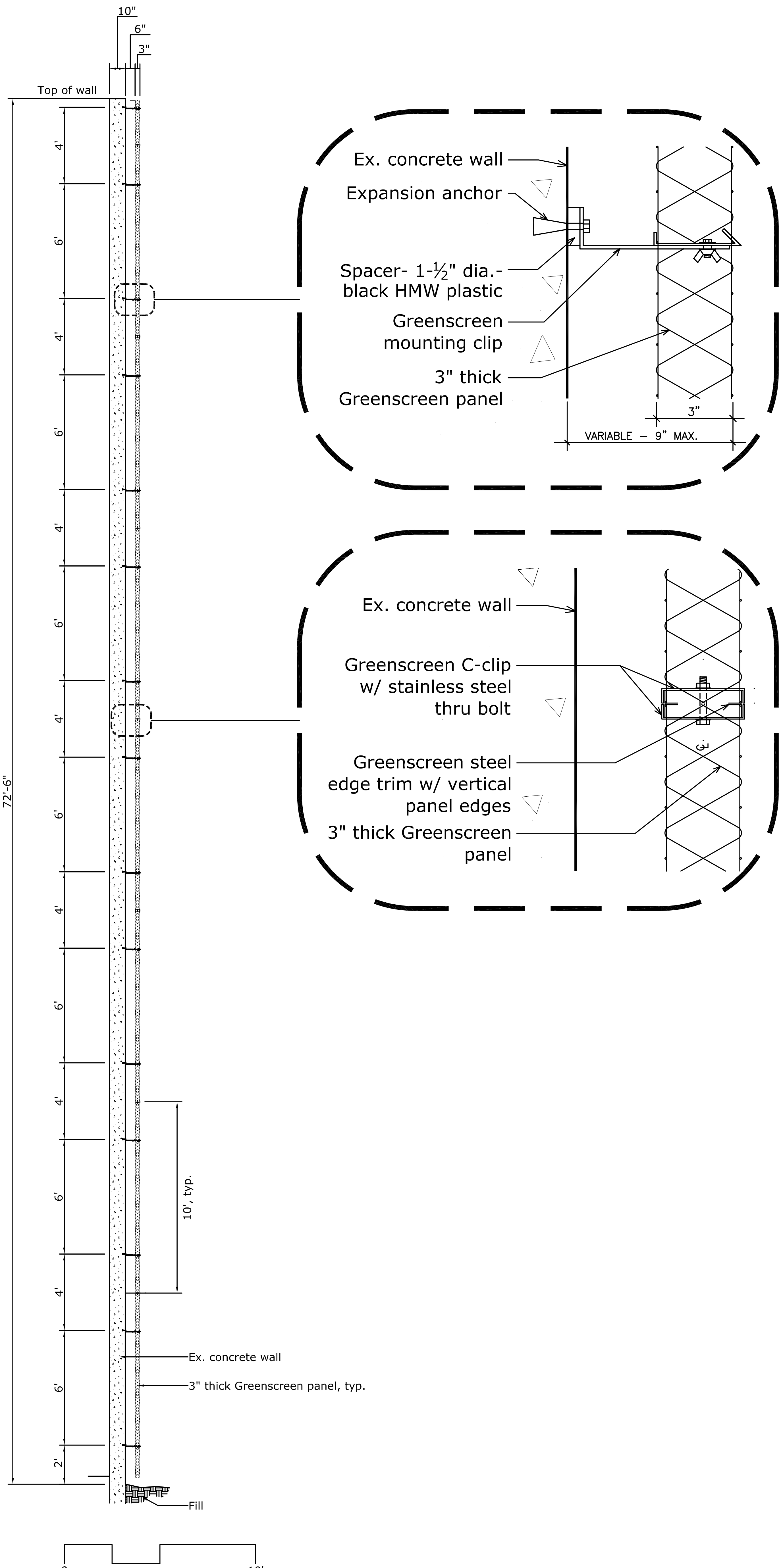


Figure 5.39. Section view of proposed structural additions for western facade of College Avenue Parking Deck (Section by Nicholas Petty)

connection accessories necessary to create the proper framework. Mounting clips will be spaced approximately two feet above and below the lower and upper edges of individual modular trellis units to ensure maximum stability. These adjustable mounting clips also make it possible to offset the 3” deep modular trellis units an additional 6” to allow for a modicum of separation between climbing plants and the adjacent 10” thick concrete wall. While the climatic benefits of this buffer zone inside the structure itself may be diminished by the open layout of the facility, it is reasonable to assume that this may have a positive effect on interior conditions in any case given the scale of this supplementary insulation measure on the western façade.

Earlier in the chapter, there was mention of the in-field connection devices manufactured by Greenscreen for the explicit purpose of providing a secure connection between modular trellis units. Using this approach, it becomes possible to create a single trellis structure from individual sub-units. Because of the size of this configuration, factory-applied assembly cannot be considered an option and so one must rely upon in-field devices, specifically the Greenscreen Flex “C” Ring designed specifically for such purposes. As one can see from the diagram, steel edge trim has been included at both the top and bottom of each individual modular trellis unit. The “C” Ring device essentially holds the steel edge trim in place so that opposite members can be bolted together between units. This enables a stable and secure connection between units that guarantees that the composite grouping of modular trellis elements performs like a unified entity.

Computer-generated renderings (figures 5.40 & 5.41) illustrate how this mature configuration might appear. Given the considerable height of the facility, it is questionable as to whether or not full coverage – from the base of the structure to its uppermost level – might be achieved given the limited number of plants in the region that are capable of ascending to such

Figure 5.41. Photoshop rendering of structural and vegetative additions to western facade of College Avenue Parking Deck (Rendering by Nicholas Petty)

an elevation. Surely, if it were possible, it would nonetheless take a considerable amount of time to achieve such a program. However, from an aesthetic standpoint, this may be an acceptable turn of events. It is unlikely that each plant rooted at the base would grow at a uniform pace relative to others planted along the western wall. The upper boundaries of growth would have a far more irregular form when viewed in comparison with the ordered geometric layout designated by those vertical gardening scenarios proposed for the eastern and northern facades. This contrast would seemingly accentuate the disparity between those facades which face the street and those that do not. Furthermore, the more chaotic appearance of the western wall might put forth an almost graffiti- or mural-like quality that would not be out of place in Athens, GA – where naturalistic scenes or vegetative motifs are often depicted upon wall sections throughout the downtown area. Be that as it may, in order to maximize the environmental benefits of the proposed structural and plant additions to this particular façade, one would hope that climbing plants might one day reach their desired vertical destination and fully obscure and otherwise unattractive aspect of the parking facility.

