

Understanding Analytic Content in Landscape Architectural Maps

Andrew Jepson-Sullivan
Spring, 2016

*Submitted in partial fulfillment for
the Master of Landscape Architecture,
Department of Landscape Architecture,
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Abstract

Landscape architects are often required to produce graphics that serve both as a presentation of data and as an exploration of design and process. These images are used to not only show what a landscape will look like when constructed, but also to understand how the composite parts of the landscape, both tangible and intangible, interact with each other. There is a lack of understanding about how to best compose these images so that they perform both aspects equally well. This project examines one aspect of this challenge: the presentation of analytic information in landscape architectural images, specifically, in landscape architectural maps.

This project proposes a framework for analyzing, categorizing, and contextualizing the basic visual methods that landscape architects use to communicate analytic information in maps. Edward Tufte's *Principles of Analytic Design* are used as a basis for this analytic framework, in order to 1) better understand the visual characteristics and techniques that maps use to present analytical information, 2) break down analytic representation techniques into their component parts so that they can potentially be applied to other landscape architectural image typologies, and 3) create a visual language to better discuss the component parts that make up landscape architectural images.

This analysis is structured around two map sets consisting of maps made by landscape architects Ian McHarg and James Corner. The results of this analysis are a set of identified analytic representational techniques used to communicate analytic content in landscape architectural maps, discussed and explored through both narrative and visual description.

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Introduction

Landscape Representation: Presentation and Exploration

Landscape architecture involves the “spatial organization of outdoor places,” through the engagement of physical form, materiality, aesthetics, ecology, natural processes, temporality, spatial relationships, and cultural requirements (Dee 2001, 1). As such, landscapes cannot be clearly or easily defined within only one area of understanding or study. As landscape theorist Anita Berrizbeitia states, “landscapes embody at once culture and nature, art and science, the collective and the personal, the natural and the artificial, the static and dynamic” (Berrizbeitia 2001, 117).

These multifaceted characteristics of landscape “pose difficulties in the depiction and representation of landscape” (Torres 2009, 54). Landscape architects are tasked with graphically representing both physical and intangible phenomena, through a medium that is, in and of itself, an abstraction of reality. In addition, the landscape architect is detached from the landscape, both in the sense that the medium of representation is physically different from that of the actual landscape, and in the sense that landscape representation is prescriptive and generative: it is a representation of something that exists in the mind of the landscape architect as an idea, as something to be built and inhabited, not something that already exists in reality. In representation, landscape processes and systems are necessarily compacted and simplified in order to present a legible image that is, at best, an approximation of the actual landscape. James Corner, landscape architect and theorist, summarizes this notion when he states, “a drawing, any drawing, is radically dissimilar from the medium that constitutes the lived landscape” (Corner 1992, 163-164).

Landscape architects have long attempted to address this difficulty in landscape representation by drawing landscapes (**Figure 1.1**) as one of two image types: as “presentation” images, or as “exploratory” images (Unwin 2008, 59; Wills 2012, 63). These image types are used for one of the following two purposes:

1. To display some known feature or information.
2. To learn a feature of the information that is being represented.

An image that accomplishes the first purpose, to display some known feature, is generally called a presentation image. Presentation images are typically analytical and data driven (e.g. graphs, charts, tables, and schematics), in that their intent is to communicate analytic information without graphic representation getting in the way of what is being communicated. Presentation images are made for the express purpose of conveying information. Because of this, these images are often plain and unembellished; to ensure that there is nothing that might get in the way of understanding the information being presented.

