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I am submitting herewith a thesis written by Vivian Ann Workman entitled "Mutualism in Architecture: An Architecture of the In-Between." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Architecture, with a major in Architecture.

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MUTUALISM IN ARCHITECTURE:
AN ARCHITECTURE OF THE IN-BETWEEN



A Thesis
Presented for the
Master of Architecture
Degree
The University of Tennessee, Knoxville

Vivian Ann Workman
August 2004

MUTUALISM ---

-Interaction between two different organisms living in close physical association, especially to the advantage of both.

Eco-Tec suggests not the extreme position of being either-or but the fluid process of in-between. Each design solution is a synthesis of a greater amount of knowledge, as well as a reconsideration of the roles played by the architect and the community.

Amerigo Marras. Eco-Tec: Architecture of the In-Between

Abstract

Architecture is a system of complex relationships. Embodied within architecture are ideas concerning built and natural form and how these two types of form interact to produce what we define as architecture. Built form without natural form is building. Natural form without building is landscape. It is this in-between area where architecture lies. Mutualism is a process by which two seemingly opposite organisms interact in such a way as to benefit one another. It is through this approach that architecture can aspire to be more than a building.

Mutualistic architecture, by its very nature, is a holistic system with the whole greater than the sum of its parts. Individual parts alone do not constitute architecture. Architecture emerges when the parts are assembled into a single organism. Examination of both the built form and the natural form must be analyzed and then synthesized to determine how they will interact in a mutualistic and harmonious way. Through the use of mutualism, architecture no longer is an either/or proposal but rather a more inclusive both/and. The series of relationships inherent in mutualistic architecture exist on the site, building and part scale.

Architecture is an inclusive discipline that, if allowed, can result in interesting and unique solutions. Architecture is not built form devoid of its presence of nature. A mutualistic architecture is, by its very definition, an inclusive discipline that allows for diversity and integration. In a symbiotic architecture, the built environment and the non man-made world exist in harmony within an architectural design.

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CHAPTER 1 MUTUALISM

Mutualism is a term borrowed from the life sciences. Mutualism is a type of symbiosis in which both participants benefit from the interaction. Symbiosis is defined as the living together of two or more species in a prolonged and intimate ecological relationship. Symbiosis consists of four types of ecological interactions: mutualism, predation or parasitism, commensalism and amensalism. Predation or parasitism involves one organism benefiting itself while harming the other. Commensalism is when one organism benefits from the interaction without harming the other. Amensalism is where one organism is harmed while the other is unaffected.

Mutualism is a type of symbiosis in which both participants benefit from the association. Other types include parasitism, amensalism and commensalism; the form in which one organism benefits from the other while the other is neither harmed nor benefited.

Symbiosis is a mutually advantageous partnership between two interdependent plant or animal species. ²

Why is mutualism desirable versus the other types of symbiosis?

Mutualism involves both organisms benefiting from the interactions (figures 1 and 2). In nature, an example is a species of wading bird removing parasites from a crocodile's teeth. The bird feeds itself while performing a service for the crocodile. This relationship could easily lapse into one of predation; the crocodile is much stronger than the bird. Yet both benefit from this interaction and neither is harmed. As applied to architecture, the two organisms are the man-made form and the natural. Architecture should be a form of mutualism: both the built form and the natural should benefit through their interactions and not be one of predation. ¹

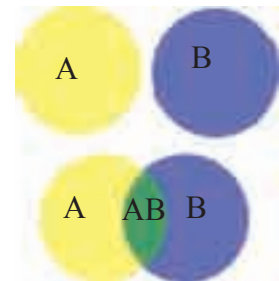


Figure 1. Mutualism between organisms A and B.

1. William Purvis et al. LIFE: The Science of Biology. (Sunderland, Massachusetts: Sinauer Associates, Inc., 1995), G31.

2. Webster's New College Dictionary. (New York: Geddes & Grosset, 2001).

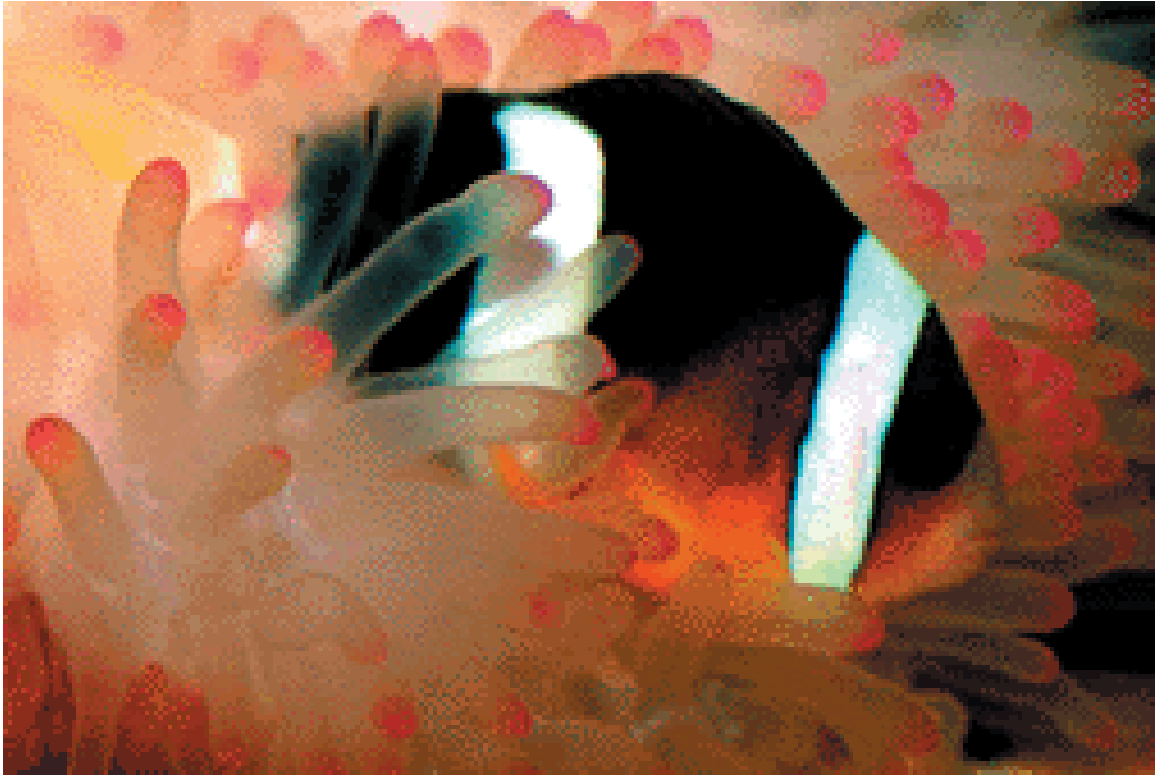


Figure 2. Clown fish in anemone. The anemone provides the fish with food and shelter. In return, the fish acts as a cleaner and protector of the anemone. This mutualistic relationship benefits both and neither is harmed by it.

Why should architecture favor a mutualistic approach instead of another type of symbiotic relationship? It has to do with the other forms of interactive relationship between the parts. Commensalist architecture is undesirable because only one element benefits from the relationship, there is not a positive interaction (figure 3). It is this interaction which gives architecture its power and the absence of this interaction is mere building. An ugly building can be set amidst a beautiful landscape. The building's aesthetic appeal is enhanced while the landscape is unchanged. Architecture should also not be a symbiosis of ammensalism nor one of parasitism; the natural world should not be destroyed or harmed for the propagation of building. This seems to underlie many buildings whether direct or indirect. Direct sources

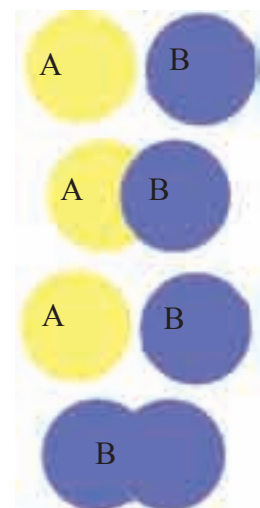


Figure 3. Commensalism and predation between organisms A and B.

include the desecration of the natural landscape (figure 4) of the site (building over a wetland) or indirectly through the usage of non-sustainable or hazardous materials.

If an organism or aggregate of organisms sets to work with a focus on its own survival and thinks that is the way to select its adaptive moves, its 'progress' ends up with a destroyed environment. If the organism ends up destroying its environment, it has in fact destroyed itself.³

A mutualistic architecture seeks to reverse this trend of wanton consumption of non-renewable materials with disregard to the environment. Mutualism and its advocating of the both/and instead of the either/or forces the architect to examine both aspects of architecture and to make a more informed decision that is a mediation between the interests of the two. It may not always be equal but a greater emphasis on the natural than was previously conceived will help to stabilize the current sway of consumption and depletion.

General features of Mutualism:

- Great stability
- Typically generalist and diffuse
- Increased niche breadth
- Occurrence decreases with increased resource availability
- More common in stressful situations



Figure 4. Actions with disregard to nature. The three forces at work here are mountaintop removal for coal, deforestation and clear-cutting of forests. Each of these actions is propagated with little concern for the impact that they will have on the natural environment.

3. Gregory Bateson, "Form, Substance and Difference" www.rawpaint.com/library/bateson/formsubstanceanddifference.html

CHAPTER 2 FORM

Architecture lends itself to the application of ideas of mutualism because it consists of numerous patterns that are in interaction with one another.

The Vitruvian ideal stresses firmness (durability), commodity (utility) and delight (aesthetically pleasing). Added to these three tenants of architecture are built form and natural form. It is felt that built form is separate from the three Vitruvian ideals in that they deal primarily with the end results, the product, while built form is more of a process. Natural form is included because architecture, as built, has a definitive place; a locale. All of these parts interact to form architecture (figure 5). For the purposes of this thesis, mutualism between nature and built form will be explored. It is these two criteria that seem to be in the greatest juxtaposition and afford the greatest possibility for a mutualistic

Architecture consists of numerous patterns . . . mutualism between nature and built form will be explored.

Vitruvian ideals: firmness, commodity and delight.

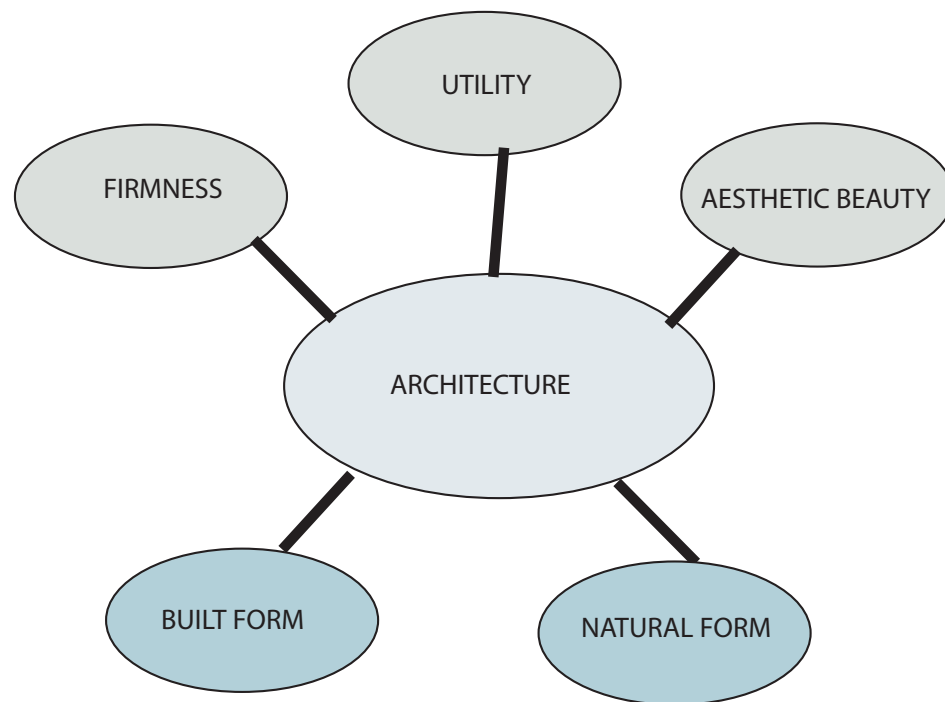


Figure 5. Components of architecture.

approach in architecture.

This thesis investigates the relationship between two types of form: built or man-made and natural or non-man-made form. Form is the principal way in which we process the identity of an object. It is how the characteristics of a space or container are defined. There are many properties that can be used to describe form such as symmetry (figure 6), order (figure 7), geometrical (figure 8), complexity (figure 9), harmony (figure 10) and balance (figure 11). These characteristics serve as the basis for a language of forms.

Built Form

Built form is typically a man-made construction or artifice. It is commonly a geometric expression of volume expressed through the utilization of materials (figure 12). Without the experience of the form, the architecture is inherently incomplete; there is nothing to signify the idea of a man-made mass. Built form should not be the overpowering design principle, however. To do so is to neglect the natural realm and its qualities. Built form conceived without the natural realm is a cold, static building with no dialogue with its surroundings. This type of built form relinquishes the vocabulary that the natural realm can supply it with when it disregards its inclusion.

Built form also includes the usage of processed materials. Man can devise and create a landscape yet it can still be natural form. Built form emerges through the materials used and intentions of the participants. Once a processed material is inserted into this natural landscape, it is

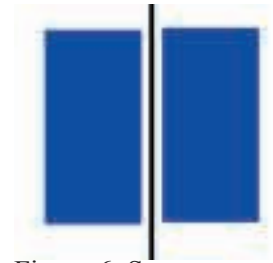


Figure 6. Symmetry.

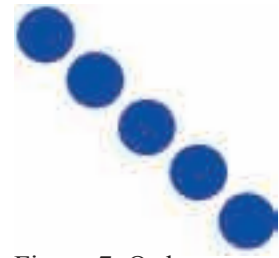


Figure 7. Order..

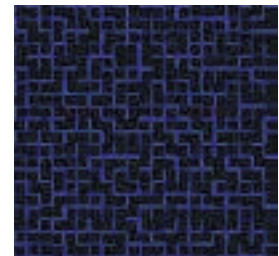


Figure 8. Geometric.



Figure 9. Complexity.



Figure 10. Harmony.

man-made built form.

Natural Form

Nature is the non man-made world around us. Nature is not always chaotic nor always simplistic; it is process and sequence dependant.

Nature can exhibit great complexity due to these processes. Something as simple as a snowflake can exhibit the same order, complexity, symmetry, balance, harmony and geometric precision desired in architecture. Every snowflake is different, there is complexity in their final form (figure 13). Yet they are all based upon a hexagonal shape. They are not chaotic; snowflakes contain a triangular pattern that is repeated twelve times. There is complexity in natural form. Complexity theory explains how complexity in nature leads to greater order in that particular system.

...what you find are the two extremes of order and chaos... But right in between the two extremes, at a kind of abstract phase transition called 'the edge of chaos,' you also find complexity: a class of behaviors in which the components of the system never quite lick into place yet never quite dissolve into turbulence, either. These are the systems that are both stable enough to store information, and yet evanescent enough to transmit it. .⁴

An example of proportion in nature is the nautilus shell (figure 14 and 15). It is a manifestation of the golden mean (figure 16): it reveals the proportional progression that is purported to be the most aesthetically pleasing.

4. Guorgy Doczi. The Power of Limits: Proportional Harmonies in Nature, Art, and Architecture. (Boston, London: Shambhala, 1994), 79.



Figure 11. Balance.

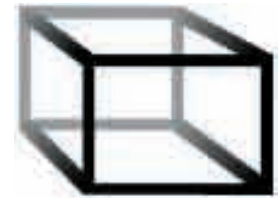


Figure 12. Cube. Is it a space or a container of space?



Figure 13. Snowflake.



Figure 14. Nautilus shell.



Figure 15. Cross-section.

Mutualistic Form

What form should this new mutualistic architecture assume? It should not be a specific “style” but rather a form that emerges from a series of processes. By refusing the notion of a fixed “style,” mutualistic architecture is free to concern itself with the greater issues of how the patterns of natural and built form interact. Form is an emergent quality and beauty will result from the synthesis of the condition and the resultant ideas. Beauty is not merely visual delight; it is more than this superficial definition. The beauty of mutualistic architecture is the result of the system that is expressed. Mutualistic architecture will not have the same look at all locations; it cannot be the same and include the unique forces at work in a particular location.

Mutualistic architecture embraces complexity. It cannot be a simple system because there are too many processes at work and to call it a simple system is to ignore this (figure 17). It is because of this complexity that mutualistic architecture is in a unique position to reestablish the natural presence and its non-man made physical characteristics in the built urban landscape and establish a sense of harmony between the two. In this era when the effects of our actions on the natural world are becoming increasingly evident, it is necessary for architecture to embrace the complexity, diversity and uniqueness that exists between built and natural form.

Examine Sverre Fehn’s Ivar Aasen Center of Language and Culture located in Orsta, Norway (figure 18). It displays a mutualistic relationship with its surroundings. The building does not attempt



Figure 16. Golden mean.

By refusing the notion of a fixed “style,” mutualistic architecture is free to concern itself with the greater issues of how the patterns of natural and built form interact.



Figure 17. Complexity from harmony.

Form is an emergent quality and beauty will result from the synthesis of the conditions and the resultant ideas.