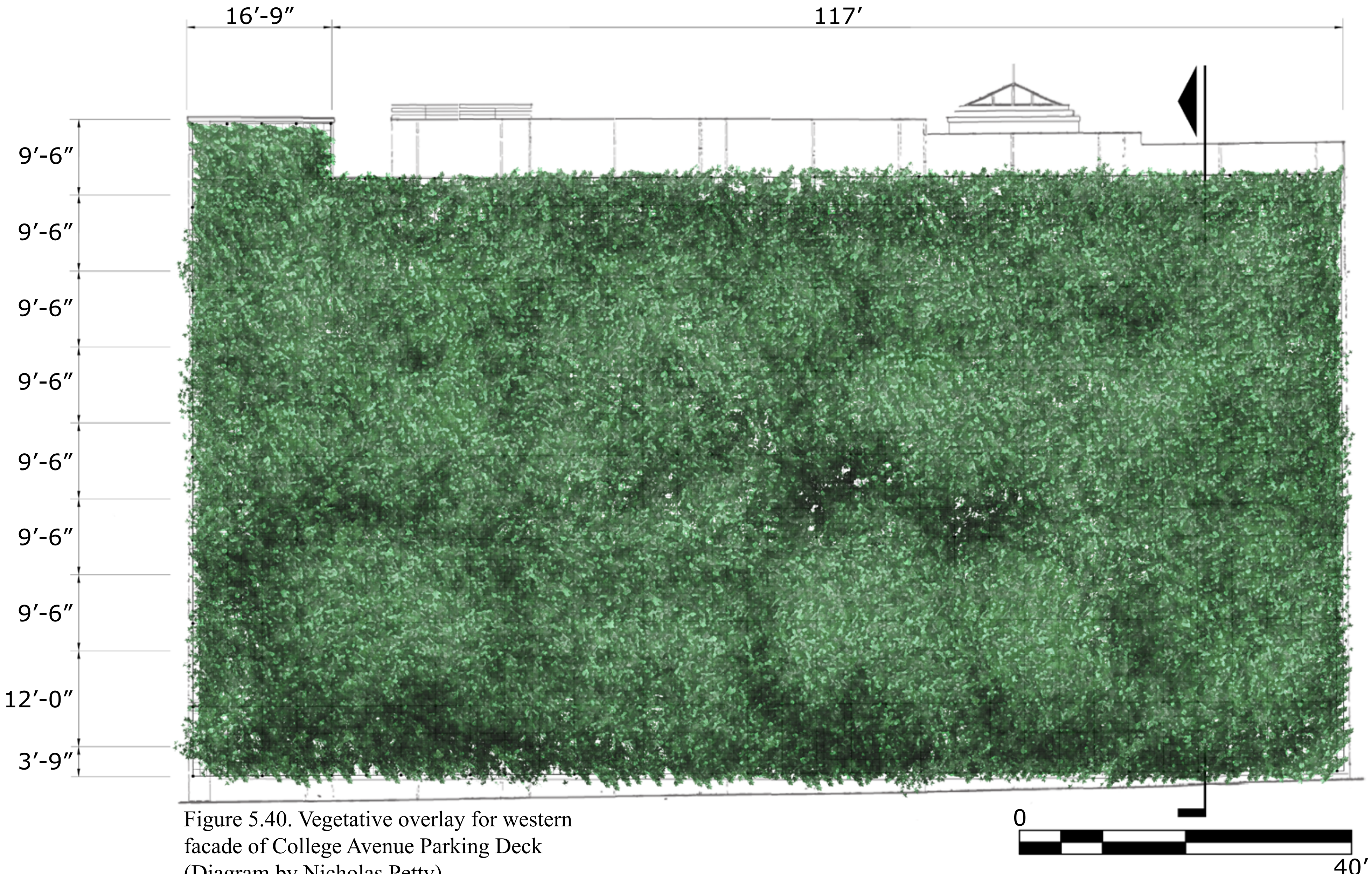


Figure 5.40. Vegetative overlay for western facade of College Avenue Parking Deck (Diagram by Nicholas Petty)

The southern façade of the College Avenue Parking Deck is much like the western façade just mentioned. Those responsible for the project must have concluded that because it backs up against existing structures which partially obscure its featureless aspect, little attention would be required in terms of lending it a proper appearance. In this regard, it may also be a prime candidate for vertical gardening strategies, but the author's search for architectural details for this façade yielded few results that might have directed such a program. Few recommendations can be made at this time beyond those basic strategies implemented on the western facade. Complicating matters are those known variable conditions that appear to be present at this side of the structure alone. Because of neighboring facilities, any façade greening program that might be integrated upon this side of the building would have no access to natural soil for planting at the base of the edifice. Therefore, one might potentially rely upon a series of elevated planters mounted above the roofline of adjoining commercial buildings, but it remains to be seen as to whether or not such a strategy might be successful given the dearth of information available. For this reason, the decision has been made to leave out any vertical gardening recommendations for this section of the parking structure. This will mean that, for the time being, an entire quarter of the structure will remain unvegetated. And though this quarter of the structure is that which is least visible to passersby on the street, it remains that a sizeable level of biomass might still be applied as information becomes available.