In landscape architecture, presentation images are often used to create “direct analogies between drawing and construction” (Corner 1992, 170). They are used to represent the physical, tangible parts of the landscape. Presentation images in landscape architecture typically include “the plan, the elevation, the section, the axonometric, and, in a lesser way, the perspective” (Corner 1992, 170). Each of these image types is used to graphically document specific elements of the landscape. Plan, elevation, axonometric, and section are used to show spatial relations, thickness, and scale in some way or another. Plans provide a top-down view that shows the horizontal organization of forms and material and space. Sections and elevations reveal vertical relationships and the relational scale between humans and the landscape. Axonometric drawings attempt to combine these two viewpoints by creating a drawing that shows both horizontal and vertical dimensions in relation to one another. Ultimately, all of these projections are meant to aid in construction. Perspective is often left to solely reproduce the “natural vision” (M’Closkey 2014, 118) of a site: what the landscape in question would look like from a single vantage point, at a single point in time.

An image that accomplishes the second goal, to facilitate

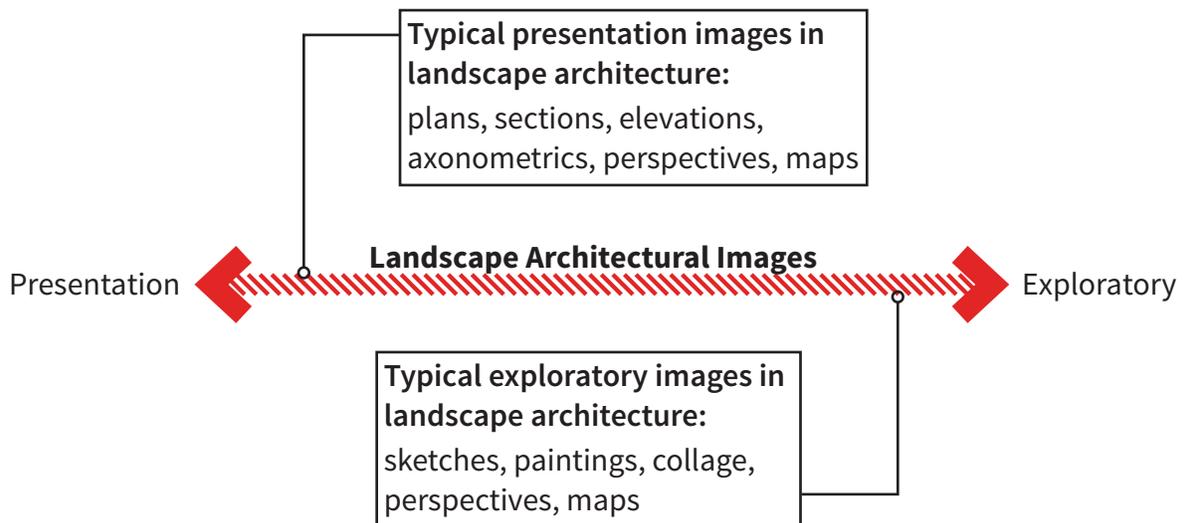


Figure 1.1 Conceptual diagram of typical representation approaches for landscape architectural images. Some images are often used as either presentation or exploratory images, depending on the intent of the image.

learning about a feature that is being represented, is considered to be an exploratory image. These images, in contrast to presentation images, are meant to be helpful for generating ideas and revealing knowledge (Unwin 2008, 60). Exploratory images are generally artistic in nature, and are often (although not always) made for the sole benefit of the image-maker. They are an iterative and transitional form of representation that is often illustrative and not expressly understandable to every viewer. In landscape architecture, exploratory images can include sketches, paintings, or other forms of artful inquiry. These images are often used to help a designer learn about a site or design, as opposed to creating and presenting a finished image to other people.

It is important to note, however, that even though specific image types are often associated with explicit graphic categories (for instance, plan drawings as presentation images), the “difference between the two is not one of content, but of goal” (Wills 2012, 64). A plan drawing or a chart might be thought of as a presentation image, and a sketch or perspective drawing might be thought of as an exploratory image, but only because the former is typically used to present information and the latter is typically used to generate and explore ideas. The content or form of a chosen image does not determine whether or not it is a presentation or exploratory image. The intent of the image is what is important.