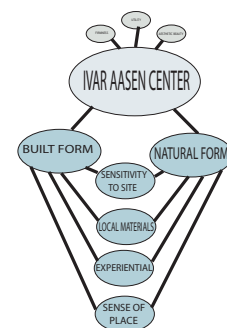


Figure 18. Ivar Aasen Center patterns.

to overwhelm the site; it is the building and the relationships it establishes. It respects without distracting, without dissolving the environment. Integrates itself harmoniously into it (figure 21). The Center attempts to evoke a visual metaphor with the mountainous terrain and respect the undulation present in it. “The world of architecture has this thing about the ‘site finding you’, and the architecture forms the literary program.”⁵ It appears to be a rock formation jutting out of the ground. The Center sets up a dialogue between the valley below and the mountains above. It does not introduce discordant materials/treatments. The building is not an object, screaming for attention. It allows the environment to shape the experience with the building and at the same time the building shapes the viewer’s new interaction with the environment (figures 19-20, 22 and 23). It is mutual and not exclusive. This building is not a didactic structure; it seem to be of the



Figure 19.
Materiality of text on wall.

Source: Living Architecture 18.



Figure 20.
Materiality.
Source: Living Architecture 18.



Figure 21. Relationship to the ground. The building seems to emerge from the earth, mimicing an outcropping of rocks and replicating the idea of the valley below in form.

⁵ “Living Architecture: Scandinavian Design.” (Copenhagen, Denmark: Living Architecture 18 , 2002), 207.

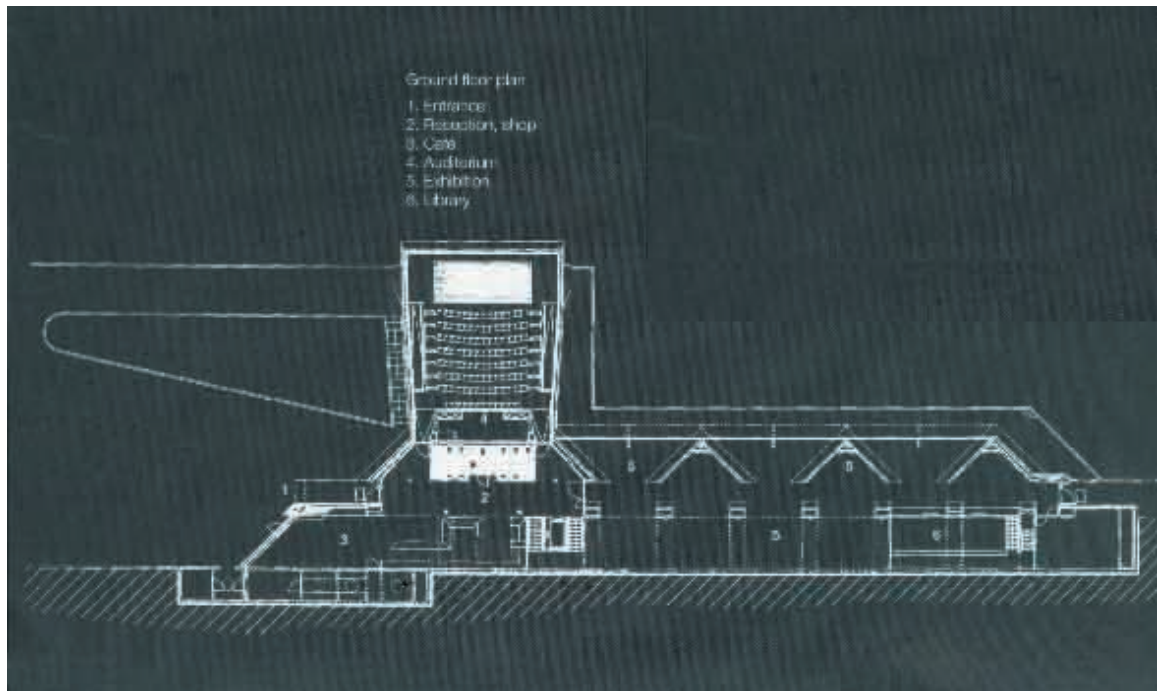


Figure 22. Plan. Source: Living Architecture 18.

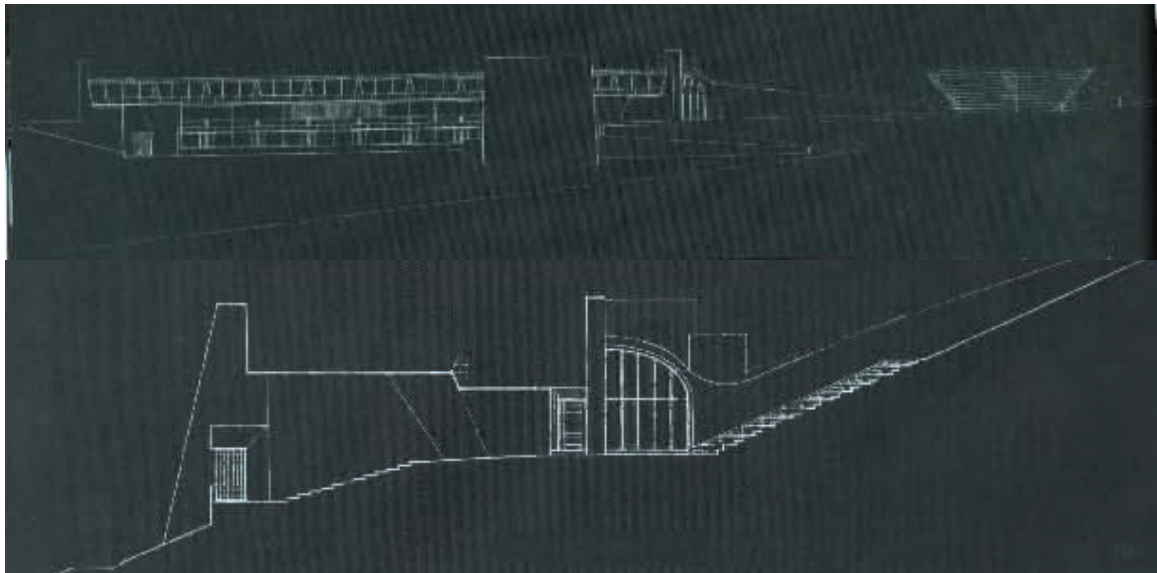


Figure 23. Section and elevation. Source: Living Architecture 18.

environment rather than in contrast to the environment (figure 24).

This is the in-between; a building that is both aware of the natural and the built form. There is a complexity that is inherent in this type of relationship.

Architecture of mutualism between the natural and the man-made can negate the dialectical position that is prevalent in architectural trend.

The Ivar Aasen center gave Fehn the rare opportunity to create a complete environment in which he was responsible for the building, the design of the interior and the design of the exhibition. Thus, the museum exudes an unusually pristine freedom from compromise. Sverre Fehn has created a modest, yet unique building in a strong, expressionistic form idiom in a stirring dialogue with the powerful Norwegian nature.⁶

Architecture of mutualism between the natural and the man-made can negate the dialectical position that is prevalent in architectural trends. It is more inclusive by its very definition. Mutualistic architecture allows both the value of the natural and the built form to exist within a project.



Figure 24. Ivar Aasen Center images. Source: Living Architecture 18.

6. "Living Architecture: Scandinavian Design." (Copenhagen, Denmark: Living Architecture 18, 2002), 207.

CHAPTER 3

THE LANGUAGE OF AN ARCHITECTURE OF MUTUALISM

Language of Mutualism

An architecture of mutualism is one that uses a mixture of vocabulary from architecture, landscape, science and environmental concerns.

An architecture of mutualism is one that uses a mixture of vocabulary.

Mutualistic architecture is not exclusive but rather inclusive of these disciplines. Designing with mutualism as a goal forces one to consider all of these aspects in order to achieve the desired whole (figure 25).

One way of defining this language is to draw from set theory. This theory will also provide a framework for which diagrams can be made. In it's most basic form, set theory deals with relationships between objects. A set is defined as a group of objects. There are four basic sets defined as Z (all intergers), N (all positive integers), Q (all rational

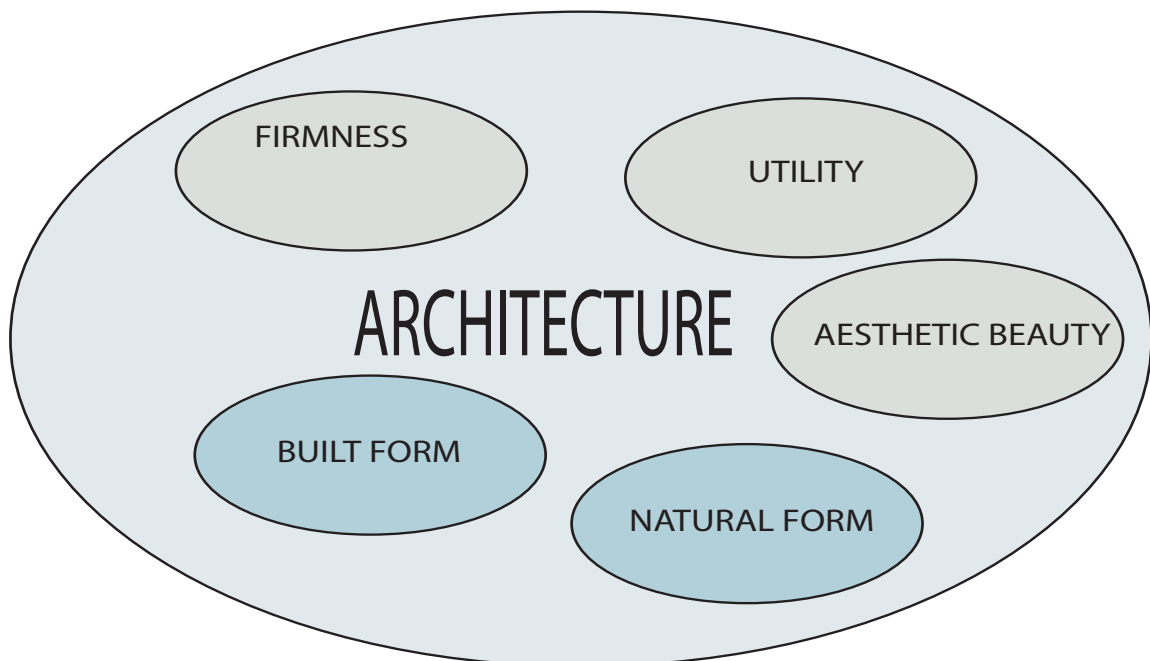


Figure 25. Architecture redefined. Redefining the original separate diagram to reflect the wholeness of architecture and how the components are part of a set that defines architecture.

numbers) and R (real numbers). Other sets are defined by groupings and are labeled. Venn diagrams are used to graphically represent the relationships between these sets. There are five relationships that are useful in defining mutualistic architecture. First is the idea that A is part of the entire universe (represented by a rectangle, figure 26).

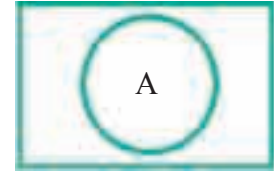


Figure 26. Universe.

This relates to architecture through the idea of the holistic nature of mutualism; that architecture is part of a larger system. Secondly, there is the complement of a set which contains all objects not part of that set (figure 27). This idea allows for there to be a distinction in what is being emphasized. Third, there is the relationship between two sets with one being a subset of another, the primitive (figure 28). The components of architecture exhibit this form of relationship. Fourth, there is the union of sets containing all the objects in both sets (figure 29). This underlies the idea of a mutualistic relationship between built and natural form. Fifth, there is the intersection of the sets with the intersection being only those objects common to both (figure 30). This is effective in breaking down the component parts of mutualistic architecture. Set theory and the usage of Venn diagrams has provided a clear graphic language for the diagrammatic representation of the patterns of mutualistic architecture.

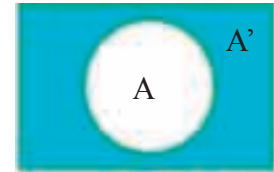


Figure 27. Complement. Written as A' .

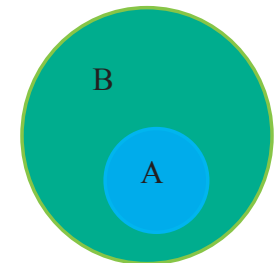


Figure 28. Primitive. Written as $A \supset B$.

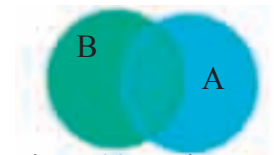


Figure 29. Union. Written as $A \cup B$.

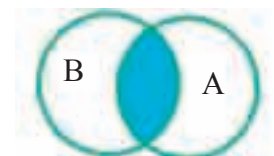


Figure 30. Intersection. Written as $A \cap B$.

Verbal or written terminology is harder to define. As stated before, since mutualism borrows from so many sources, these are a fertile ground for the terminology. Ideas such as systems theory, sustainable design practices, environmentally friendly, ecologically sound, complexity, sustainable, adaptable, permeable and so on can be used to describe aspects of mutualistic architecture. The language of mutualistic

architecture is broad yet it shares a common idea: the idea of integrating numerous relationships into a whole. It is a language of processes and interpretation, a language of complexity and combination. Words have a more in-depth meaning associated with them. Site is more than a physical geographical locale; it embodies ideas concerning climate, topography, culture and the impact that a building will have (figure 31). It is not to say that the architect should consume all their time attempting to address all these issues in depth but rather to have the knowledge that these aspects are there and are a vital part of what the architect is doing; there needs to be a cursory understanding of the forces at work. This approach to architecture, while internalized as it may be, allows for the greater integration between the built and natural form.

The language of mutualistic architecture is broad yet it all shares common themes of complexity and combination.



Figure 31. Site is more than its physical boundaries. Thesis site in Knoxville. By focusing solely on the defined boundaries of the site, the surrounding area would be ignored. Thus the building would become an object without any relationship to its surroundings.

CHAPTER 4 AN ARCHITECTURE OF MUTUALISM

Building with Respect to Nature

Architecture, in regards to the natural environment, should not be an either-or proposition: such an approach neglects the complexity of the whole that gives architecture the ability to move and inspire. Without this richness of meaning, the built form is simply anonymously repetitive building (figures 32.33). Symbiotic architecture allows for this complexity resulting from the combination of the two views to result in an architectural design that represents the synthesis of both realms.

Complexity in Mutualism

Many times in contemporary American Architectural practice built form can exhibit poorly integrated ideas concerning the natural environment. It is this failure to properly integrate the natural realm that distinguishes the industrial, ready-made from the symbiotic. The natural realm, conversely, is not a simple or primitive construct; there is complexity and variety in nature. Examine something as simple as a leaf (figure 34), which is part of a greater whole. The leaf exhibits a high degree of specialization, yet its purpose is multifold. The leaf gathers sunlight for photosynthesis, water and then disposes of itself (in a biodegradable way) when it is no longer needed in the photosynthesis cycle. The leaf, once it falls, enters into a new relationship with the earth and the cycle begins anew. A similar process happens in architecture. Buildings are highly specialized systems, combining a multitude of parts. Before a building is even conceived, though, raw materials are being produced. These materials undergo processes to make them into



Figure 32. Office building. Where is nature here? Source: Yahoo image Search.



Figure 33. Storage units. These repetitive, uninspired buildings provide mass storage and little else. Source: Yahoo image Search.



Figure 34. Leaf.

specialized components. The building is designed and assembled from these materials. If the building is mutualistic, it's components, when they are no longer viable, can be returned to feed their source and the cycle starts once again. As in the example in figure 35, stone is gathered from nature to become part of the building. This is only one form of a mutualistic relationship between the building and nature.

The common mistake that many may make is to assume that architecture, as built form, cannot exist within this type of mutualistic relationship; that the natural realm must be, by definition, subordinate to the built world. Architecture, in fact, always interacts with the natural realm - the presence of the building within nature is a vital part of the design. The natural aspect of the design can produce an experience of communing with the building as an integral element of its surroundings, just as the leaf, branch (figure 36), tree , roots (figure 37) and the earth belong to one another. This provides a sense that the building *belongs* in that location; it is situated precisely according to those natural principles of symbiosis.

An excellent example of mutualism is Renzo Piano's UNESCO Laboratory and Workshop in Genoa. It is situated on a steep hillside. The form of the topography influences how the building was designed (figure 38 and 39). The building is mutualistic because it utilizes this topography to it's advantage, the result of which is dynamic. The building could have been cut into the hill (figure 40) but this would not have been respectful to the natural environment and would have



Figure 35. Process of a part of a building: stone. Stone is gathered, processed, assembled and then returned to enter the cycle again. Source: Yahoo image Search.



Figure 36. Branch.



Figure 37. Root.

resulted in a poorly conceived and static building. It is this connection that gives it life and vitality. Built form, then, becomes the physical manifestations responses, whether visual, verbal or sensual, of the conscious integration of program and site (figures 41, 42).



Figure 38. Building with topography.

The built form of architecture and the elements of the natural realm should be in a constant state of dialogue concerning their integration and reaction; there is a necessary reciprocity between the two. Built and natural form do not exist separately; they are simultaneous entities. Architecture should not be compromise, it should incorporate both. It is a positive interaction between two the build natural form. Nature influences the built form. Frank Lloyd Wright provides an example of the perception, experience and mutualism that the integration between



Figure 39. Overlap due to topography.



Figure 40. Ineffective alternative.