Finally, there is the matter of supplying the proper irrigation to all the structures and vegetated additions that have henceforth been proposed. Similar to the North Campus Parking Deck example, there is no reason to doubt that similar rainwater catchment measures might be taken at the College Avenue Parking Deck. Presently, storm drains located on the roof (figure 5.42) are responsible for collecting the water that falls upon this impervious area. It is clear that

Figure 5.42. Storm drain on roof of College Avenue Parking Deck (Photograph by Nicholas Petty)

this water is simply routed to the lower reaches of the facility where it is discharged off-site. By installing a cistern or, perhaps, a series of cisterns at the parking level just below the roof (figure 5.43), it would be possible to capture and store rainwater that could then be distributed amongst the various façade greening features both above and below. For those elements located at roof level, pumping mechanisms would be

Figure 5.43. Proposed cistern addition below roof level at College Avenue Parking Deck (Photoshop Rendering by Nicholas Petty)

necessary to carry water to the upper reaches of the facility. As for providing irrigation to the lower structures, one can hide irrigation lines amongst the cable column arrangements to provide water to the planters below. These drip lines might also diverge where necessary the follow a horizontal course for the purposes of irrigating those elevated planters acting in coordination with the Greenscreen modular trellis panels recommended earlier. With regards to the Western façade – where natural soil is present – one could assume that this area might receive a fair amount of water from rain falling directly into this recess and from roof runoff deposited from the adjacent structure. Therefore, any systematic irrigation efforts would be unnecessary for the most part. Under this proposed strategy, all water requirements might be provided on-site, thereby eliminating the need to provide water from elsewhere and minimizing the amount of water that might have otherwise been discharged off-site.

With the physical components having been described that might be applied to the College Avenue Parking Deck for the purposes of providing both support and elevated planting media for climbing plant species, tabulating the amount of vegetation, in square feet, that such measures will help introduce to the exterior of the structure becomes possible. The eastern façade facing College Avenue possesses a total vertical surface area of approximately 13,000 square feet. This figure may be somewhat misleading in that nearly 4,500 square feet of this area is made up of windows, doors, vehicular entrances, and openings for ventilation – all of which must be considered unsuitable for the implementation of any vertical gardening strategy. Therefore, in terms of available surfaces where vegetation might be integrated, this hypothetical application only had about 8,500 square feet to work with on this particular face of the structure. In either case, the proposed scheme would introduce nearly 6,500 square feet of exterior plant cladding, more than enough to satisfy the stated goal of one-third coverage. Similar figures emerge when analyzing the proposed scheme for the northern façade illustrated in the digital rendering of the facility shown earlier. Using more or less identical structural devices to support vegetative additions, about three quarters of the available surface area of this façade can be greened. As for the western façade, the barren vertical stretch of concrete with no discernable elements of interest, it is hoped that climbing plants might cover the entirety of this wall over time – thereby introducing an additional 11,000 square feet of vegetation – but it may be the case that such a scheme is impossible due to horticultural limitations. In such an instance, further vegetative additions, possibly elevated at the upper reaches of the façade, may be necessary to reach one-hundred percent coverage.

CONCLUSION

Many of the principles of the modern vertical garden are not exclusive to the present. The integration of vegetation and architecture – the organic and the inorganic – epitomizes a time-honored tradition that dates back to some of the earliest civilizations on record. These efforts imply both reverence and an acknowledged usefulness for nature and its bounty. Motivations may be microclimatic, aesthetic, or even metaphorical, but they tend to remain in some form or another across time and across cultures. However, the relationship that this signifies, that which exists between man and the nature from which he has emerged, has nonetheless endured countless shifts over the corresponding time span, particularly with regards to the all-important notion of control. For over a half-millennium, a distinctly Western philosophy towards nature – one which suggests man's dominion over all that is before him – has come to dominate a correspondingly global consciousness with decidedly mixed results. On one hand, this confidence in control and the ability to do so have engendered innumerable triumphs and advances that have consequently improved the quality of life and of experience for humans. On the other hand, drunk on his own achievements, man's controlling aspect has oftentimes mutated into a type of hubris that now threatens to undo many of his previous accomplishments.

Vertical gardening represents one design effort that may be able to harness certain inherent processes of nature for the benefit of mankind and the larger environment within which it is but a single actor. Current endeavors have been enabled by recent advances in horticultural understanding and building technologies that allow for greater possibilities than ever before.

The timeliness of this development is fortuitous. Concerns have never been greater with regards to the harmful effects of automobile exhaust and other gaseous pollutants upon the atmosphere and the interrelated absence of an appropriate plant presence in population centers where large-scale development and industry are present. In reference to this latter concern, it might be concluded that while vertical gardening strategies can be introduced most anywhere, the greatest potential benefits of their implementation might be realized in the urban environment. The rise of the urban center has been necessarily (and unfortunately) preceded by massive clearing efforts that have stripped much of the landscape of its native vegetative cover. In doing so, the machines of progress have deprived these areas of vital ecological services while simultaneously creating a homogeneous landscape of concrete and steel offering little in return beyond material considerations. And while attempts are currently underway to reintroduce vegetation on the ground, available land is often scarce – if it is, in fact, available at all – thereby restricting the viability and efficiency of such an approach. However, where space is at a premium there is often a tendency to build upwards rather than outwards, and here one can identify a new frontier for the reintroduction of vegetation in regions where it might have otherwise proved impossible: the realm of the vertical.

Without relying on any mathematical figures, it reasons to conclude that, in an average city, there is potentially more vertical surface area generated by the sides of structures than may exist on the ground itself. At the North Campus Parking Deck, the vertical-to-horizontal surface area ratio was approximately 1.2:1. However, this is an enormously long structure of unique scale and cannot be considered a prototype for future construction. More likely, structures will assume proportions more akin to those of the College Avenue Parking Deck where this ratio is closer to 3:1. Were to swath the majority of building façades in vegetation, one might be able to introduce a substantial amount of biomass approaching – or even exceeding – that which had been displaced by initial clearing and construction.

The decision as to whether or not to pursue such an approach would appear an easy one. From a collective standpoint, the implementation of such strategies can improve air quality and alleviate heat stress generated by absorptive surfaces while simultaneously enhancing the visual quality of the environment in terms of variety and the ameliorative effect of plants upon the psyche. And though there may be some difficulty in quantifying these benefits, it should suffice to say that any introduction of vegetation where it had otherwise been absent will have a positive effect on that environment and those who occupy it.

Nonetheless, some may not be swayed by a plea for the greater good. For those individuals to which the bottom line is most persuasive, one might refer to the numerous economic benefits that may be generated by reducing the energy demand for heating and cooling functions and the various incentives available for green building projects. In either case, it stands that there are few excuses left for designers not to consider the inclusion of vertical gardening elements in most, if not all, projects.