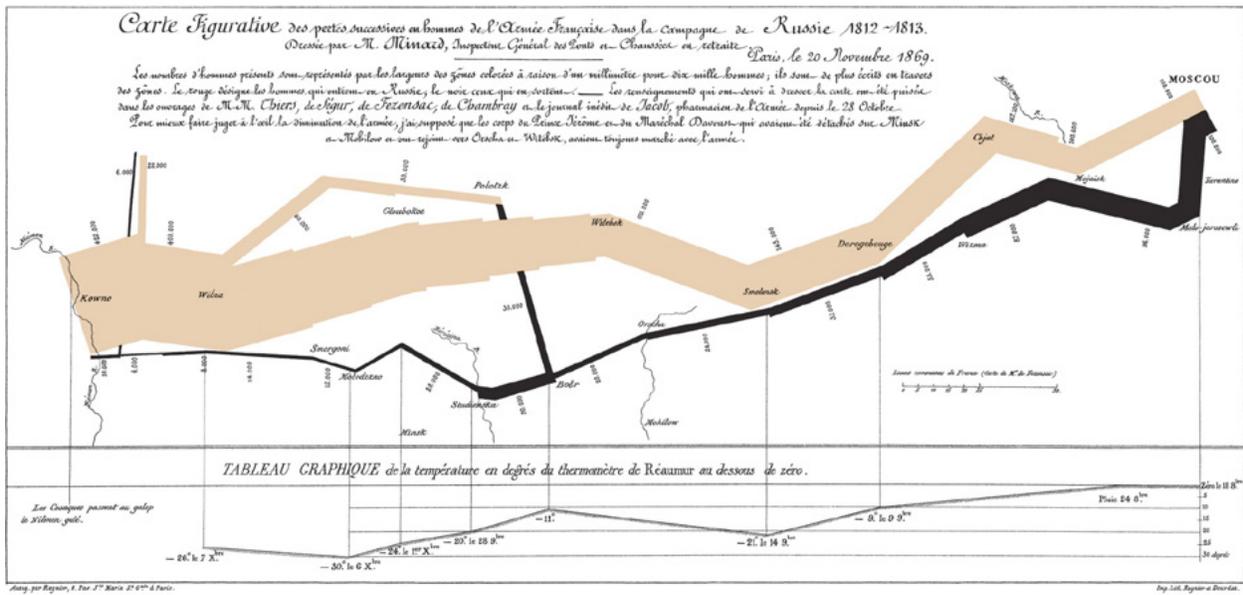
Understanding this duality of image types is important for the very fact that “the way landscape architects make images influences both what and how places are conceived and made” (Dee 2004, 22). Frequently,

landscape architectural images are required to straddle both of these graphic categories, to both present and explore, within the same image. They need to present detailed analytic information while at the same time communicating the intangible processes of the landscape and the unspoken motivations of the designer. Plans, sections, and other typical presentation images are often created in the form and manner of an illustrative exploratory image, intended to do the work of both.

Unfortunately, this combination of presentation and exploratory approaches is often unsuccessful. Landscape architectural images that are skewed too heavily toward presentation prompt the viewer to “bypass the complexity of the proposed landscape and avoid a lengthier but possibly more fruitful discourse” which might have been brought about by more abstract drawing methods (Foley and Tynan 2012, 128). Images that are skewed too heavily the exploration of landscape design risk obfuscating analytical content behind graphic meaning and symbology that only the maker of the image really understands.

If landscape architects expect to design places that respond to both the tangible and intangible aspects of landscape, then an understanding of how to compose images so that they perform both presentation and exploratory aspects equally well is imperative. One way to approach this problem is by understanding the most basic methods that landscape architects use to make and construct images. This project attempts to address this issue by trying to understand one small aspect of this challenge: how do landscape architectural images communicate analytic information?

The term “analysis” is defined by the Merriam-Webster dictionary as the “separation of a whole into its constituent parts.” The intent of any analysis is to study an idea and break it apart into smaller, simpler elements, so that it might be better understood. In landscape architecture, images are often used to accomplish analytical tasks. Images are used to highlight and separate the landscape into discrete, measurable parts, so that they can be easily read, compared, and contrasted, in order to understand how the different parts of landscape systems interact and relate to one another. By understanding how landscape architectural images accomplish this task, analytic elements can be applied to other image types, allowing for the creation of more comprehensive images.