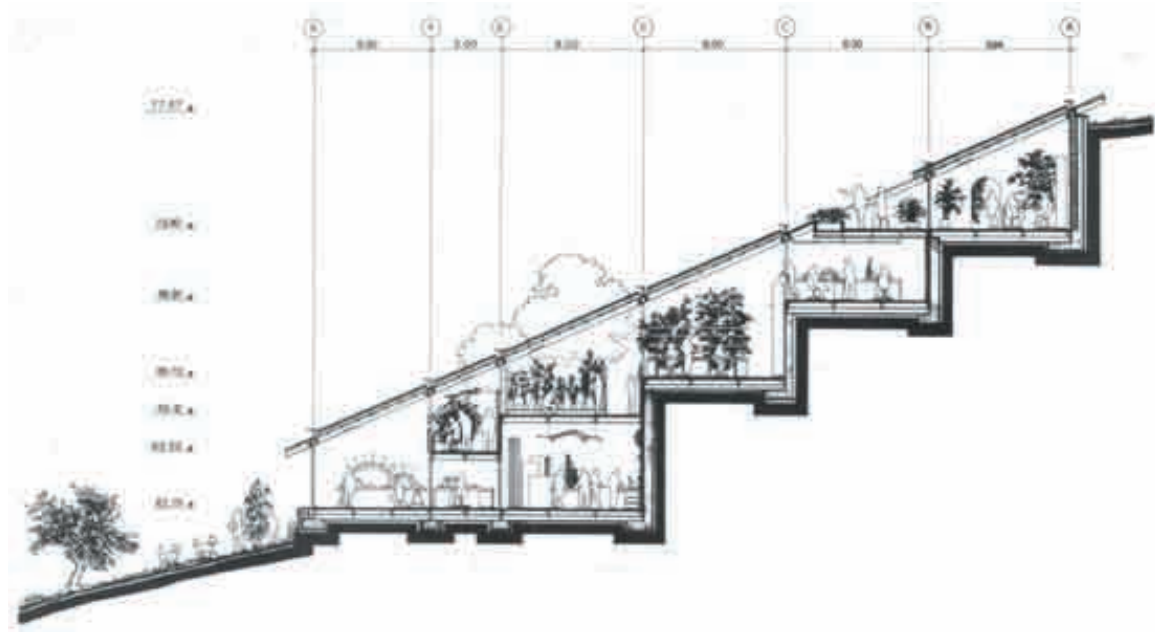


Figure 41. Section through Workshop. Source: Renzo Piano Log Book.



Figure 42. Workshop images. Source: Renzo Piano Log Book.

built form and nature makes possible. In his work, the man-made elements exist in concert with nature. This is evident even in his lesser-known small-scale projects. The Shavin House (figure 43), located in Chattanooga, Tennessee, exemplifies this. The site is upon the bluffs above the river. The original (and current) owners approached Wright to design their home. It is not one of his more expensive or well-publicized projects. Yet even in this small home, his ideas concerning the natural and built realms are evident. It uses natural materials along with the man-made to create a work that communicates the properties of the environment and the location of the building. The materials bring the natural inside and push the man-made out, blurring this distinction and creating a symbiosis of the two. The forms of the piers seem to arise from the earth, they are a part of it just as the tree is part of the

The natural materials along with the man-made create a work that communicates the properties of the environment and location of the building.



Figure 43. Shavin House. Chattanooga, Tennessee. Source: author

earth. The horizontal roof respects the horizon, accentuating it.

Other Wright project's are Taliesin West (figure 45,46) and East (figure 47). Here the forms, like in so much of his work, interact and energize the physical environment (figure 44). Yet there is the respect for nature, the buildings are not a tour-de-force of built form that overwhelms nature. They are a tour-de-force of how the two interact. The elegant way in which Wright handles the different materials in each location are evidence of this. They utilize the natural materials and respect the properties of their surrounding, they want to fit-in. This harmony enriches and enlivens the project. Wright resists the temptation to treat architecture as a dialectical entity and combines the two positions in a

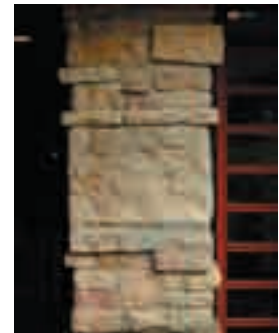


Figure 44. Pier. The detail of the craft with local materials.



Figure 45. Taliesin West a Source: Frances Nemtin

cohesive manner. This wholeness is achieved and the individual parts cannot be disassociated with one another.

Organic and Mutualism

Symbiotic architecture is neither a purely organic architecture nor does symbiosis require the application of organic forms to architecture.

Organic architecture is vague in its definition; it can be defined in a multitude of ways from a relationship to natural form to integrated and unified throughout. Wright's architecture is organic in the terms that it is unified throughout. He does not impose the organic shape as the defining factor for the form, he utilizes them as a way of discovering the form that best fits a site.

Yet it is not functionalism per se that identifies organic architecture. Rather, organic architecture transforms the concerns of functionalism into a search for aesthetic appropriateness, the reflection of spirit in material expression



Figure 46. Taliesin West b.



Figure 47. Taliesin East. Source: Frances Nemtin

and the rigor of a controlling, but self-defining, conceptual discipline.

His architecture establishes a dialogue with the environment and is symbiotic in this respect.

Mutualistic architecture is also not purely ecological or environmental design. An ecologically or environmentally designed building only addresses a particular issue. While these are important factors to consider, they are not the primary driving principles. By attaching too much importance to these parts, the whole is neglected. Mutualism is

The symbiotic approach to the problem of the city has an extremely simple and familiar premise. It is that man, in addition to his spiritual identity, is part of nature. He is a biological organism... There should be no misunderstanding at this juncture of the importance of the city. No one is suggesting that the man-made environment is inherently unnatural; no one is advising a return to more primitive ways of living. On the contrary, the city is (or should be) an environment where certain natural influences operate unimpeded by others. ⁸

7. Sidney K. Robinson. The Continuous Present of Organic Architecture. (Cincinnati, Ohio: The Contemporary Arts Center, 1991), 11.

8. J. B. Jackson, Landscapes. (Boston: University of Massachusetts Press, 1952), 78.

about the relationships between without sacrificing one for the other.

What Mutualistic Architecture Is

“For Goethe, the botanist, the total form or gestalt of an organism accounts for the complexity of its life cycle as it gradually develops, yet somehow retains its identity”⁹ (figure 48 and 49). Mutualistic architecture is the integration of the ideas and values from both the natural world and the man-made world of built form. Mutualistic architecture is a synthesis of a defined set of characteristics of both. Architecture is a totality formed through its multitude of interactions and it is this totality that gives it its complexity. Mutualistic architecture is about change: how do built and natural form morph over time through this relationship?

Conclusion

Mutualism is an approach to architecture, a way of allowing oneself to explore the idea of the integration of the whole. It is by no means a recipe for success but rather a view or way of examination. Recipes, as such for architecture, can lead to static and unoriginal design solutions. It is not a style that has an aesthetic expression but a process that can be overlapped onto a project.



Figure 48. Clown fish revisited. Goethe studied fish and observed their life cycles.



Figure 49. Recycle. Recycling makes us aware of the life cycle of a product.

9. Deborah Gans, ed. The Organic Approach to Architecture. (Chester, England: Wiley-Academy; Hoboken, NJ: John Wiley and Sons, 2003), vi.

CHAPTER 5

CRITERIA INVESTIGATED IN PROJECT

Two aspects of mutualism were investigated: built form and natural form. Within this limited scope, three types of relationships/interactions were investigated: site, water and energy. Each of these three area was broken down further into three subsets. From the resulting analysis, a program and ultimately a building emerged.

Patterns of Mutualism

Patterns represent a way of defining variables in a manner that is easy to understand. They are a regular way of doing something. Mutualistic architecture is made up of many different patterns that interact on multiple levels.

Figure 50 shows a simplified view of a few of the larger patterns. These larger patterns have the greatest influence on how the built and natural form interact. These are the areas with the greatest possibility for action and expression. For the purposes of this thesis, three were selected: water (figure 51), energy (figure 52) and site (figure 53). These three topics were chosen because they influence both the exterior and interior expression; it is here where the choices made can have a visible impact and in such a way as to be able to educate others. The remaining two patterns flow from the moves made at the water, energy and site level. This interrelatedness is reinforced by the idea of mutualism and the plurality that can be architecture. A set of secondary patterns were also analyzed (figure 54) as a way to add another layer of complexity.

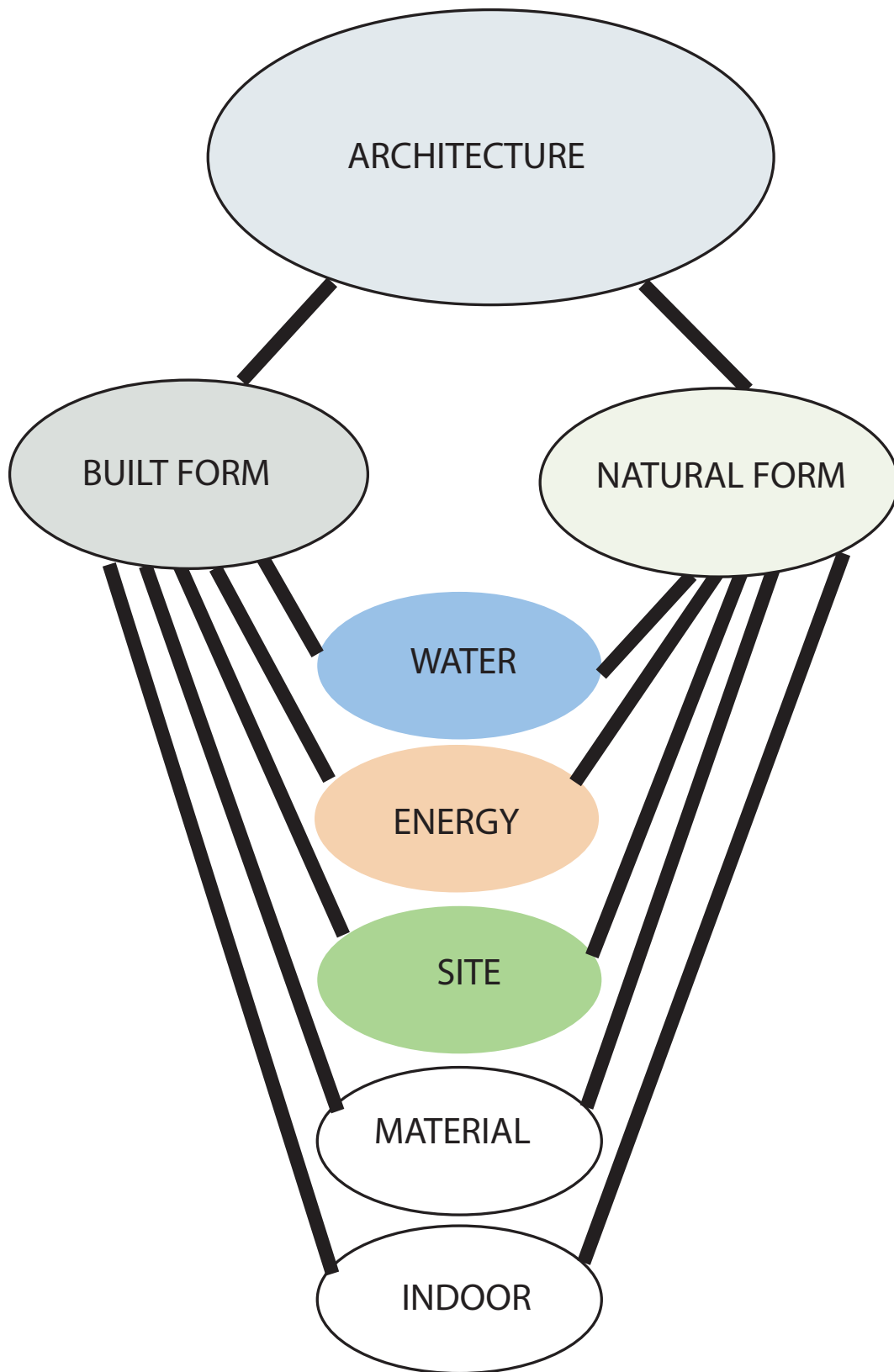
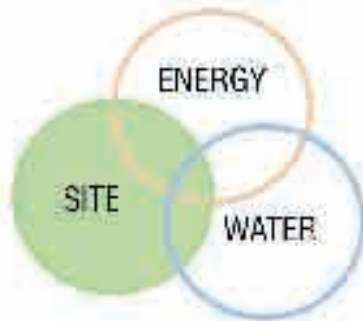


Figure 50. Large pattern.



SITE

1. TOPOGRAPHY

Not all sites are equal. Rarely will a site be untouched; some may be brownfields. How the topography is handled will help to decide the effectiveness of the project.



2. CIRCULATION

All good plans must have an appropriate circulation system. The overall must be examined so that the correct system can be implemented.

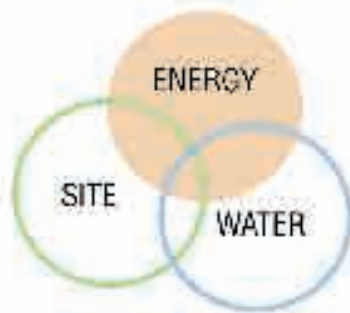


3. VIEW

Either you have a view worth looking at or you want to screen something unpleasant. Analysis must be made as to what is present and whether it should be viewed or not.



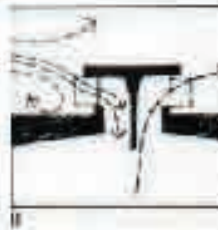
Figure 51. Site.



ENERGY

1. DAYLIGHTING

Natural light is an important aspect in any good design. Emphasis should be placed on allowing for the greatest amount of natural light into the building while maintaining the desired level of comfort.



2. SOLAR

Strategies that emphasize responses to the sun also aid in comfort or can be utilized for passive strategies. The site/building should allow for areas that are open to the sun and for those areas that are guarded against the sun. It should also not contribute excess amounts of heat into the area.

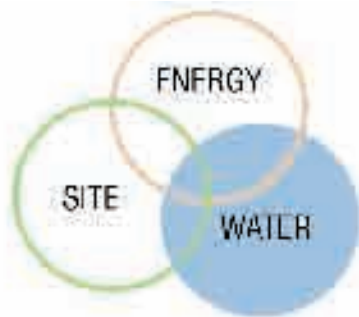


3. EXPRESSION

How these ideas are implemented influence the visual language of the form. A strategy can be effective yet aesthetically unpleasing.



Figure 52. Energy.



WATER

1. COLLECTION

There are many different ways to collect rainwater. At the site/building scale, water is typically collected from the roof or from the site itself. Excess water is dumped into stormdrains which also carry pollutants from the site.



2. STORAGE

Water, once collected, needs to be stored so it can either be used or gradually introduced back into the water table. The storage methods can be either above or below ground, the choice dependant upon how the water is going to be used.



3. EXPRESSION

Expression of how the water is being handled can be as simple as a barrel catching rain or as complex as a waterwall, depending upon the aesthetic desired. Expression is as much about aesthetics as it is about education.



Figure 53. Water.

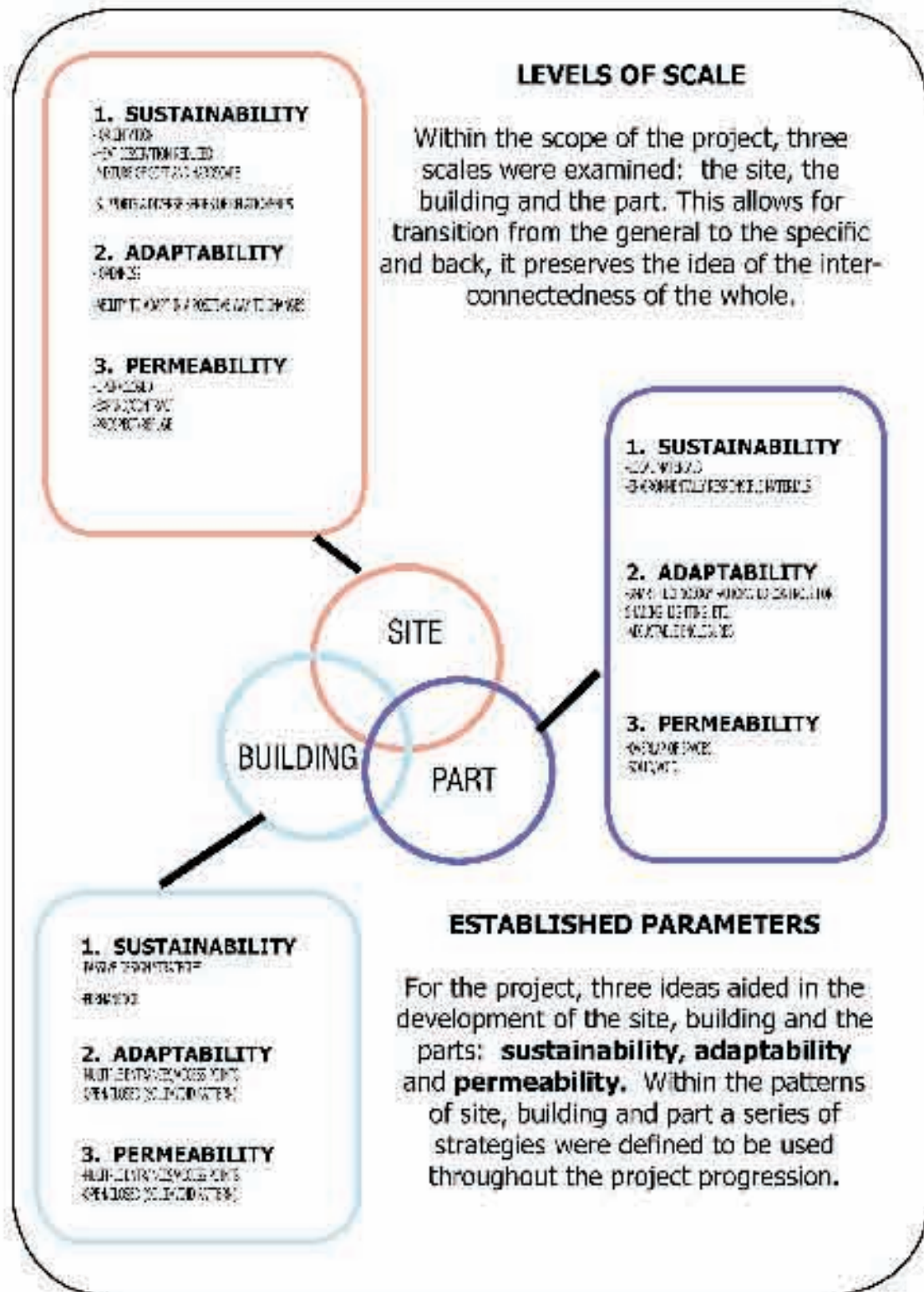


Figure 54. Secondary patterns.