Given the wide assortment of products and methods available, it is presently possible to seamlessly integrate vertical gardening into future architectural layout with considerable ease. If one were cognizant of the necessary elements vital to ensuring a successful vertical gardening endeavor prior to the design process, one could potentially base a design around these features with few constraints. The end result may be of a wildly innovative variety the likes of which have rarely been accomplished; a new type of functional architecture that may reconfigure conceptions of the city to that of a truly living entity.

Although this represents an exciting prospect, new or proposed projects will only comprise a minor portion of the total construction which currently occupies a built environment established – for the most part – prior to the mainstream ascendance of sustainable and ecologically-conscious design philosophies. Therefore, the challenge of introducing vertical gardening measures to the urban environment in the present must become, foremost, an exercise in retrofitting those existing structures that physically occupy the majority of urban centers. In other words, before erecting the buildings of tomorrow, it may be necessary to update the buildings of yesteryear to coincide with future standards. This may be a somewhat more difficult task, by comparison, than that of integrating vegetation in new or yet-to-be-conceived projects where designers may have *carte-blanche*. Retrofitting procedures will be dictated by the layout, infrastructure, and structural integrity of an edifice that was not assembled with such uses in mind. Therefore, one must become intimately familiar with the existing structure before one can even attempt to come up with a viable vertical gardening scheme. This can take a tremendous level of effort – far more than if one were to design vertical gardening features into a new project from the onset – particularly where support additions may compromise public safety if appropriate considerations are ignored.

Furthermore, there is the matter of convincing the involved parties to adopt such strategies in instances where proposed additions may alter present building conditions. Many potential clients will have become accustomed or attached to their existing façade appearance and performance and may initially decide to leave “well enough” alone when reviewing the unavoidable costs and potential redundancy of installing a secondary façade. For it is the case that while the appeal for vertical gardening may be made upon ecological, aesthetic, and economic grounds; vertical gardens are by no means required upon extant structures. Even in the instance of the Seattle Green Factor described in Chapter 3, vertical gardening additions represent a single action, among many, that new business owners *might* take to meet the minimum standards set forth by the ordinance. However, as one may recall, the implementation of such an approach does grant the maximum score towards meeting official criteria and, in this sense, one can identify the value already attributed to this practice by forward-thinking legislators.

With regards to vertical gardening measures as they pertain to extant parking structures, it has already been conceded that certain benefits attributed to vertical gardening applications elsewhere – particularly those associated with structural insulation – may be moderated by the necessarily open quality characteristic of facilities requiring proper ventilation and natural lighting. While this appears to be an unavoidable facet of such an undertaking (much like parking structures themselves appear to be an inescapable reality of the urban parking solution), given the general scale of parking structures and the high volume of automobiles in operation and at rest within, vertical gardening efforts can improve the impacts of this arrangement. At both the North Campus Parking Deck and the College Avenue Parking Deck, the design strategies put forward were able to vegetate somewhere between one-third and one-half of each vertical surface suitable for application. These measures may not alter the negative output of each facility by an analogous percentage, but if one understands the implications of introducing any type of vegetation under such circumstances, one would have to conclude that the additions to each structure would be beneficial from a variety of standpoints. This might include a potential decrease in concentrated CO_2 levels and ambient temperatures, better air quality, the creation of new urban habitats for birds and invertebrate species, decreased stormwater runoff (because of catchment systems installed for irrigation) and a heightened degree of visual interest.

However, the reader must note the use of the term "potential" in considering the aforementioned list. For it is the case that many of the advantages of vertical gardening have yet to be quantified to the degree necessary to make an outstanding and undeniable case for such measures – the type of information that might be most influential when pitching these types of project to clients. Because vertical gardening schemes have not been propagated over large areas (i.e. an entire block, neighborhood, etc.) where a cumulative effect might be observable, it may be difficult to gauge the success of isolated projects. Any recorded effects might be so minor in the context of the overall environment that the quantitative results may remain unidentifiable or inconclusive. So while this thesis has shown how vertical gardening schemes might be accomplished, it remains to be seen what the net result of such efforts might be. Much of the argument in favor of such endeavors remains intuitive in nature, but in the coming years, more hard scientific data will emerge to cement the case for vertical gardening measures and the benefits that might be accrued through implementation.

For the time being, one might have to rely upon an appeal to public perception. Among the most remarkable features of any vertical gardening project are its high degree of visibility and the unfamiliar visual qualities generated by such an undertaking. To the citizen concerned with ecological and environmental matters, the vertical gardening strategies proposed in the previous applications at the North Campus Parking Deck and the College Avenue Parking Deck clearly look the part of a responsible and worthwhile endeavor. One issue with certain "eco-friendly" projects, green roofs being a prime example, is that many individuals are not aware of their presence and, even when they are, these projects do not seem particularly tangible. For the layperson, becoming excited about a given project and its attendant significance may prove difficult if he or she cannot experience it firsthand. The vertical garden can confront the viewer directly and, in this sense, may serve as a transmission device for a much broader ethos that many cities, business, and individuals are hoping to cultivate. For the town of Athens, GA or the University of Georgia, the striking vegetated appearance of either facility would announce the intentions of the associated municipality or institution to a more pronounced degree than might be accomplished through those efforts that often require explanation or specific knowledge prior. For some, this may come off as a somewhat superficial approach, but it remains that perception is critical in fostering new public attitudes towards “green” projects if they are to gain widespread support.

Turning to the physical projects discussed in Chapter 5 – the primary subjects of this exploration – although the each scenario might be considered a hypothetically productive and successful scheme, certain issues remain which require further consideration. In both cases, the design was limited by the number of options available under existing conditions. In the case of the North Campus Parking Deck, only a limited area was available for anchoring additional structural members on the facility. This created a very strained arrangement because of the offset necessary to deliver support structures beyond the aluminum grillework. The further one stations load bearing structures from the wall, the necessary support for that structure increases dramatically and greater strain is placed upon that vertical surface upon which it is anchored. Mounting anything akin to an elevated planter upon the existing framework of the structure to ensure full and expedient coverage at the upper reaches of the parking deck – some seventy feet above ground level, in certain cases – was not an available option. With that being the case, the design had to rely upon the growth of climbing plants alone. Ideally, one would like to believe the testimony of plant guides that suggest that such heights can be achieved, but it remains that plants can be very unpredictable from region-to-region and even from town-to-town. As one may recall, what works in Atlanta may not work in Athens. In such instances, a horticultural understanding of precisely what works where and to what extent becomes critical.