Evaluation of Tufte’s Principles of Analytic Images

In his book, *Beautiful Evidence* (2006), Edward Tufte, statistician, artist, and publisher of several books about visualization and informational graphics, proposes a set of criteria that defines an ideal analytic image. These “Principles of Analytic Design” are rooted in the “fundamental cognitive tasks” (Tufte 2006, 137) that are relevant for both producing and consuming images that present analytic information. According to Tufte, an image that exhibits these principles is one that can be said to be analytic, in that it assists in the understanding and dissemination of critical thought.

The following is a review of all six of Tufte’s principles, presented with their original rationale. Tufte uses Charles Joseph Minard’s map (Figure 1.2) describing Napoleon’s invasion into, and retreat from, Russia in 1812 as an example for each principle. Minard’s map and Tufte’s explanation of how it satisfies all six principles are described and reproduced here:

1. *Show comparisons, contrasts, and differences.* Tufte says that the “fundamental analytical act,” regardless of what is being analyzed, is to make “intelligent and appropriate comparisons” (Tufte 2006, 127). For Tufte, the exact content of what is being compared is not important; visual displays, if they are meant to convey analytic

Figure 1.2 Charles Joseph Minard’s map titled “Figurative Map of the successive losses in men of the French Army in the Russian Campaign 1812-1813.” Originally published in *Tableaux graphiques et Cartes Figuratives de M. Minard, 1845-1869*, and republished by Edward Tufte in his book *Beautiful Evidence*. The map shows the invasion and successive retreat of Napoleon’s army during the Russian Campaign of 1812.

information, should make comparisons. The act of comparing is what makes the image analytic. This use of comparison is most evident in Minard's map with the thick lines that traverse the image. This line shows both the relative size of Napoleon's army at any given moment and geographic location (the line's thickness in relation to its spot on the map), and the difference between the army when invading (tan line) as opposed to retreating (black line).

2. *Show causality, mechanism, explanation, and systematic structure.*

According to Tufte, the reason that we examine evidence is to understand why something is the way it is. This is what he terms a "fundamental intellectual task" and why this principle is important to creating a true analytic image. He notes that this might be as simple as collecting and disseminating data ("measurements are inherently comparative"), and that making comparisons often leads to reasoning about causality. Tufte notes that Minard's map provides thin causal analysis ("the map routes of invasion/retreat show the location of the bad news but do not explain what caused the deaths"), but he also states that the temperature graph at the bottom of the map helps to understand causality by linking cold temperatures to the shrinking black line that represents Napoleon's retreating army (Tufte 2006, 128).

3. *Show multivariate data; that is, show more than one or two variables.* Tufte states that most of the interesting things that we seek to understand are multivariate by nature. Because of this, representational strategies for analytic images should "make multivariateness routine, nothing out of the ordinary" (Tufte 2006, 130). Images that exhibit multiple variables make the first two principles (comparisons and causality) easier to accommodate. In Minard's map, someone looking at the map is able to compare and contrast between multiple variables: "the size of the army, its two-dimensional location (latitude and longitude), the direction of the army's movement, and temperature on various dates during the retreat from Moscow" (Tufte 2006, 29). Comparing these variables against one another allows certain connections to be made: for

instance, when sudden changes in the width of the line (representing the size of Napoleon's army) happen, the viewer can understand where it happened, when it happened, and perhaps even some of the circumstances that led to the event.