CHAPTER 6

SITE SELECTION AND DOCUMENTATION

The site selected in Knoxville, Tennessee along Cumberland Avenue (figure 55-58). Across the street is World's Fair Park. Currently the site is being used as a surface parking lot. This site was chosen because it is located at the juncture of the downtown, the World's Fair Park, a new greenway system Maplehurst residential neighborhood and the University of Tennessee. The site is activated during the University of Tennessee Football home games when it is utilized as a thoroughfare to the stadium from downtown and the World's Fair Park. There are current plans for the addition of a greenway system that would follow the rail lines.



Figure 55. Aerial View. Site highlighted in red.



Figure 56. 1886 map of Knoxville . Site in blue.



Figure 57. Current map of Knoxville . Site in red.

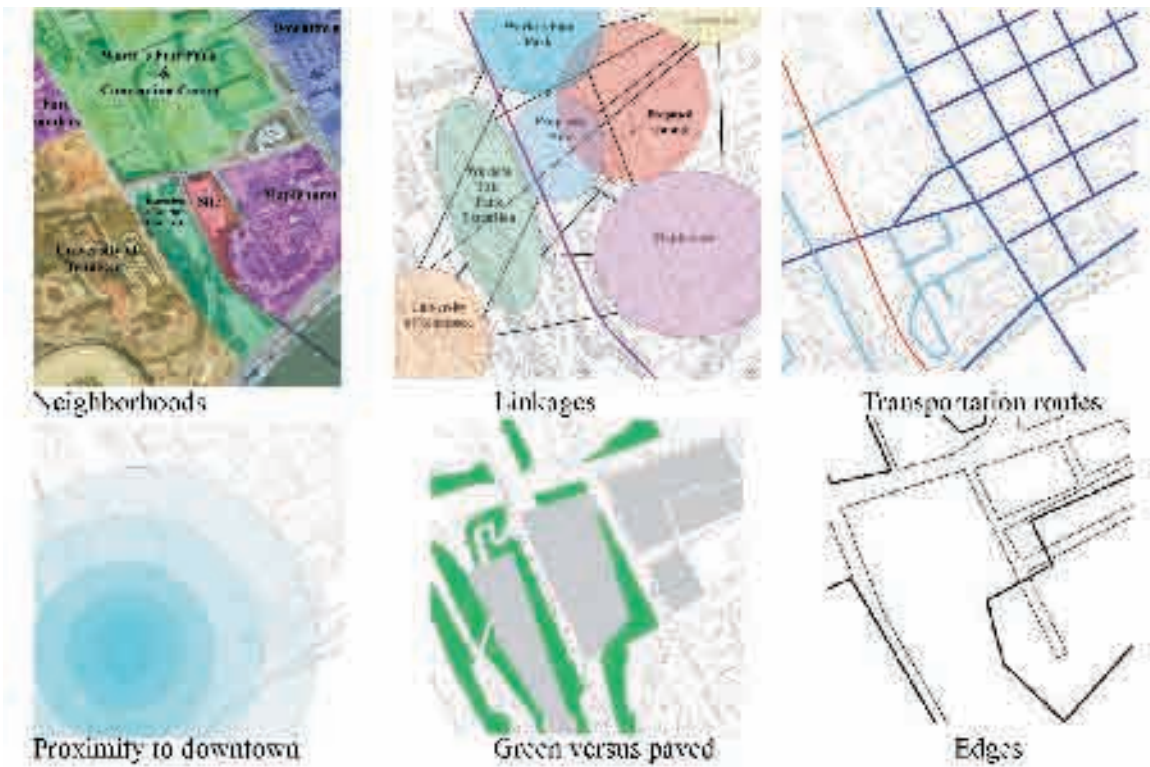


Figure 58 Diagrams of current conditions.

Site Description

The selected site is southwest of the new Knoxville Convention Center and east of the University of Tennessee. Currently, the site is occupied by a surface parking lot, which is connected to World's Fair Park via a pedestrian bridge. A rail line runs adjacent to the site and separates it from the Second Creek and lower parking area (figure 59-61). The surrounding area is somewhat of a canyon both topographically and urbanistically. Second Creek, which runs adjacent to the site, is a health hazard due to industrial pollution. Knoxville is in the River Valley which accounts for the similarity in the summer and winter wind patterns. The site in the Appalachian climate zone (figure 62) and is not in a flood prone area (figure 63).



Figure 59. View of site.



Figure 60. Site images.



Figure 61. Site images 2.

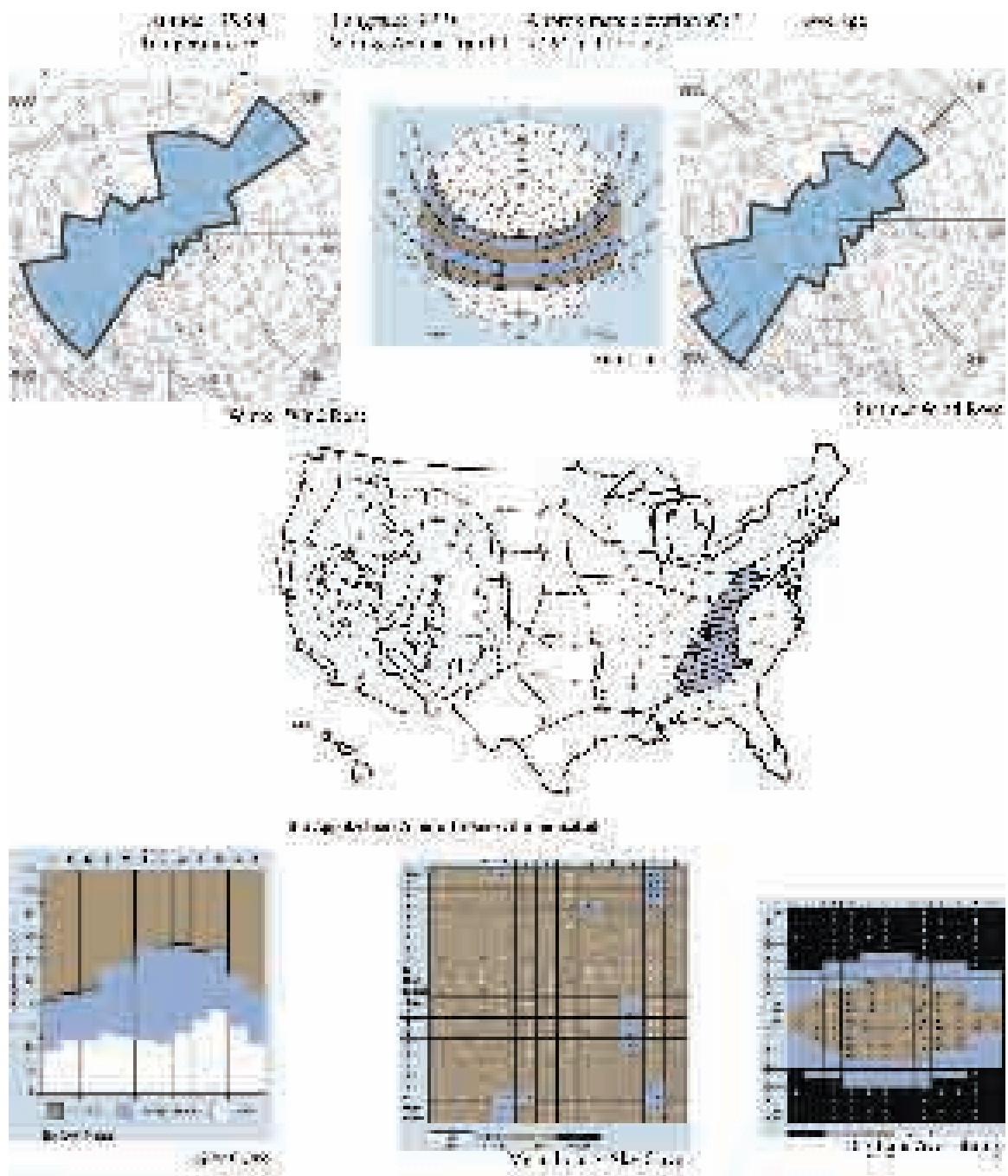


Figure 62 . Climatic data for Knoxville, Tennessee. Source: www.Ecodesignresources.net



Figure 63. Flood Data. 50 year flood line in light blue. 100 year line in dark blue. Source: FEMA

CHAPTER 7 THE PROJECT

Preliminary Exercise/Models

Exercise. Piece of wood.

The focus of this project was to take a piece of wood and sand it to discover the typography inherent in it (figure 64).

Models were constructed to examine other ideas concerning the project such as water flow studies (figure 65) and permeability analysis (figure 66).

Analysis and Synthesis

Five characteristics of the site were chosen to be analyzed (figure 67). Each of these parameters impact the usage of the site. The current conditions are first examined followed by an analysis of how to improve the conditions or reinforce a parameter. Finally a new diagram emerges that is the synthesis of the study (figure 68). These new diagrams are then combined into a single composite diagram that represents the acting forces and establishes a basis for further development of the site.



Figure 64. Wood.



Figure 65. Water flow model.

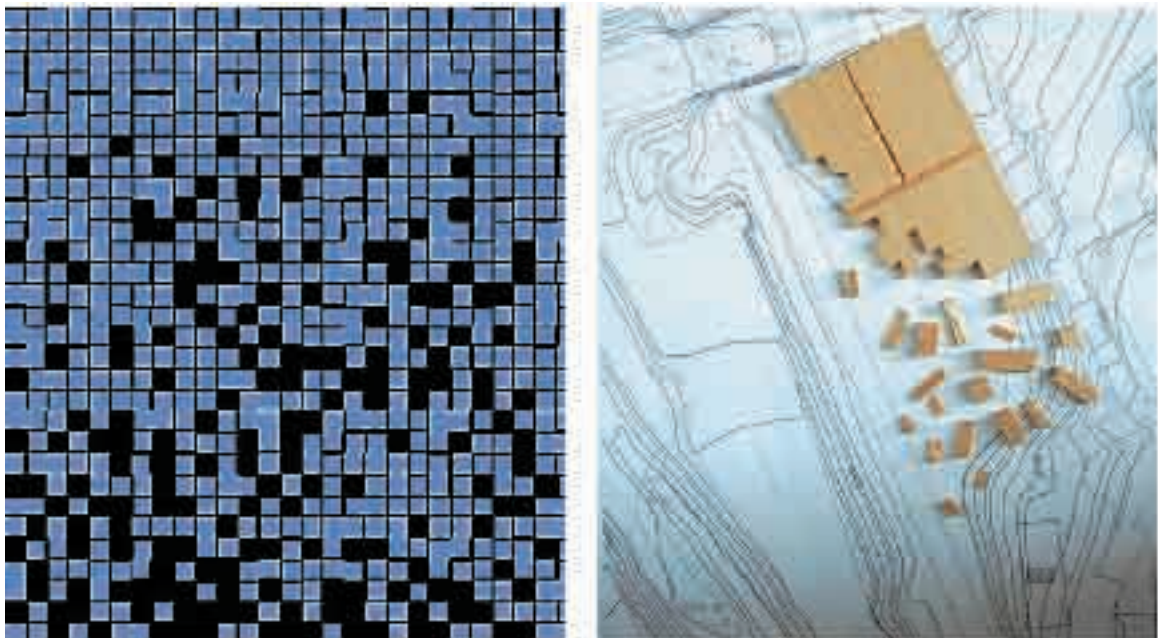


Figure 66. Permeability models.

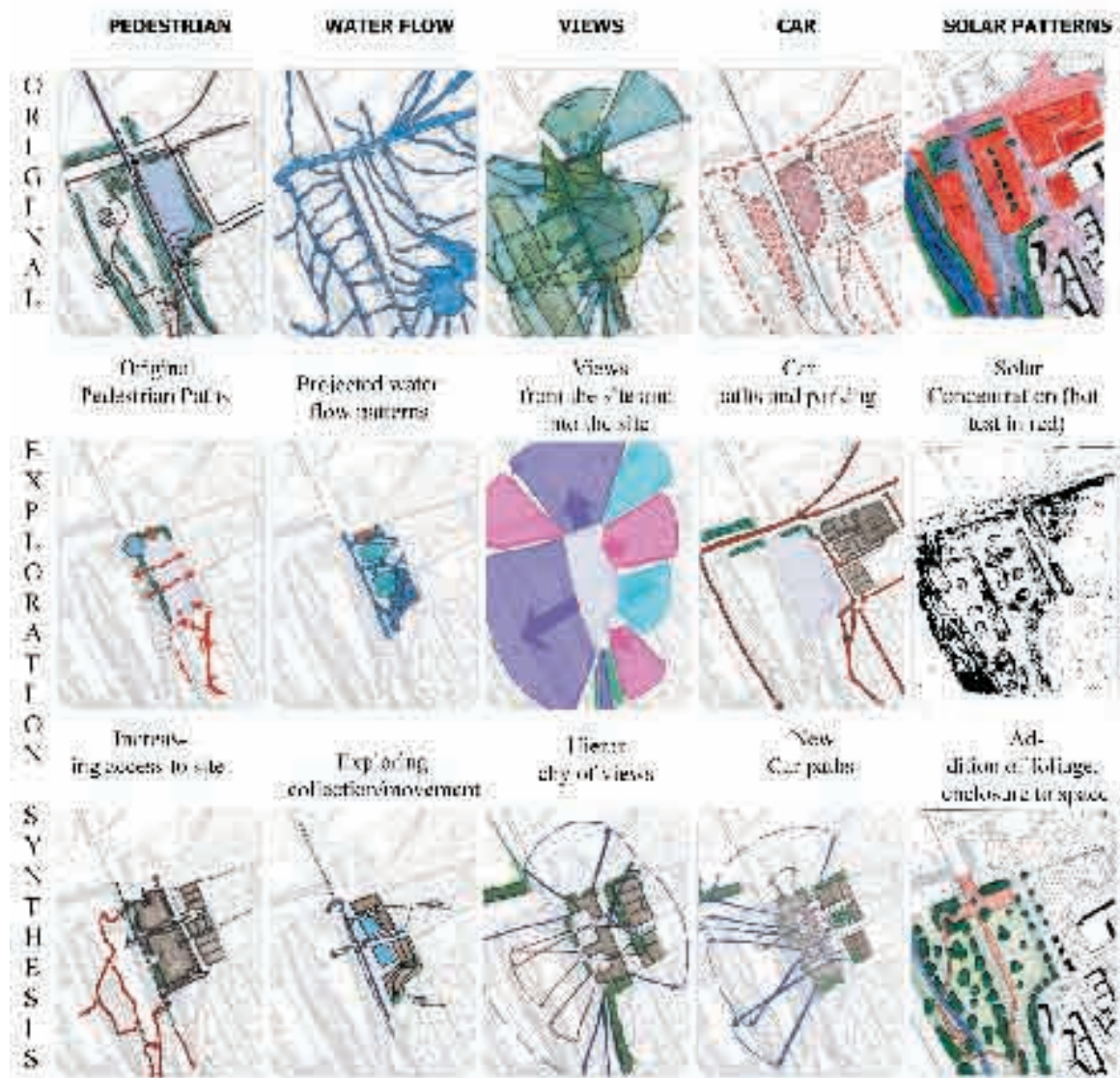


Figure 67. Analysis of the site. Examining five major ideas.



Figure 68. Composite Analysis. The composite synthesis represents the combination of the analysis and is used as a guide for the shaping of the site. It displays the new patterns that were developed and those deemed important in the making of a successful site. It is not a prescriptive nor finalized guide but rather a tool to remind and show how the patterns interact.