Owing to the relatively new demands of façade greening, one can only speculate upon the viability of a plant species as these strategies have rarely been attempted in such grand proportion. Of course, there are examples that would suggest that a certain climber can reach a certain height, but the question is: can one guarantee that it will? One might assume a "you never know until you try" attitude but, given the efforts necessary to coordinate the structural support for this type of endeavor, it would be wise to know the end result prior to giving the green light. Façade greening efforts may need to be carried out at a small scale (where results can be ensured) for the time being while the limitations and unforeseen properties of various species – both good and bad – are determined under the guidelines of this approach.

As it stands, climbing plants may represent a somewhat neglected region of horticultural understanding, particularly as the issue pertains to this revised modern use. Clearly, the body of useful horticultural information needs to be expanded at a general level while simultaneously specialized and catalogued for use under the most specific conditions. The University of Georgia, given its distinguished work in the fields of horticulture and other branches of the natural sciences, is in a unique position to organize this knowledge at a statewide level in coordination with satellite campuses and allied institutions. Doing so can ensure the success of future façade greening programs which, as it is the author's hope, will be numerous in the coming decades.

With regards to selecting the methods by which vertical gardening strategies might be achieved at the North Campus Parking Deck and the College Avenue Parking Deck, the living wall method was rarely relied upon for these purposes. Between the two methods, the living wall approach is a more cutting-edge and newsworthy by extension; the product of enhanced botanical understanding and inventive material configurations epitomized by the work of Patrick Blanc and others. These projects tend to grab a majority of the headlines when compared to a façade greening approach that may often be viewed publicly as a minor act of growing vines on a building – a scene which might be witnessed almost anywhere. To be sure, the work of Msr. Blanc makes use of literally hundreds of plants laid out vertically as one might otherwise plan a garden on the ground. Façade greening relies on isolated plantings of climbing species and essentially creates a small monocultural arrangement. However, if one were to use a variety of climbing species to cover individual vegetative support sections – thus creating a series of patches, so to speak – a greater degree of diversity will be present when considered as a whole. Compositionally speaking, one might consider this in a manner similar to the 19th century gardening debates over the practice of "bedding out," as was the practice in certain botanical or scientific gardens, versus the more natural and informal approach championed by Gertrude Jekyll and others. Just the same, when one views the Wonderwall or G-Sky Green Wall compositions, there is often a limited natural appearance to these compositions. Plants are set in uniform geometric positions and appear almost crop or carpet-like in some cases. No, discussions of formal and informal qualities may not be appropriate for these are stylistic decisions where designers might have taken any course and decided upon one. In vertical gardening schemes – particularly on extant structures – the designer is limited firstly by the form of the façade, then by the uniform shape of standardized support and planting units, and then by the habits of the plants themselves. So while, for instance, a series of living wall systems might have been applied in place of the elevated Greenscreen modular trellis/planter units on the eastern and northern facades of the College Avenue Parking Deck, design-wise one would still be left with a more or less rectangular configuration using G-Sky Living Wall Panels – which can only be applied in standard 1’ x 1’ units.

This brings the discussion to the topic of maintenance, which has only been briefly discussed in previous chapters. Living wall systems were eschewed in the College Avenue example because, under the proposed scheme, one would be dealing with a series of individual systems rather than a single unit. Most living wall systems tend to be implemented *en masse* as a continuous arrangement; one that is much easier to install and maintain with regards to the numerous structural and irrigation mechanisms that are required under such a setup. In the case of the College Avenue Parking Deck, a series of living wall systems – potentially elevated some thirty to sixty feet above ground level – might present serious technical concerns if wall panels or irrigation devices were to fail given the number of elements present with the potential to do so. Furthermore, because these systems are flush with the wall, maintenance access might only by available through death-defying feats.

Moving away from this specific example for a moment, regardless of the approach selected, vertical *gardening* does imply constant care. None of these methods are of a “set it and forget it” variety. While, in most cases, a properly installed living wall or façade greening scheme may only require twice-annual maintenance for the purposes of pruning and minor structural adjustments, this is clearly not your average undertaking. The heights to which vertical gardening projects may potentially ascend dictates that widespread implementation of such strategies may breed a new type of gardener, one who will conduct their work suspended several stories above the ground. This will demand extensive safety procedures and a high degree of skill, both aspects of which would certainly command higher wages, labor-wise, than the average landscaping crew.

The overall costs of implementing the proposed vertical gardening schemes exhibited in Chapter 5 was beyond the scope of this thesis. To restate a critical point: this type of endeavor would never be undertaken without enlisting a diverse and long list of professional collaborators. No single discipline currently possesses the comprehensive understanding of the subject that would be necessary to go it alone. Architects and engineers can lack the required horticultural knowledge or ability to design with plants while those who do understand these principles may possess deficiencies with regards to structural matters. In this ideal sense, the practice of vertical gardening – an inextricable conglomerate of both landscape and architecture – appears to bridge the gap with relative ease between closely-linked disciplines that are often wont to consider themselves both disparate and distinct from one another.

The author's sincere hope is that, for the reader who might be picking up this thesis in five or ten years, the majority of the information supplied here with regards to vertical gardening will be universally familiar. Such a development would imply the prevalent propagation of a set of tactics that are both viable and necessary in the modern reconception of the built environment. It may also be the case that some of the approaches here described may be found out of date or obsolete. This is to be expected, and even embraced. Vertical gardening is truly in its nascent stage and, like all new endeavors of this sort, future revelations in scientific understanding and building technologies will undoubtedly push designers and builders beyond their current capabilities. These advances will generate new and innovative methods and products that will make today's methods seem rudimentary by comparison. However, under the current trends of repopulation and revitalization in urban centers, the coincident reintegration of vegetation will continue to be a challenge of the utmost concern and, from this standpoint, it can truly be said that vertical is the new horizon.