4. *Completely integrate words, numbers, images, and diagrams.* Layering and separation of data “can increase the informational depth” of an analytic image through added data density. As an example of this, Tufte uses the example of maps that “routinely integrate words, numbers, line-art, grids, and measurement scales” (Tufte 2006, 131). As an example, Minard's map uses words and numbers to describe the movement and size of the army as it moves into and out of Russia. This annotation acts as a reinforcing component that supports the main graphic element of the map (the varied-width line representing the size of the army). The inclusion of the army size as a number also adds precision to the image – whereas the relative width of the line is sufficient to show that the army decreases in size over time, the numbers allow the viewer to know the size precisely at any given moment and geographic location.

5. *Thoroughly describe the evidence. Provide a detailed title, indicate the authors and sponsors, document the data sources, show complete measurement scales, and point out relevant issues.* Tufte highlights documentation as another important factor in how well an image behaves as an analytic work. He describes it as an “essential mechanism of quality control” in that credibility of evidence is directly tied to the integrity of its authors and their sources. Likewise, Tufte points out that images absent of documentation might signal an “evasion of responsibility,” and therefore an untrustworthy or misleading analytic image (Tufte 2006, 132-133). Tufte calls Minard's map “remarkable” in regards to how thoroughly documented it is. Minard communicates information about himself (the author), the subject of the map, when and where it was created, where the data for the map came from, what scales of measurement were used, and what (if any) assumptions were made in the making and presentation of the map. This level of documentation adds credibility to the map:

viewers are able to retrace Minard's work and confirm his data. In addition, the relationship between the original source of information and its representation is retained. Tufte calls this level of detail "appropriate to nearly all visual presentations of information" (Tufte 2006, 132).

6. *Analytical presentations ultimately stand or fall depending on the quality, relevance, and integrity of their content.* Minard's map, according to Tufte, was not meant to glorify war or to tell a story about Napoleon. It was intended as an "anti-war poster" which focused on the human cost of war by exclusively concentrating on the loss of men. This, says Tufte, "exemplifies the spirit behind excellent analytical graphics: a good knowledge of the content, and a deep caring about the substance" (Tufte 2006, 134). This, he says, also implies that an effective analytic image inherently prioritizes quality. An analytic image should start with the question, "what are the content-reasoning tasks that this display is supposed to help with?" Image aesthetics should follow from there. Tufte also says "the most effective way to improve a presentation is to get better content" (Tufte 2006, 136).

While not initially intended to be specifically applicable to landscape architectural images, Tufte's principles offer a constructive way to characterize how these types of images attempt to communicate analytic content. Each of the six criteria put forward by Tufte attempt to address a different measure of analysis, with the implication that an image is more analytic if it exhibits more of the principles. Thus, Tufte's principles provide a unique sliding scale with which to measure exactly how analytic any specific image is. Since all "excellent" analytic images exhibit these six characteristics (according to Tufte), landscape architectural images that purport to represent analytic content should also exhibit at least some of these characteristics.

Maps and Analytic Images in Landscape Architecture

Maps, as an image type, provide an excellent example to study the integration of presentation and exploratory approaches, and the

communication of analytic content, in landscape architecture. Maps possess a “double-sided characteristic” wherein the map’s surface is “directly analogous” to the features and characteristics of the earth’s surface (Corner 1999, 199), while at the same time exploring specific ideas through selective data and spatial representation. Maps are inherently unable to show a one-to-one representation of *everything*, and are therefore required to be selective in how they reveal “relationships and operations in the land” (Torres 2009, 53). In this way, maps are an image type that can embody both the analytic qualities of a presentation image, while at the same time revealing and creating understanding the same way that exploratory images do. Corner likens this ability of a map’s surface to operate as both an analogue and an abstraction to that of “an operating table, a staging ground or a theater of operations upon which the mapper collects, combines, connects, marks, masks, relates, and generally explores” (Corner 1999, 199).

Maps are characterized by Corner as being constructed or schematized in three distinct “stages”: the “field,” where maps are drawn and where both analogue and abstract observations are made and presented, “extracts,” consisting of representations of the real world being transcribed onto the field, and “plotting,” which describes the drawing and connecting of relationships between the different extracts within the map’s field (Corner 1999, 213-214). With this definition of mapping in mind, what can be considered a map broadens considerably. A map can thus be any number of *extracts plotted* upon a *field* in such away as to allow the connections and comparisons to be made between the data presented.