Topographic restoration (figure 69) and the phasing of massing onto the site (figure 70) resulted from this study. Due to the extreme slope condition of the site, it was decided to modify the terrain to a more natural and flowing configuration. This serves three purposes: it slows runoff by providing a larger surface area for absorption, allows for a greater amount of pedestrian movement and enhances the experience of the site. The current site is a surface parking lot surrounded by other surface lots, residential and a city park. The site is free of any structures other than a small parking attendant booth. In the second interaction, multiple buildings were erected on the site to fill the area. The final site is filled with a mixture of buildings and open spaces.

The Building

PROGRAM:

Research Institute cooperative between the University of Tennessee and TVA (figure 71).

Lab facilities	Classrooms	Storage	Library
Computer room	Small residence	Offices	Archive
Machine shop	Conference room	Auditorium	Display

The Research Institute will address issues of water quality, including causes of contamination and methods of clean-up. The Institute will also be an educational experience for the citizens of Knoxville to learn more about their own streams and the steps that they can take to improve them. Located adjacent to the site is Third Creek, which currently fails state bacteriological tests. This stream will serve as a showpiece on what was the past and how, through research, education and action, the stream can become viable in the future. Drawings will show the design intent as well as diagrams relating to the three major topics investigated (figures 72-95)

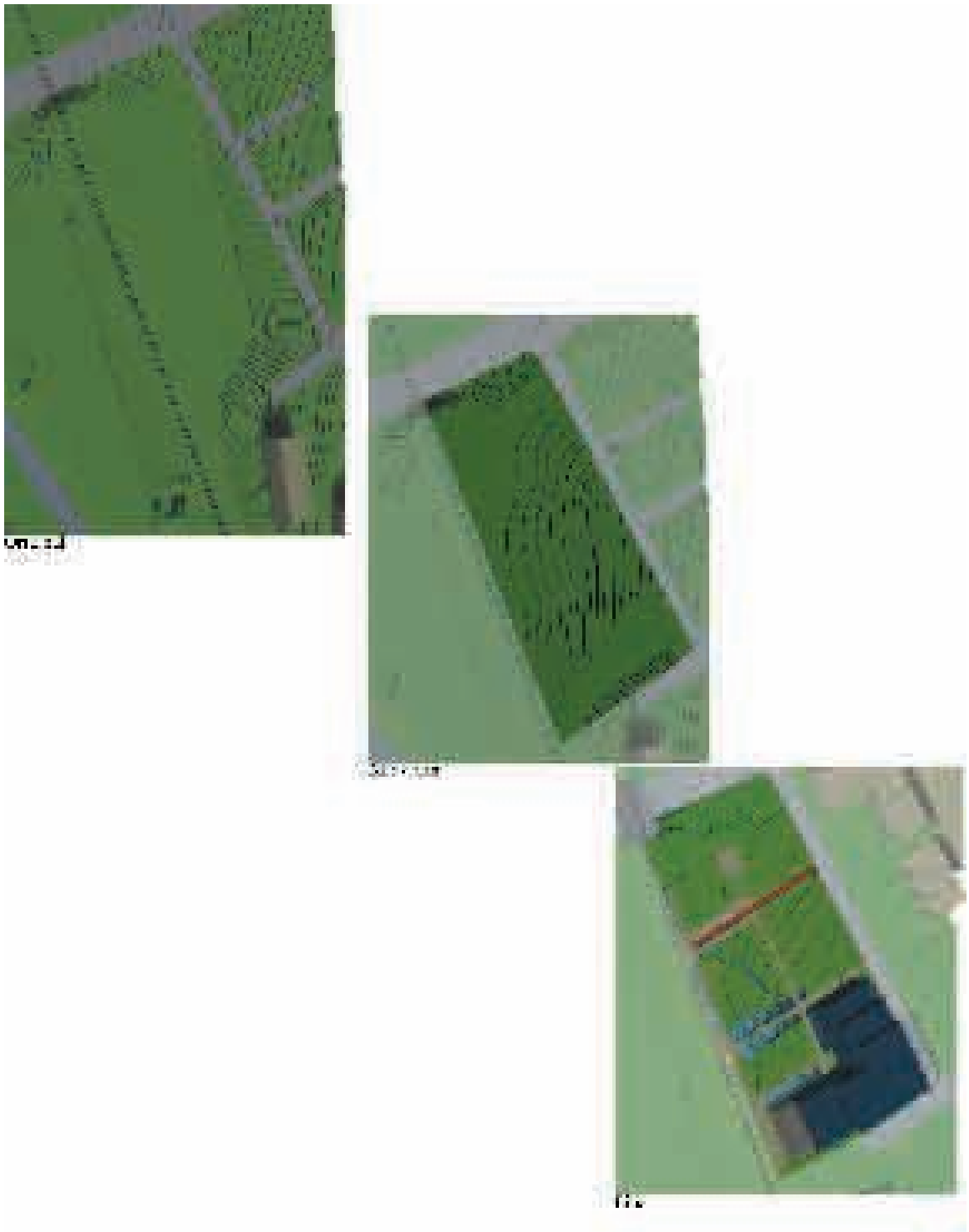


Figure 69. Topographic Restoration.

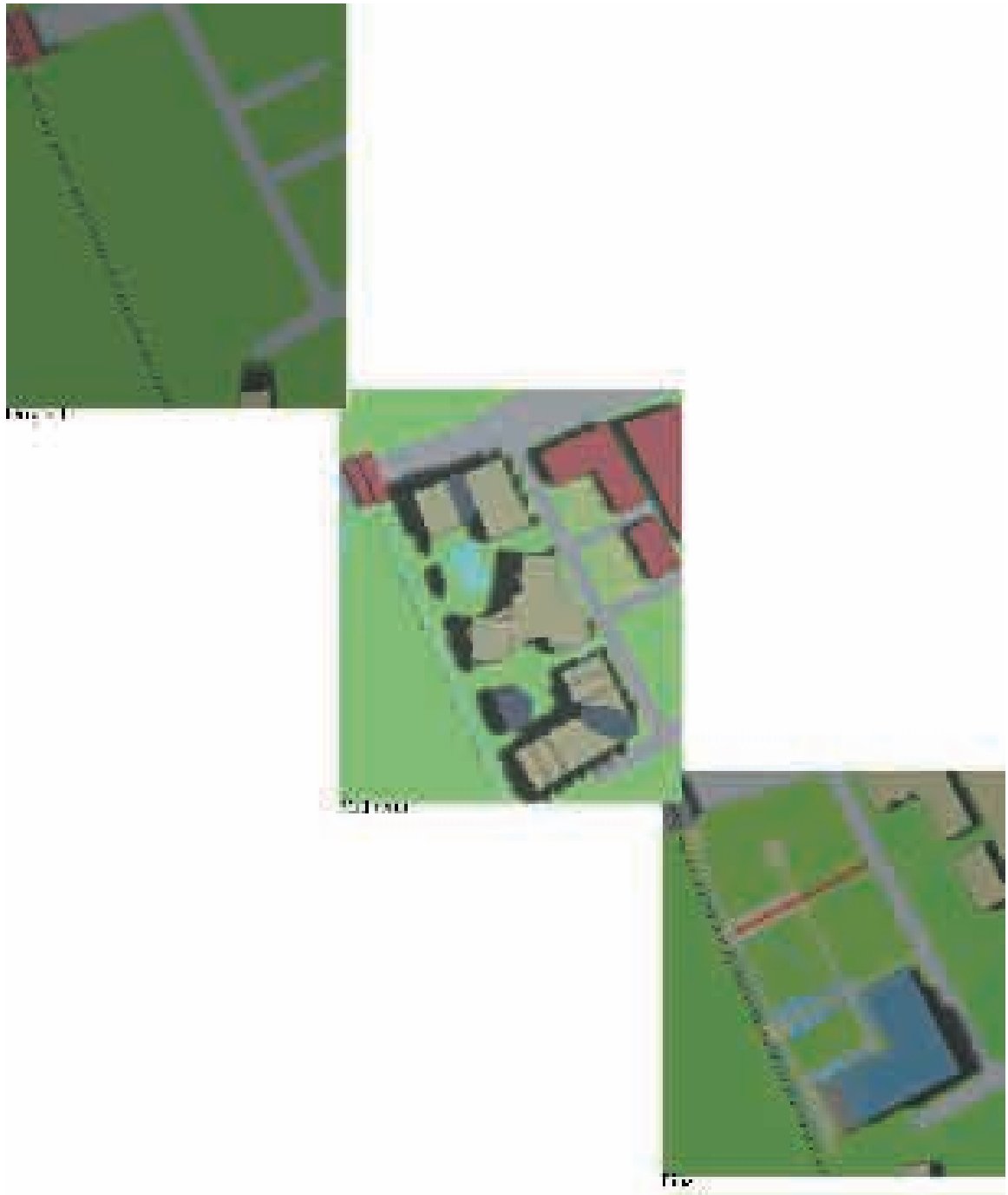


Figure 70. Massing.



Knoxville Hydrology Research Institute

A Cooperative Research Venture between the University of
Tennessee, Tennessee Valley Authority and the City of Knoxville

Figure 71. Building logo.



Figure 72. Site Plan.

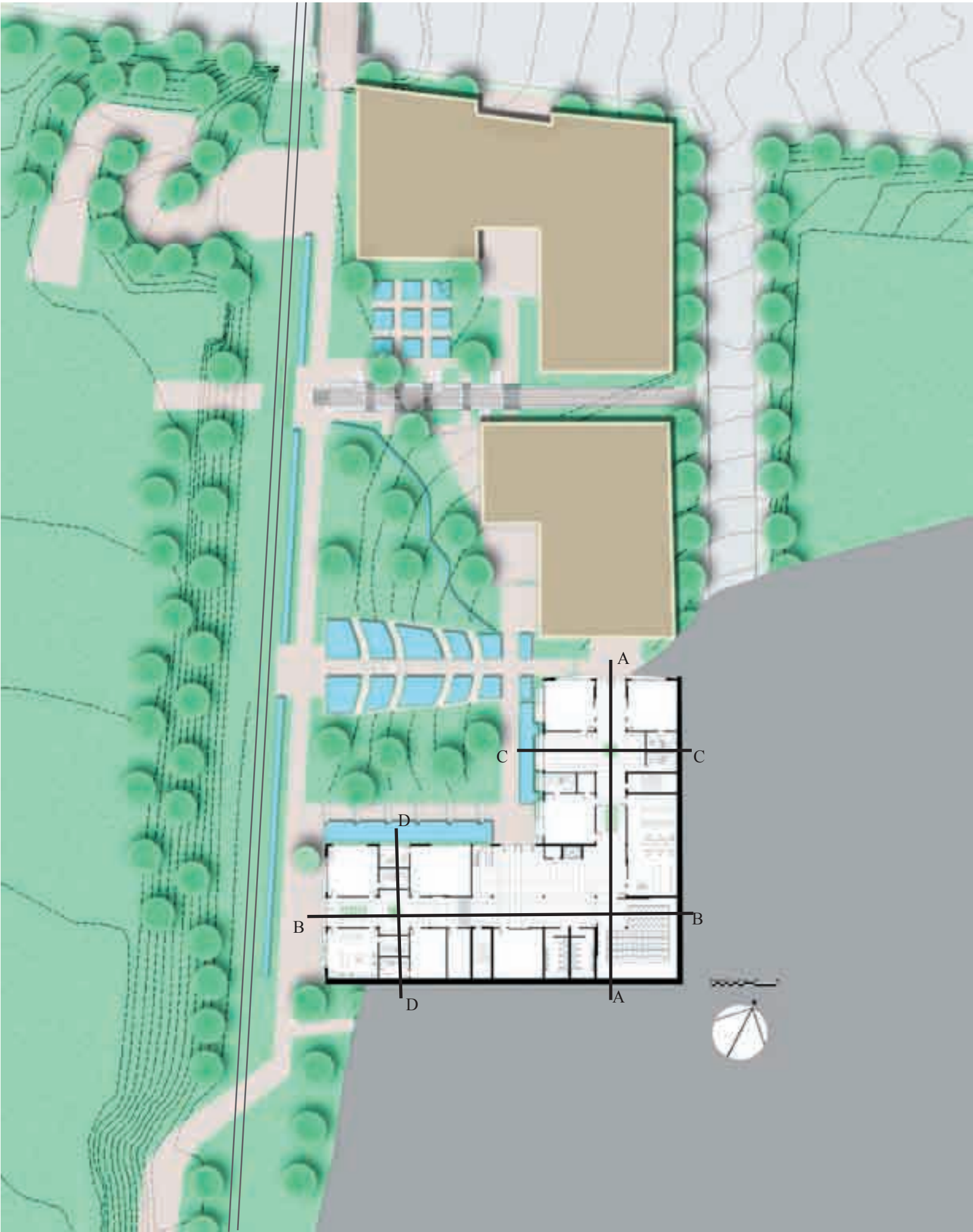


Figure 73. Plan 1.



Figure 74. Plan 2.



Figure 75. Plan 3.



Figure 76. Plan 4.

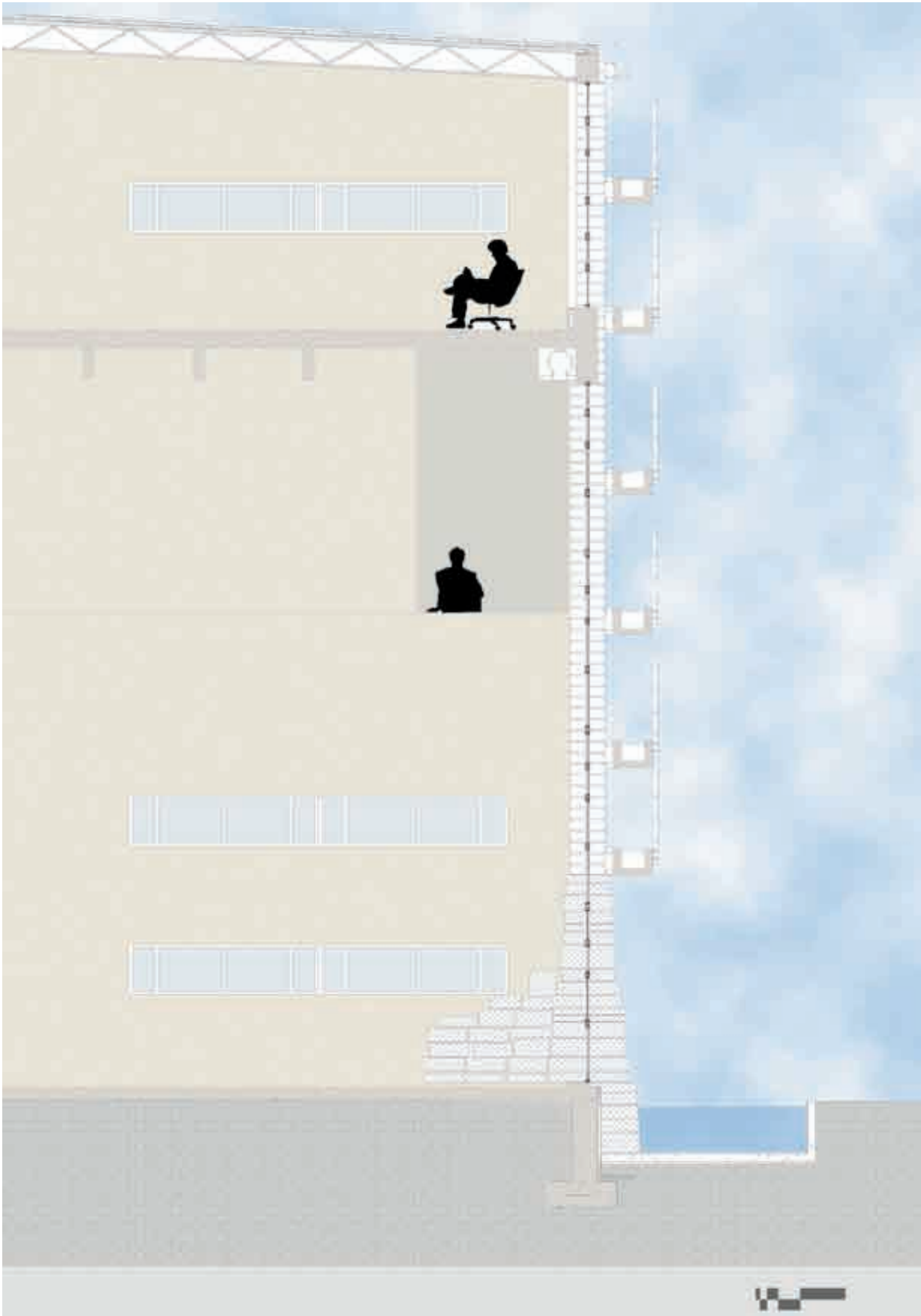


Figure 77. Wall Section.