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APPENDIX A

VINES IN GEORGIA

University of Georgia Extension Service Departmental Fact Sheet

THE UNIVERSITY OF GEORGIA
COOPERATIVE EXTENSION
Colleges of Agricultural and Environmental Sciences & Family and Consumer Sciences

Vines in Georgia

Timely Horticulture Tips **Departmental Fact Sheet H-00-052**

Robert R. Westerfield and Gary L. Wade, Extension Horticulturists
Carolyn R. Hawkins, Clayton County Master Gardener

Vines are among the most versatile plants in the landscape. Most people associate vines with arbors or trellises, but they can also be used to screen unsightly views, to provide privacy on patios, to lend character to a stone, brick or stucco wall, to break up the monotony of a long chain link fence, to accent or soften the architectural details of a building, or as a ground cover where turfgrass is either undesirable or will not grow.

Landscape architects sometime use vines on trees to provide a new dimension to the tree canopy. An oak tree bearing bright-orange flowers of Cross Vine, for instance, is sure to create a conversation piece in the landscape. Some vines, like Bougainvillea or Allamanda, are excellent for use in patio pots or hanging baskets. Moonvine adds a wonderful fragrance with an evening bloom. Honeysuckle and Trumpet Creeper are prized for their flowers, while other vines, like Five-leaf Akebia, Climbing Fig and Ivy, are grown for their foliage. Wisteria is sometimes trained as a single-standing specimen or small tree in the landscape.

Selecting Vines

When selecting vines, there are a number of factors to consider, including their intended use, location in the landscape (ie., sun vs. shade), soil adaptability, type of support needed and color of bloom or foliage characteristics. In addition, you also need to consider the maintenance requirement. Will the vine need constant pruning to keep it within bounds? Certain fast-growing vines, such as wisteria and common honeysuckle, require a great deal of routine pruning. If allowed to spread without restraint, their profuse growth can cover trees and shrubs, reducing light and aeration within the canopy. Kudzu is an excellent example of this. Some vines can even injure or kill small trees by wrapping around them and cutting off nutrient flow. Other vines, like Autumn Flowering Clematis, will disperse its seeds after flowering and may pop up in areas where they are not wanted.

Another important consideration is the amount of training a vine requires. Some vines cling and climb naturally while others must be trained to follow the supporting wire, pole or other structure. Therefore, the type of structure on which you intend to grow vines will influence the type of vine you choose.

Annual vines are very popular, such as Moonvine (*Ipomoea alba*), Black-eyed Susan Vine (*Thunbergia alata*), Sweet Pea (*Lathyrus odorata*), Purple Hyacinth Bean (*Doliches lablab*) and Morning Glory (*Ipomoea* spp.). Annual vines are grown from seed each year. Perennial vines persist from year to year. Foliage may die back in winter and re-sprout in spring.

Perennial vine favorites include Trumpetcreeper (*Campsis* spp.), Carolina Yellow Jessamine (*Gelsemium sempervirens*) and Clematis (*Clematis hybrida*). See the table at the end of this publication for a listing of favorite vines and their characteristics.

Types of Climbing Vines

Most vines, except those grown as groundcovers or in pots, require some type of support to grow. Climbing vines can be separated into three basic types: *clinging, twining and winding.*

Clinging vines grasp onto a rough surface by means of rootlets or adhesive disks. Climbing Fig *(Ficus pumila),* Confederate Jasmine *(Trachelospermum jasminoides),* Virginia Creeper *(Pathenocissus quinquefolia)* and Trumpet Creeper *(Campsis radicans)* are examples of clingers. These types of vines are often used to cover solid surfaces, such as walls and fences. However, clinging vines may loosen mortar between bricks over time and are difficult to remove once they become anchored. Their methods of climbing also can damage wood by clinging too closely, preventing good air circulation and promoting wood decay. Therefore, clinging vines are best suited for trellises or arbors away from solid surfaces.

Twining vines climb by encircling upright supports, such as poles, wires and lattice. These vines require mechanical training to follow a support. Examples are Mandevilla *(Mandevilla splendens),* Wisteria *(Wisteria sinensis),* Carolina Jessamine *(Gelsemium sempervirens)* and Morning Glory *Ipomoea* spp.)(

Winding vines climb by means of tendrils; slim, flexible, leafless stems that wrap around anything they contact. One of the best known examples of this type of vine is the Muscadine Grape. Ornamental vines that fall into this category include Maypop (*Passiflora* spp.), Trumpet Honeysuckle (*Lonicera sempervirens*), Clematis (*Clematis hybrida*) and Cross Vine (*Bignonia capreolata*).

Location in the Landscape

Most flowering vines require at least one-half day of sun to be vigorous and bloom abundantly. Other vines, like variegated English ivy, will develop more vivid leaf patterns when provided a few hours of morning sun.

Vine Supports

Twining and winding-type vines are supported best on wires, lattice, trellises and arbors. They need some type of support to help them along when grown on a flat surface.

It is recommended that vine supports be constructed from sturdy, durable materials. Always use treated lumber for outdoor structures. Redwood, cedar and cypress are particularly durable in the outdoor environment. A wood preservative/water seal applied after construction will also help prolong the life of the structure. Wrought iron also makes an excellent support. Use aluminum or copper wire to attach plants because it is resistant to rusting.

Planting

Most vines grow best in fertile, well-drained soils. Bare-root vines are best transplanted during the fall and winter months, while container-grown vines can be planted any time of year, provided irrigation is available.

If you determine that organic matter is needed to improve the soil, incorporate it into the top 12 inches of soil with roto-tilling before you dig the planting hole. Compost is an excellent organic amendment.

Dig the planting hole two times wider than the root ball and to the depth of the root ball. Make certain the top of the root ball is level with the soil surface, then backfill with soil removed from the hole, tamping it lightly to eliminate air pockets. Water immediately after planting, and use a mulch on the soil surface to keep moisture in the soil.

An economical way to plant a large number of vines as a groundcover is by purchasing and planting rooted cuttings or “liner” plants. Ask your local nurseryman about the availability of liners.

Fertilization

If you plant during fall and winter, wait until spring to fertilize. If you plant in the spring and summer, wait four to six weeks for the plants to get established before fertilizing. Then apply a light sprinkling (about a tablespoon) of a complete balanced fertilizer, such as 8-8-8 or 10-10-10 around the perimeter of the planting hole and water it in.