Specific research into how maps communicate analytic content is a topic that has received little attention in general, and especially in the field of landscape architecture. However, the study of how scientific and analytic graphics present information has been a topic that has been remarked upon intensely by many visualization specialists and statisticians. Most notable perhaps is the work of William S. Cleveland and Robert McGill who published the paper *Graphical Perception: Theory, Experimentation, and Application to the Development of Graphical Methods*, which details “graphical methods for data analysis and data presentation” (Cleveland and McGill 1984, 531) and analyzes how

individuals perceive different types of statistical imagery. The most enduring and oft-quoted result from this research is a “hierarchy of graphic elements used to construct data graphics” (Ellison 1993, 17), which provides a list of graphic elements that people are able to visually decode and understand, ranked from best to worst (**Figure 1.3**). In order, these graphic elements are: position along a common scale, position along identical scales, length, angle/slope, area, volume, and shading. Cleveland and McGill call these “elementary graphical encodings,” and emphasize that they are only the most basic guidelines for encoding information into presentation graphics (Cleveland and McGill 1984, 552). This research provides a basis for understanding how analytic content can be displayed and understood graphically in a basic presentation image, and also poses an interesting question for further research: what graphic elements do other images use to communicate this type of information?

In the last 15 years, landscape architects and theorists have begun to investigate the potential for “new kinds of visual research methods and communication in landscape architectural research.” Landscape theorist Catherine Dee refers to this new inquiry as “critical visual study,” and has suggested that landscape architects should explore graphical representation strategies “in which imagery is employed both as method to investigate and as form to communicate a research study” (Dee 2004, 14). She outlines five areas of visual study that loosely overlap and provide a foundation for future research, including mapping. The five areas of study that Dee suggests are: art as inquiry, dialogic drawing, hypothetical design, mappings, and visual narratives.

Specifically related to mapping, Dee advocates for the examination of the uses and meanings of maps by “looking critically at their relationship to place and what they tell us about cultural and social practices and values” (Dee 2004, 23). She further defines the critical visual study of maps through three example investigations: the use of mapping to generate new forms or ideas, to study movement and practices, and to explore undefined boundaries. She mentions the idea of creating new representation techniques through the combination of cartographic media and “new kinds of imagery,” (Dee 2004, 24) but does not elaborate beyond this broad statement.