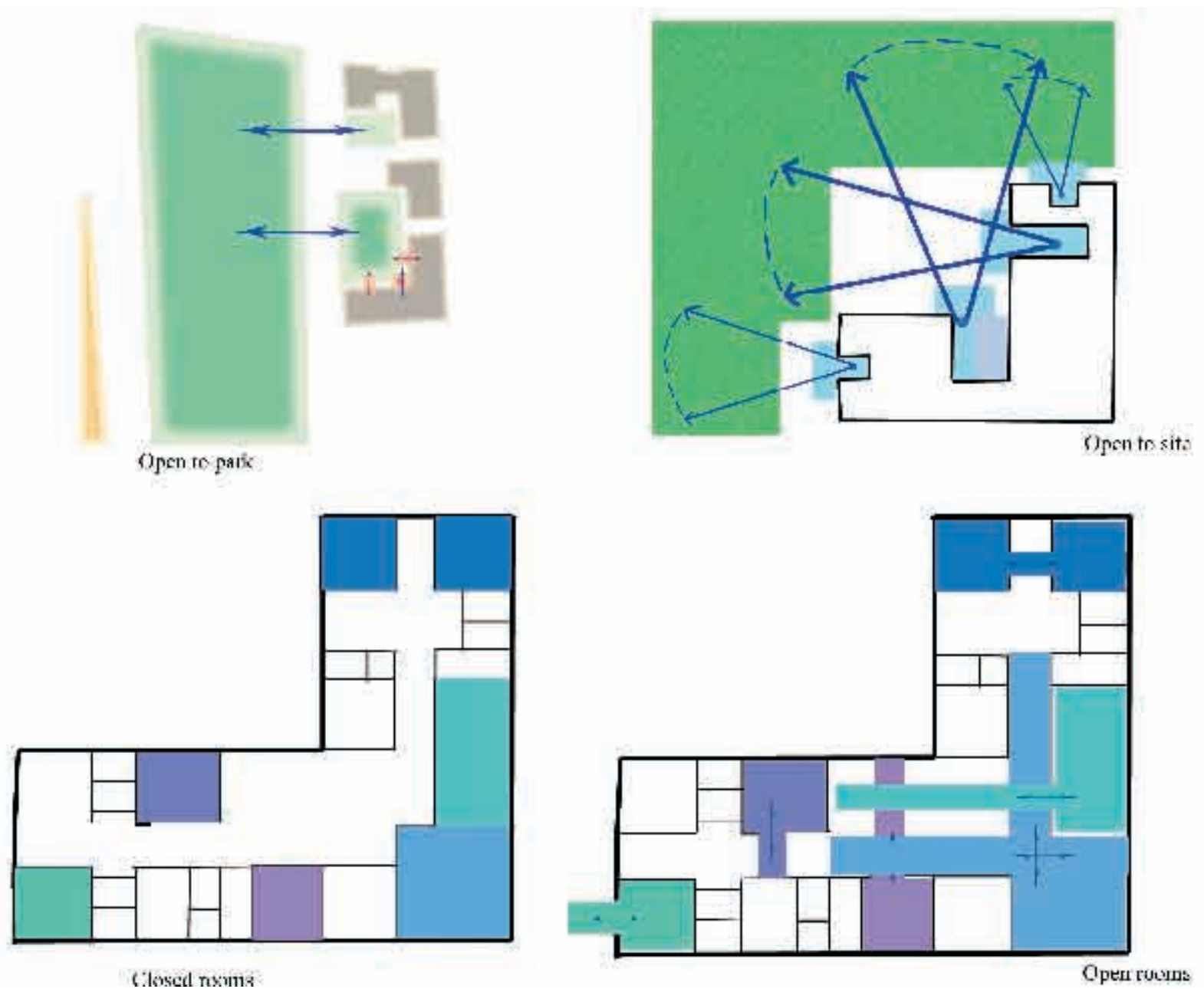


Figure 78. Permeability diagrams. The idea behind a permeable building is that the building can alternately be read as open and closed. Space is extended through the use of sliding doors. This also allows for greater flexibility in the usage of the spaces.

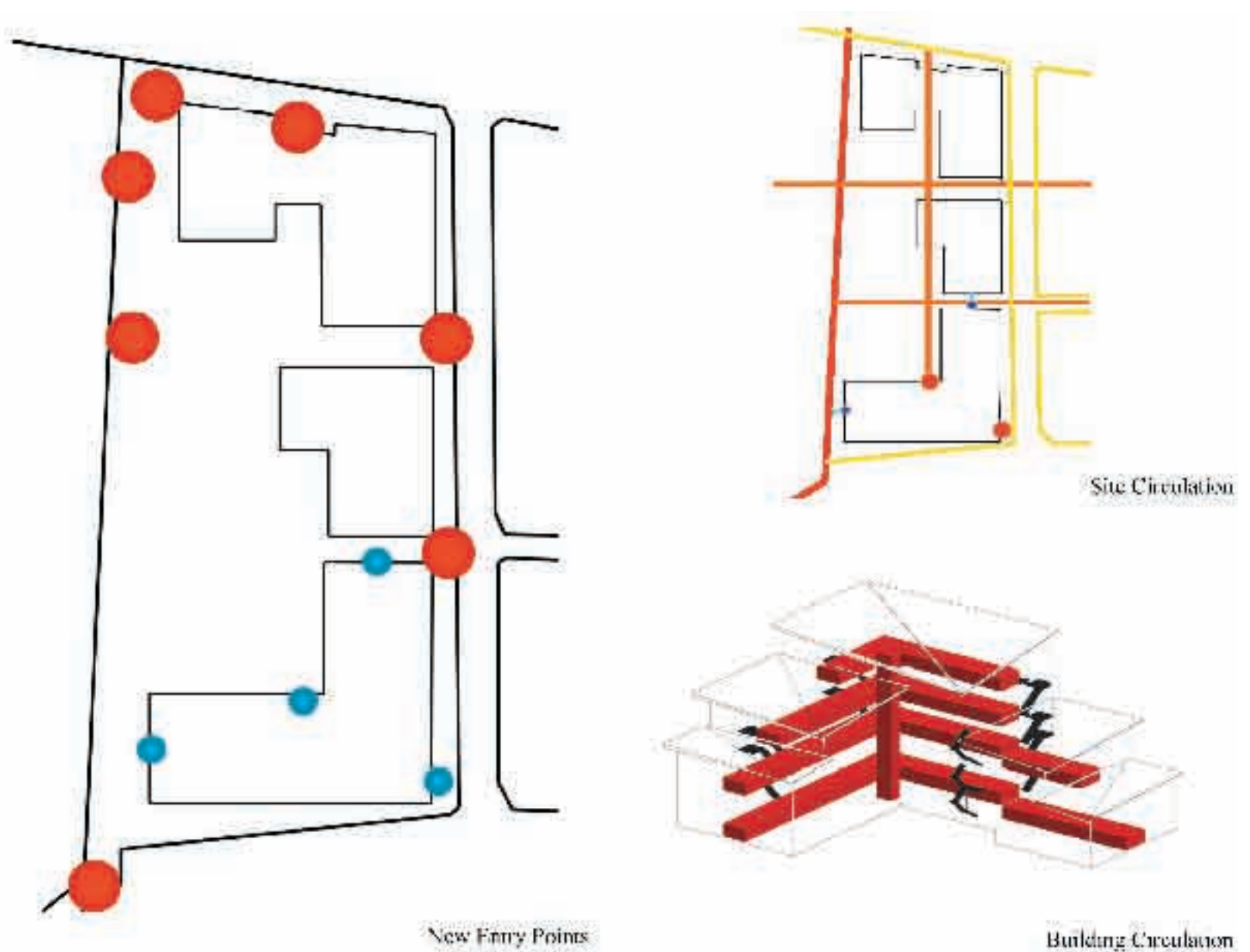


Figure 79. Circulation diagrams. Key to any effective site redevelopment is efficient and clear circulation. For the redevelopment of this particular site, new entry points were created so pedestrians could move through the site instead of around it. A new path was built under the railroad tracks and two new entry points added on the east. A new connection was also made to connect the residential to the path below.

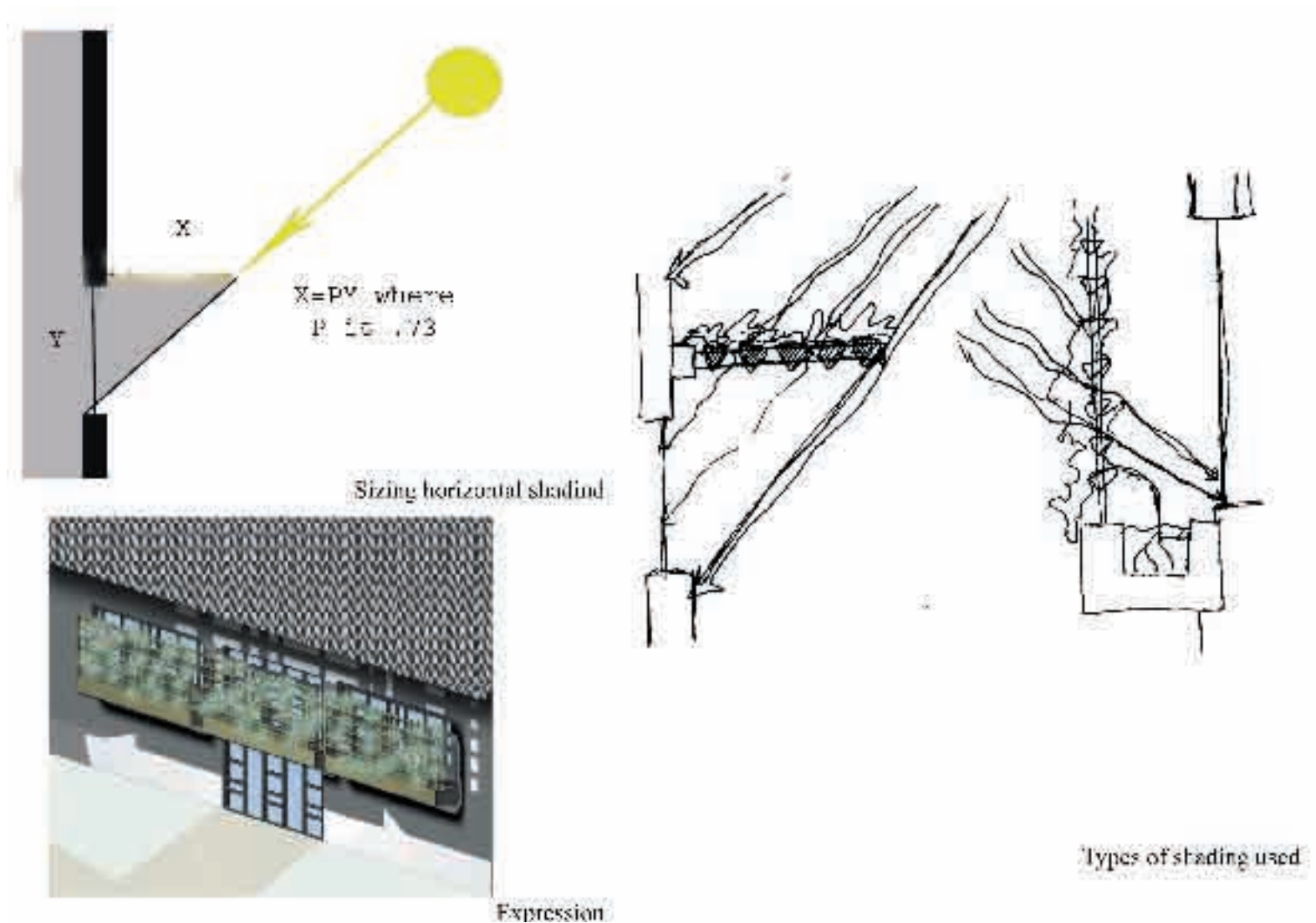


Figure 80. Energy diagrams. SOLAR ACCESS- The site, which is oriented to the north, originally was completely open with few trees to provide shade. The new modified site introduces clusters of trees to provide shade and to vary the experience of the site. DAYLIGHTING- The building is thin so that almost every space has access to daylighting. Internal automatic controls adjust the lighting so that the electrical lights work with the natural light to maintain the desired level of illuminance. EXPRESSION- The external shading devices allow for expression of the passive systems designed into the building. Due to the angle of the site, there is no need for shading on the east or the north. The west facade, where vertical shading devices are desired, has a series of trellises with horizontal louvers. These compensate for the angle of the sun. The south facade has horizontal louvers that extend outward placed above the fenestration. Both types of shading devices incorporate plants that add an additional level of shading when desired during the summer months.

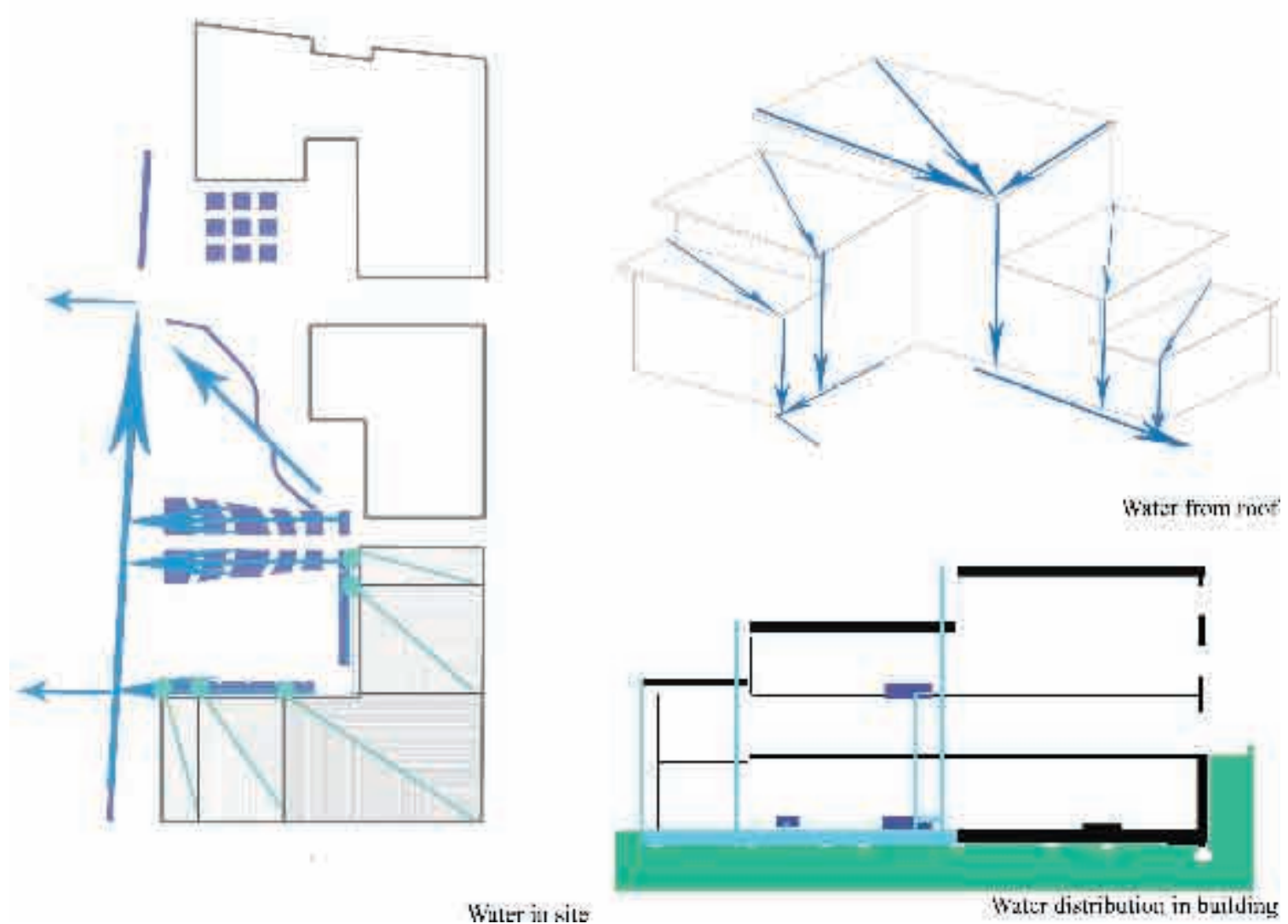
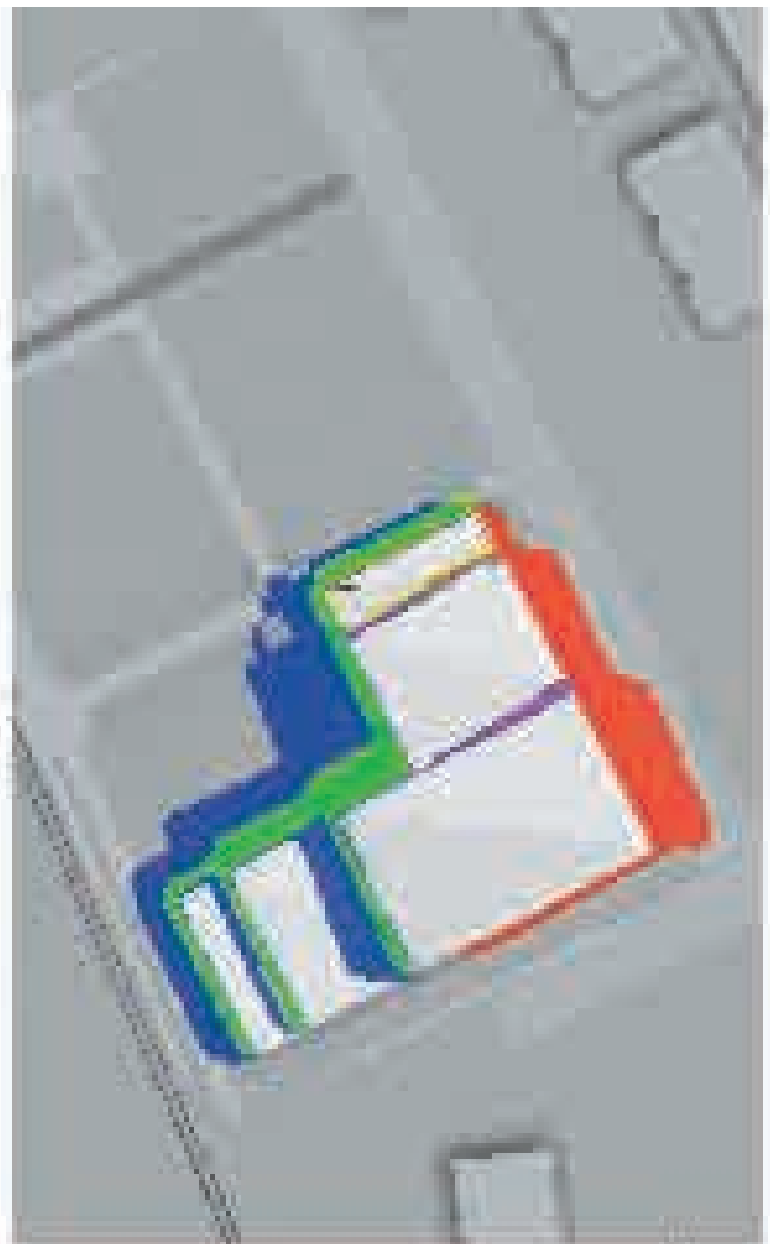


Figure 81. Water diagrams. Water can affect a site in either a positive or negative way. If water is allowed to flow on the site unrestricted, erosion and the resultant pollution from this runoff will occur. The solution presented here is to channel the excess runoff in a multitude of ways to minimize this impact. One of the systems established on the site is a series of collection pools for the water. These serve the purpose of slowing down the runoff, thus allowing a greater amount to be absorbed. Trees are located near these collection points and the water also serves to irrigate them. The shape of the roof also serves to channel the water into the collection pools and restrict the movement on the site.