Once the vines are established, fertilize in early spring and mid-summer with a complete fertilizer, such as 6-12-12 or 5-10-10 at a rate of $1^1/_2$ lb. per 100 sq. ft. A soil sample taken to your local county extension office for analysis can help you determine your soils precise nutritional needs.

Pruning

Vines have different pruning requirements. Generally pruning is done to remove dead, diseased and damaged wood, to reduce size and to promote branching. Vigorous vines, such as Honeysuckle, Trumpet Vine and Wisteria may require regular pruning to keep them confined to the support.

As a general rule, flowering vines should be pruned after they bloom. This is particularly true for vines like wisteria and spring-flowering clematis that bloom on previous season's growth. Pruning these vines before they bloom will reduce flowering.

The amount of pruning depends on the vigor of the vine and the amount of foliage you desire. Some vines will form layer upon layer of growth unless they are thinned out regularly. Wisteria, for instance, requires annual pruning to reduce the amount of vegetative growth. Removing approximately $^1/_3$ of the canopy of wisteria each year will encourage the production of short spurs on the remaining branches which will bear next season's flowers.

Propagation

Most annual vines are propagated from seed**.** Perennial vines are often propagated from cuttings, vegetative division or layering. A discussion of the techniques for propagating each vine species is beyond the scope of this publication. A good plant book will provide specific recommendations.

Perennial Vines

Botanical Name/ Common Name	Flower Color	Season of Bloom	Leaf Type[1]	Light Requirement	Climbing Habit [2]	Landscape Use[3]				Remarks
						A	F	T	W	
Akebia quinata/ Five-leaf akebia	purple/ brown	Spring	E	full sun/ partial shade	T	X	X	X		Very attractive foliage. Prized for its foliage. Flower is not showy. A variegated form is available in the trade.
Bignonia capreolata/ Cross Vine	red/ yellow	Spring	E	full sun/ partial shade	T, C	X	X	X	X	Prefers acid soil. Tolerates moist and dry soils. Flowers visited by hummingbirds; foliage browsed by deer.
Bougainvillea spp./ cultivars Bougainvillea	wide range magenta to white/orange/ yellow	Summer	E	full sun/ partial shade	C	X	X	X		Grow as container plants in N. Ga. Perennial in S. Ga. Can be trained as a shrub. Thorns.
Campsis spp./ cultivars Trumpetcreeper	orange/red/ coral	Summer	D	full sun	C	X	X	X		Very vigorous. Several nice cultivars, such as 'Madame Galen.' Native of Eastern United States. May require support
Clematis hybrida Large Flowered Clematis	many	Spring	D	full sun/ partial shade	T	X	X	X		One of the most popular vines. Can be used effectively on trellises, arbors or mailboxes; but also can be used as a groundcover to trail over rocks and stone walls.
Gelsemium sempervirens Carolina Jessamine, Poor Man's Rope	yellow	Spring	E	full sun/ partial shade	T	X	X	X		Attracts hummingbirds and butterflies. A hybrid called 'Rankanii' blooms both spring and fall.
Lonicera sempervirens Trumpet Honeysuckle	orange/red/ yellow	Spring	D	full sun	W, T	X	X	X		Several outstanding cultivars are in the trade, including 'Alabama Crimson,' 'Magnifica,' 'Leo' and 'Sulphurea.'
Parthenocissus quinquefolia Virginia Creeper	insignificant		D	full sun	C	X	X	X		Vigorous vine with five leaflets. Fiery red color in fall. Birds love the berries. Regular pruning required to keep in bounds.
Parthenocissus tricuspidata Boston Ivy	insignificant		D	full sun	C	X	X	X		Glossy green leaves shaped like maple leaves, with three leaflets; blue-green berries enjoyed by birds. Brilliant red color in the fall is the outstanding feature.
Passiflora incarnata Passion Vine; Maypop	many colors red/pink/ purple/white, etc.	Summer	D	full sun	C	X	X	X	X	Can be grown as a container plant. Very vigorous. Many new cultivars are not hardy outdoors and should be grown in containers.
Polygonum aubertii Silver Lace Vine (Fleecevine)	pinkish-white panicles	Summer	D	full sun	T	X	X	X	X	Good salt tolerance for use in coastal areas. Tolerates poor soil. A Chinese introduction.
Rosa banksiae Lady Banks' Rose	white/yellow slightly fragrant	Spring	D	full sun	W	X	X	X		No thorns. Double and single flower forms. Requires support. Exfoliating bark with age.
Schizophragma hydrangeoides Japanese Hydrangea-vine	white flat-topped inflorescence	Summer	D	partial shade	C	X	X	X		Not quite as vigorous as *H. petiolaris.* Slow grower. Bark exfoliates with age. Cultivar 'Moonlight' is popular.
Trachelospermum jasminoides Confederate Jasmine	white	Spring/ Summer	E	partial shade	T	X	X	X		Hardy vine that can serve as a climber or ground cover. Fragrant blooms open from May to June.

[1]Leaf Type: E = Evergreen, D = Deciduous
[2]Climbing Habit: T = Twining, C = Clinging, W = Winding
[3]Landscape Use: A = Arbors, F = Fences, T = Trellises, W = Walls