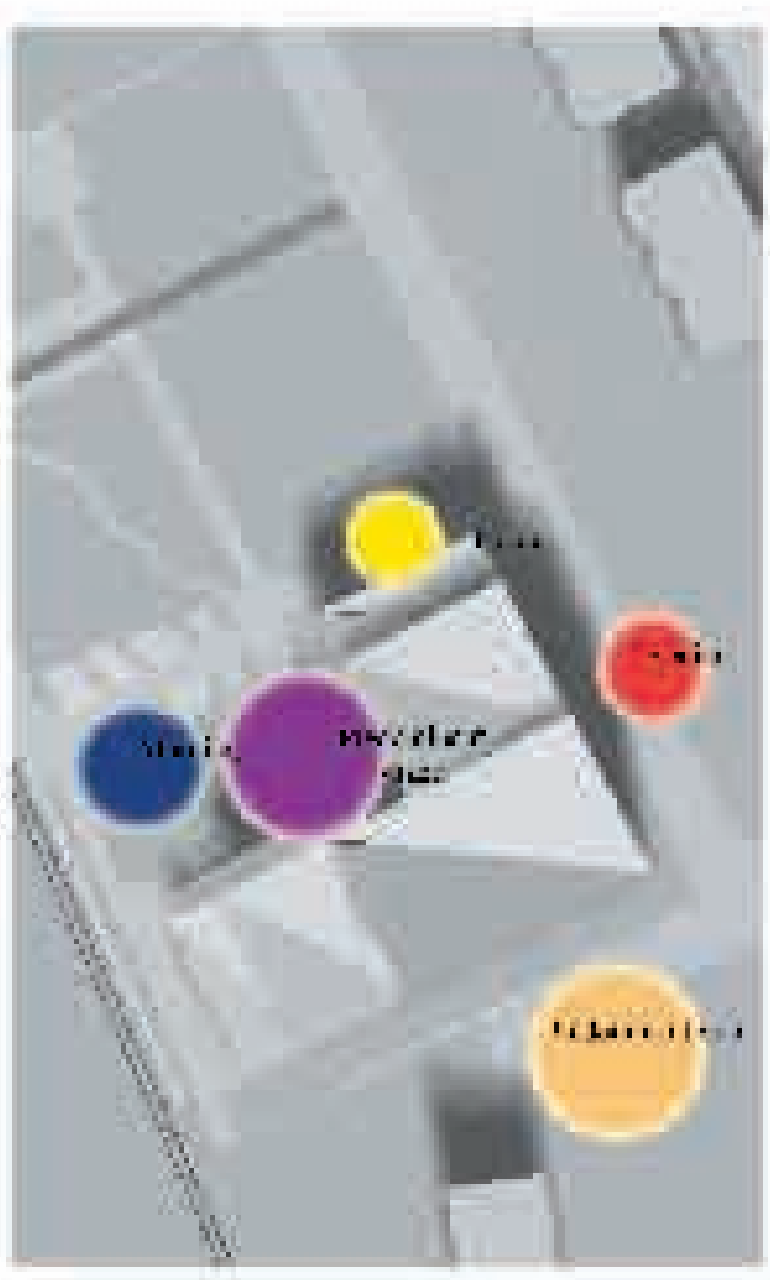
Shade diagram



Shade diagram



Shade diagram



Shade diagram

Figure 82. Shade diagrams. Analysis of the sun patterns on a building show how the building affects the site due to the sun. 9am ■ Noon ■ 3pm ■ 9am+Noon ■ Noon+3pm ■ 9am+3pm ■ 9am+3pm+Noon ■ The main times are assigned primary colors with the colors of the combination of times the result of the mixing of the colors.



Figure 83. North Elevation.

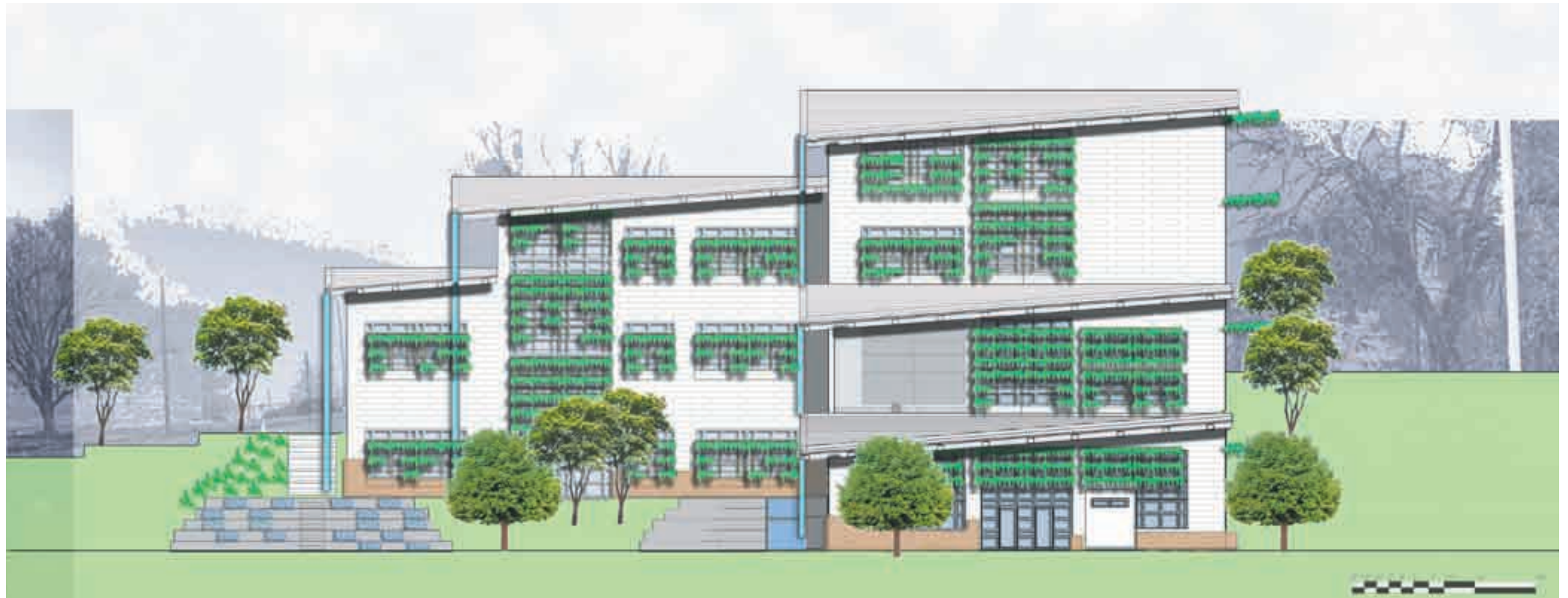


Figure 84. West Elevation.



figure 85. East Elevation.



Figure 86. South Elevation. Note usage of horizontal shading devices to shade from the southern sun.



Figure 87. Section AA.



Figure 88. Section BB



Figure 89. Section CC



Figure 90. Section DD.



Figure 91. Entry. Entrance to the building from the plaza.



Figure 92. Rain. View showing the effects of rain and the movement of this water to the collection pools.



Figure 93. Looking down hall. View looking towards theatre with the large doors partially open.



Figure 94. Room to room. View from one flexible room to another.



Figure 95. Looking out. View showing the spatial overlap and permeability of the double height atrium space.

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APPENDIX

Museum as Architecture / An Architecture of the Imagination

The first response to the museum project is the problem of the subject of architecture. How does architecture as a medium of a project convey information to create a representation of the world?

- *Frank Gehry*

How is a museum building a cultural, historical, social...



What is a Museum?

Architecture is not just a place to display art. It is a place to create art. It is a place to create a new way of seeing the world. It is a place to create a new way of thinking about the world. It is a place to create a new way of feeling about the world. It is a place to create a new way of living in the world.

Architecture is not just a place to display art. It is a place to create art. It is a place to create a new way of seeing the world. It is a place to create a new way of thinking about the world. It is a place to create a new way of feeling about the world. It is a place to create a new way of living in the world.





The first response to the museum project is the problem of the subject of architecture. How does architecture as a medium of a project convey information to create a representation of the world?

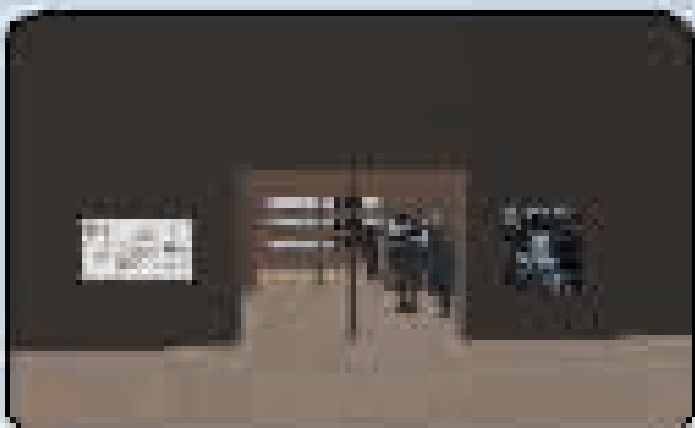


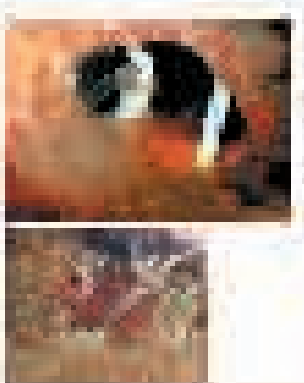




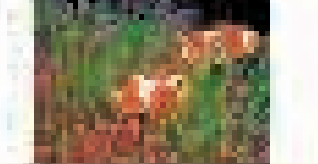
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PATTERNS OF MUTUALISM

Interrelationships and interdependencies between living organisms. This is a complex phenomenon, involving many different organisms and their interactions. The study of mutualism is a key part of ecology and environmental science.

1. Mutualism
A type of relationship where both organisms benefit. For example, a bee pollinating a flower. The bee gets nectar, and the flower gets pollinated.

2. Commensalism
A type of relationship where one organism benefits and the other is not affected. For example, a bird nesting in a tree. The bird gets a place to live, and the tree is not affected.

3. Parasitism
A type of relationship where one organism benefits and the other is harmed. For example, a tick on a dog. The tick gets blood, and the dog is harmed.

4. Symbiosis
A general term for all types of relationships between organisms. It includes mutualism, commensalism, and parasitism.

ENERGY

1. Energy
The ability to do work. It is a fundamental concept in physics and engineering. Energy can be stored, transferred, and transformed.

2. Power
The rate at which energy is transferred. It is measured in Watts (W). Power is a key factor in the design of electrical systems.

3. Efficiency
The ratio of useful energy output to total energy input. It is a measure of how well a system converts energy. Efficiency is a key goal in the design of energy systems.

PRIMARY PATTERNS INVESTIGATED

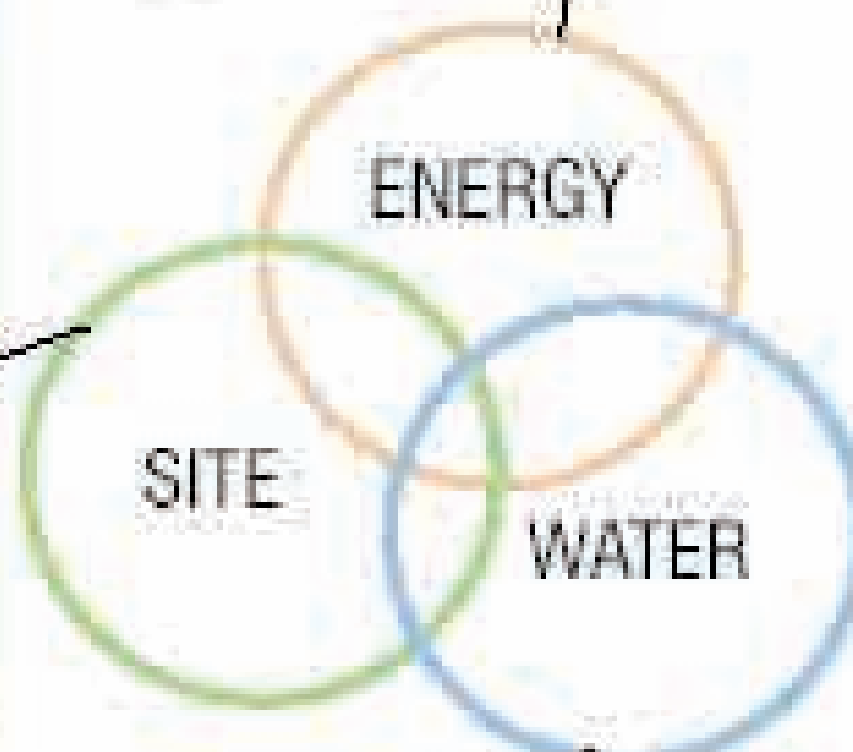
These patterns are the primary focus of the investigation. They are the key factors that determine the outcome of the study. The patterns are investigated using a variety of methods, including experiments, simulations, and analysis of real-world data.

SITE

1. Location
The geographical position of a site. It is a key factor in the design of a site. Location can affect the cost, accessibility, and environmental impact of a project.

2. Size
The area of a site. It is a key factor in the design of a site. Size can affect the cost, accessibility, and environmental impact of a project.

3. Shape
The form of a site. It is a key factor in the design of a site. Shape can affect the cost, accessibility, and environmental impact of a project.



ANALYSIS OF DATA

1. Data Collection
The process of gathering information. It is a key step in the investigation. Data collection can be done using a variety of methods, including surveys, experiments, and observation.

2. Data Analysis
The process of interpreting the data. It is a key step in the investigation. Data analysis can be done using a variety of methods, including statistical analysis, modeling, and visualization.

3. Data Interpretation
The process of drawing conclusions from the data. It is a key step in the investigation. Data interpretation can be done using a variety of methods, including logical reasoning, critical thinking, and communication.

WATER

1. Quantity
The amount of water. It is a key factor in the design of a water system. Quantity can affect the cost, accessibility, and environmental impact of a project.

2. Quality
The condition of water. It is a key factor in the design of a water system. Quality can affect the cost, accessibility, and environmental impact of a project.

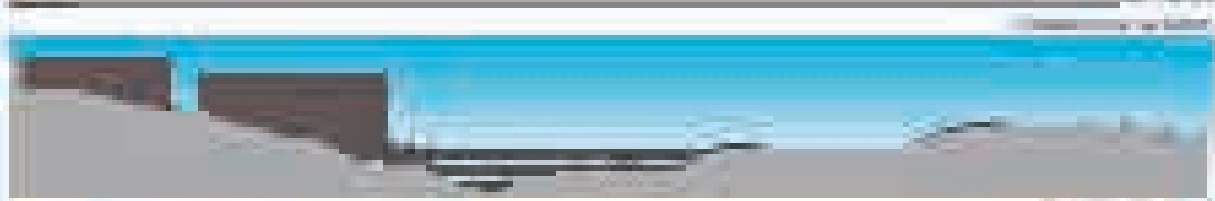
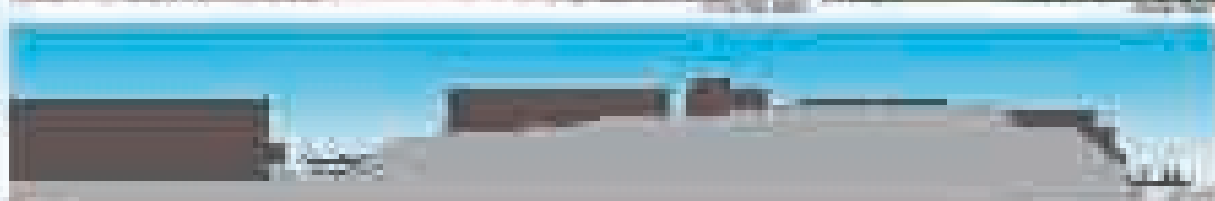
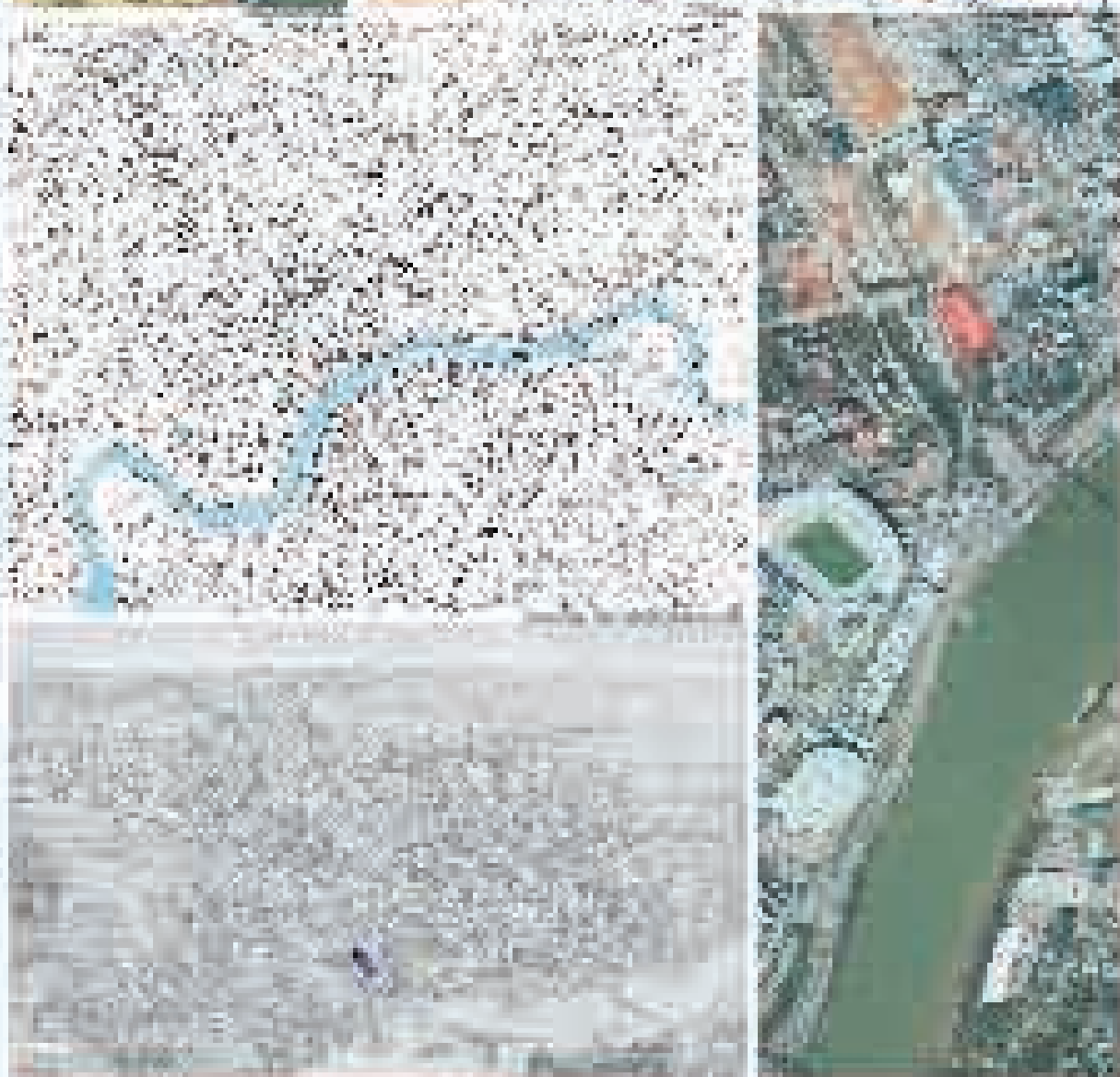
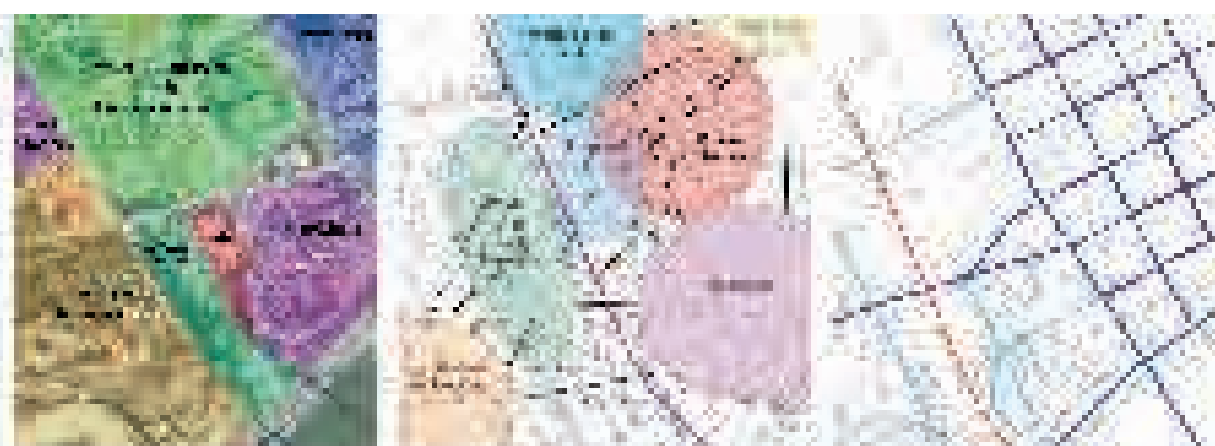
3. Distribution
The way water is spread out. It is a key factor in the design of a water system. Distribution can affect the cost, accessibility, and environmental impact of a project.

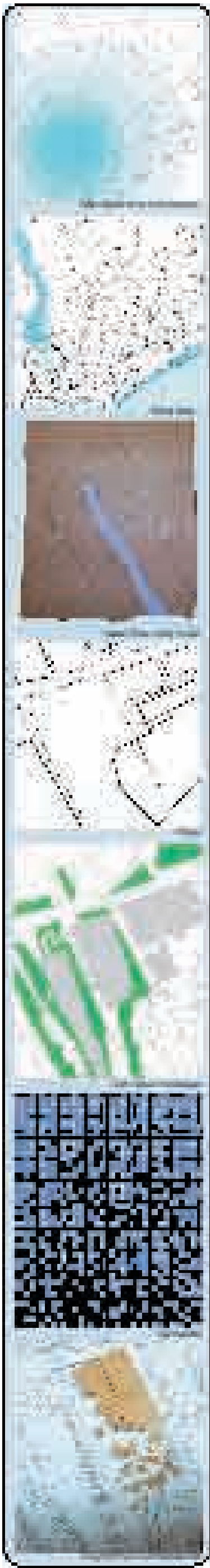
SITE DESCRIPTION

These authors also observed that the use of a single, common, standard for all countries is not appropriate. They argue that the use of a single standard for all countries is not appropriate because the standards are not the same in all countries. They argue that the use of a single standard for all countries is not appropriate because the standards are not the same in all countries.

CLIMATE DATA

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THESE ARE THE
RESULTS OF THE
RESEARCH AND
ANALYSIS OF THE
DATA. THE RESULTS
ARE PRESENTED
IN THE FOLLOWING
TABLES AND
FIGURES.

TABLE 1

TABLE 2

TABLE 3

TABLE 4

TABLE 5

TABLE 6

TABLE 7

TABLE 8

TABLE 9

TABLE 10

TABLE 11

TABLE 12

TABLE 13

TABLE 14

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TABLE 279

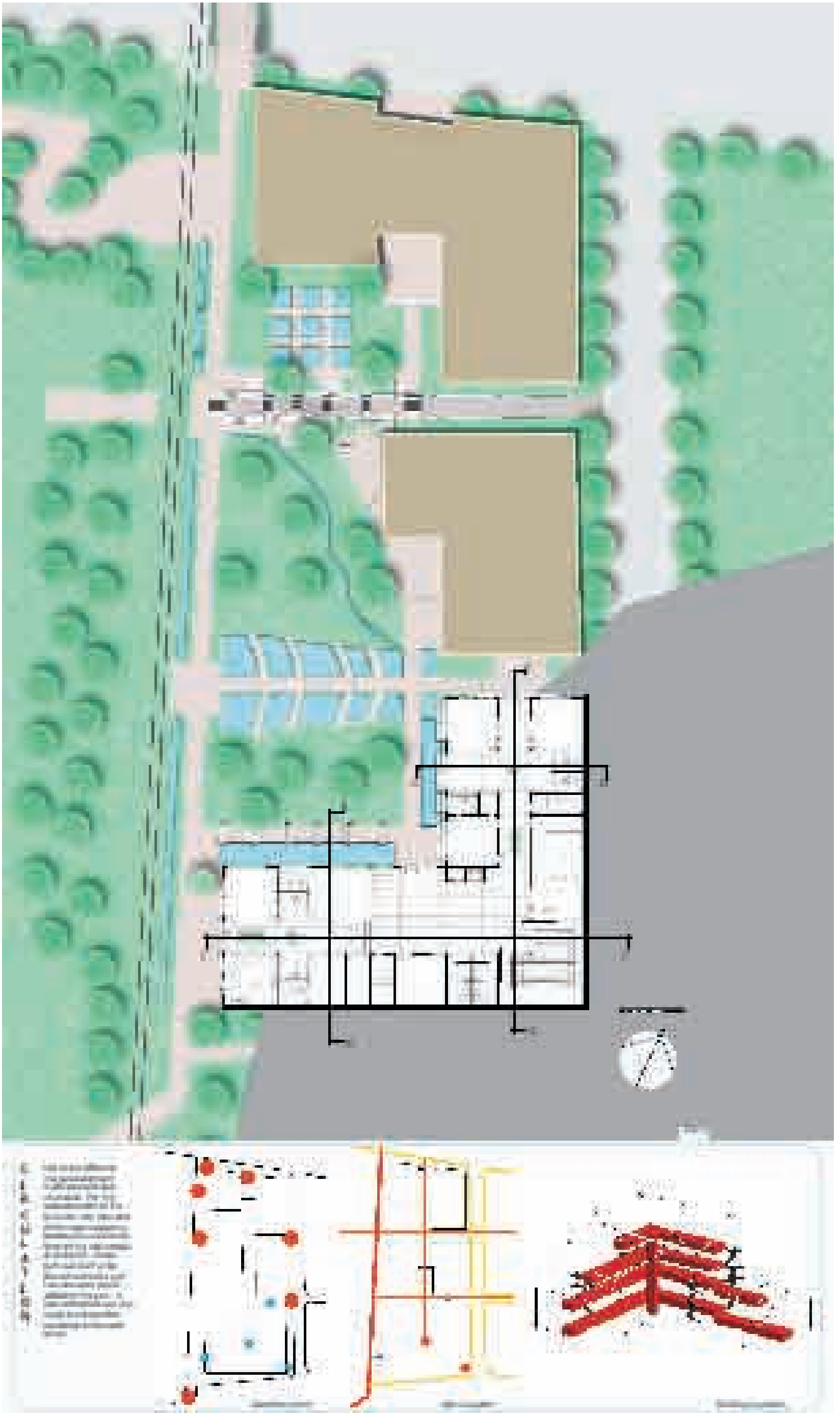
TABLE 280

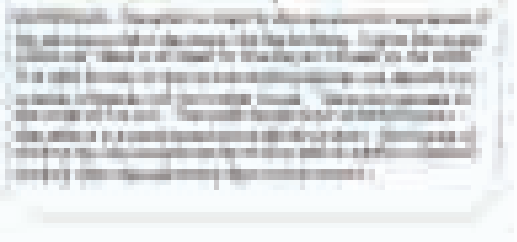
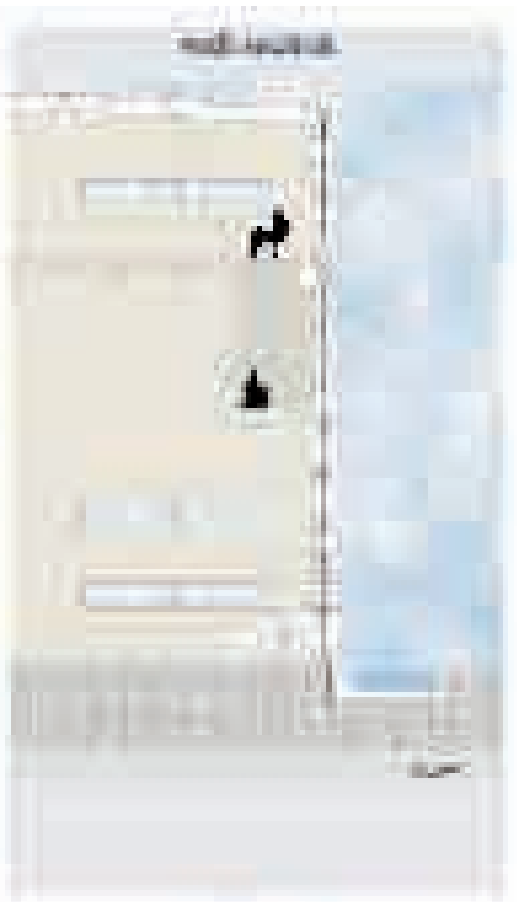
TABLE 281

TABLE 282

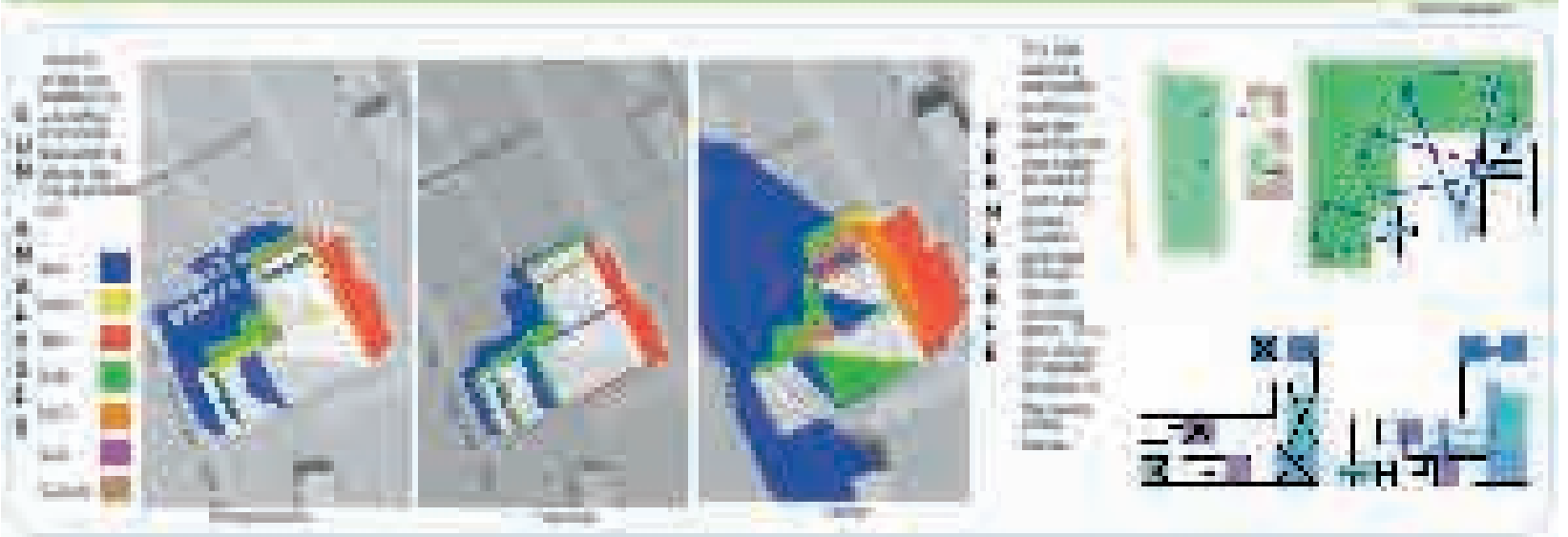
TABLE 283













Site Synthesis

Knoxville, Tennessee

Site Proposal
The site and location of the site leads to the development of the site with multiple buildings.

Program: Research Lab
 University cooperative between the University of Tennessee and TVA
 Lab facilities: 10000
 Classroom: 2000
 Storage: 2000
 Library: 1000
 Computer room: 750
 Small residence: 500
 Office: 2000
 Auditor: 500
 Multi-use shop: 500
 Plaza: 2500

Total: 28,000 (+1,000sqft)

The Research Lab will investigate water quality management techniques. Additional buildings on the site include an Apartment showcasing local artists 100 and possibly a greenhouse or manufacturing.

Synthesis
The synthesis represents the combination of the analysis and is used as a guide for the shaping of the site. It displays the new patterns that were developed and those deemed important in the making of a successful site. It is not a prescription but a helpful guide; however a need to rethink and show how the patterns interact.

Vivian A. Workman

Thesis: Mutualism Architecture and Nature

Spring 2004

University of Tennessee

VITA

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