Annual Vines

Botanical Name/Common Name	Flower Color	Leaf Type	Light Requirement	Remarks
Cardiospermum halicacabum Love-in-a-Puff	small white flowers, green seed pods	delicate lobed	full sun to partial shade	Green papery seed pods are the most attractive feature. Each pod contains three seeds with heart-shaped markings.
Doliches lablab Purple Hyacinth Bean	purple blossom spikes followed by purple bean pods	purplish-green	full sun	A large vine, easy to grow. Can grow in poor soil. Edible beans.
Ipomoea alba Moonvine	large white flowers open in the evening and last through the night	green heart-shaped	full sun	Prefers well-drained soil. Soak seeds overnight and nick seed coat before planting.
Ipomoea batatas Ornamental Sweet Potato Vine	grown for its foliage	deep dark purple lobe-shaped leaves	full sun	A striking contrast in any garden. Also attractive in hanging baskets. Two popular cultivars are 'Blackie' with burgundy foliage and 'Marguarite' with chartreuse foliage. No flowers.
Ipomoea purpurea Morning Glory	4- to 5-inch flowers in white, blue or red	olive-colored, heart-shaped or lobed	full sun	Soak seeds overnight and nick them before planting. Drought tolerant.
Ipomoea quamoclit X *multifida* Cypressvine (Cardinal Vine)	small brilliant red flowers	fern-type foliage	full sun to partial shade	Soak and nick the seeds before planting. Great attractor for humming-birds and butterflies. Very vigorous and fast-growing.
Mandevilla splendens Mandevilla	pink funnel-shaped flowers	leathery, dark green	full sun or partial shade	Tropical vine can be overwintered indoors.
Mina lobata Firecracker Vine or Crimson Star Glory	scarlet/yellow/orange; scarlet buds open to cream and orange	three-lobed	full sun to partial shade	Vigorous climbing vine from Mexico.
Phaseolus coccineus Scarlet Runner Bean	brilliant red	lobed; arrow-shaped	full sun to partial shade	Pods are edible when young, or wait to use as shelled beans.
Thunbergia alata Black-eyed Susan	white/buff/orange/yellow with dark eyes	arrow-shaped foliage	full sun	Great for arbors or containers.
Tropaeolum spp. Climbing Nasturtium	orange to yellow to cream; lightly fragrant; edible	roundish; edible	full sun	Commonly used for salads. Tolerates neglect and poor soil. Leaves and flowers are often used in salad to add their peppery flavor.

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J. Scott Angle, Dean and Director

APPENDIX B

AMMENDED LIST OF CLIMBING PERRENIAL PLANTS ADAPTED FROM APPENDIX A

by Nicholas Petty

Perennial Vines

Botanical Name/ Common Name	Flower Color	Season of Bloom	Leaf Type[1]	Light Requirement	Climbing Habit [2]	Landscape Use[3] A	F	T	W	Height*	Remarks
Akebia quinata/ Five-leaf akebia	purple/ brown	Spring	E	full sun/ partial shade	T	X	X	X		20-30' (O)	Very attractive foliage. Prized for its foliage. Flower is not showy. A variegated form is available in the trade.
Bignonia capreolata/ Cross Vine	red/ yellow	Spring	E	full sun/ partial shade	T, C	X	X	X	X	50-60' (H)	Prefers acid soil. Tolerates moist and dry soils. Flowers visited by hummingbirds; foliage browsed by deer.
Bougainvillea spp./ cultivars Bougainvillea	wide range magenta to white/orange/ yellow	Summer	E	full sun/ partial shade	C	X	X	X		20-30' (O)	Grow as container plants in N. Ga. Perennial in S. Ga. Can be trained as a shrub. Thorns.
Campsis spp./ cultivars Trumpetcreeper	orange/red/ coral	Summer	D	full sun	C	X	X	X		30-50' (H)	Very vigorous. Several nice cultivars, such as 'Madame Galen.' Native of Eastern United States. May require support
Clematis hybrida Large Flowered Clematis	many	Spring	D	full sun/ partial shade	T	X	X	X		Varies	One of the most popular vines. Can be used effectively on trellises, arbors or mailboxes; but also can be used as a groundcover to trail over rocks and stone walls.
Gelsemium sempervirens Carolina Jessamine, Poor Man's Rope	yellow	Spring	E	full sun/ partial shade	T	X	X	X		20-35' (O)	Attracts hummingbirds and butterflies. A hybrid called 'Rankanii' blooms both spring and fall.
Lonicera sempervirens Trumpet Honeysuckle	orange/red/ yellow	Spring	D	full sun	W, T	X	X	X		50-60' (O)	Several outstanding cultivars are in the trade, including 'Alabama Crimson,' 'Magnifica,' 'Leo' and 'Sulphurea.'
Parthenocissus quinquefolia Virginia Creeper	insignificant		D	full sun	C	X	X	X		20-50' (H)	Vigorous vine with five leaflets. Fiery red color in fall. Birds love the berries. Regular pruning required to keep in bounds.
Parthenocissus tricuspidata Boston Ivy	insignificant		D	full sun	C	X	X	X		50-60' (O)	Glossy green leaves shaped like maple leaves, with three leaflets; blue-green berries enjoyed by birds. Brilliant red color in the fall is the outstanding feature.
Passiflora incarnata Passion Vine; Maypop	many colors red/pink/ purple/white, etc.	Summer	D	full sun	C	X	X	X	X	60-70' (D)	Can be grown as a container plant. Very vigorous. Many new cultivars are not hardy outdoors and should be grown in containers.
Polygonum aubertii Silver Lace Vine (Fleecevine)	pinkish-white panicles	Summer	D	full sun	T	X	X	X	X	15-20' (O)	Good salt tolerance for use in coastal areas. Tolerates poor soil. A Chinese introduction.
Rosa banksiae Lady Banks' Rose	white/yellow slightly fragrant	Spring	D	full sun	W	X	X	X		20' (O)	No thorns. Double and single flower forms. Requires support. Exfoliating bark with age.
Schizophragma hydrangeoides Japanese Hydrangea-vine	white flat-topped inflorescence	Summer	D	partial shade	C	X	X	X		30-40' (D)	Not quite as vigorous as *H. petiolaris.* Slow grower. Bark exfoliates with age. Cultivar 'Moonlight' is popular.
Trachelospermum jasminoides Confederate Jasmine	white	Spring/ Summer	E	partial shade	T	X	X	X		20-30' (D)	Hardy vine that can serve as a climber or ground cover. Fragrant blooms open from May to June.
*Pueraria lobata** Kudzu Vine	reddish/purple clusters	Summer	D	full sun/ partial shade	T					50-60' (O)	Invasive vine. Not for conventional landscaping purposes. Should be restricted. Propagated by cuttings and underground stems.

[1]Leaf Type: E = Evergreen, D = Deciduous
[2]Climbing Habit: T = Twining, C = Clinging, W = Winding
[3]Landscape Use: A = Arbors, F = Fences, T = Trellises, W = Walls

* **Thesis Author's Note:** Entries for *Pueraria lobata* and height column have been inserted into original document. Heights are recorded as the maximum value found amongst Frances Howard's 1959 *Landscaping With Vines* (H), Neil Odenwald's 2000 *Identification, Selection, and Use of Southern Plants* (O), and Nigel Dunnett and Noel Kingsbury's 2004 *Planting Green Roofs and Living Walls* (D).