Still, the study of mapping as a specific image type or as a

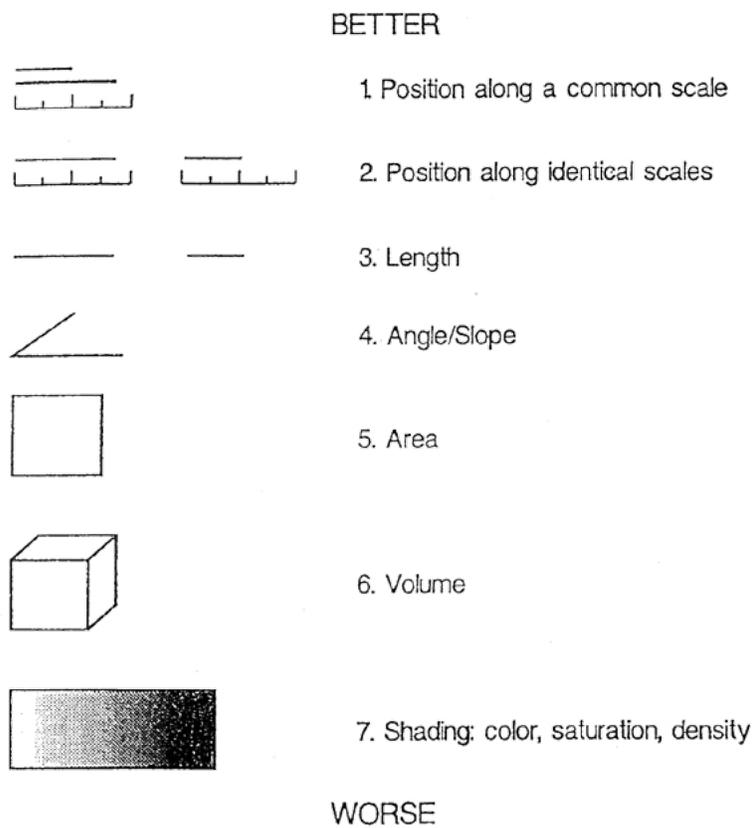


Figure 1.3 Cleveland and McGill's Ordering of "elementary graphical encodings" according to their relative accuracy in representing quantitative variation (Ellison 1993, 17).

research agenda in landscape architecture is sparse. Most prominent are the writings of James Corner about the "agency of mapping," although Corner himself acknowledges that he is more interested in how maps can work to explore new concepts and ideas rather than how they can present analytic information: "I am less concerned with what mapping *means* than with what it actually *does*. Thus, I am less interested in maps as finished artifacts than I am in mapping as a creative *activity*" (Corner 1999, 201).

Research Statement

The central hypothesis of this project is that current methods of drawing and representing the landscape, do not, in general, do a good job of expressing the multiple physical and intangible processes inherent in landscapes. Ultimately, this project attempts to address this issue by trying to understand one smaller aspect of this challenge: how do landscape architectural images, and specifically landscape architectural maps, communicate analytic information?

Maps present an excellent image typology for developing an understanding of how analytic content is communicated graphically. Maps have the characteristics of both a presentation and an exploratory image: they are at the same time, an analogous presentation of the world as it is, and also a graphic method to explore relationships and operations within the landscape. They are therefore an excellent image typology to analyze in order to understand the visual communication of analytic content.

This project proposes a framework for analyzing, categorizing, and contextualizing the basic visual methods that landscape architects use to communicate analytic information in maps. For the purpose of this project, these “methods” have been called “techniques,” defined as the most basic graphic procedures used to visually communicate an idea, and in the case of this project, to specifically communicate analytic content. Edward Tufte’s Principles of Analytic Design are used as a basis for this framework, as they provide a set of criteria that can be used objectively to understand and contextualize graphic techniques.

This framework is used to 1) better understand the visual characteristics and techniques that maps use to present analytical information, 2) break down analytic representation techniques into their component parts (similar to Cleveland and McGill’s elementary graphical encodings), and 3) document the visual language used to communicate analytic content in landscape architectural maps.

Chapter Preview

This chapter provided a broad background about landscape architectural images, examined Edward Tufte’s Principles of Analytic Design as a framework for understanding analytic images, assessed the past and current research into the understanding of analytic images in landscape architecture, and defined maps as an image type useful for exploring the communication of analytic content. The following chapters consist of the documentation of methods, results, analysis, and discussion of this research.

Chapter 2 discusses the methodological approach used to analyze landscape architectural maps, the theoretical underpinnings of this research, criteria for map selection, and methods of analysis.

Chapter 3 presents the results and analysis of the research, including the categorization of analytic representational techniques, their applications and implications. Chapter 4 discusses the significance of the research, its limitations, and applications to other types of landscape architectural images.

2 Methods

Methodological Approach

The purpose of this project is to understand how images created for landscape architectural practice visually communicate analytic content. The principle methodological approach used to understand this question is an adaptation of Edward Tufte's Principles of Analytic Design. In his book, *Beautiful Evidence*, Tufte asserts that all excellent analytic graphics exemplify the "fundamental principles of analytic design," outlined as six criteria that an image must meet if it is to be considered an analytic image (Tufte 2006, 122). Tufte's criteria were used to evaluate landscape architectural maps for how well they communicated analytic content. The result of this evaluation was then used to identify, categorize, and evaluate 'analytic representational techniques' (defined in this project as the most basic graphic procedures used to communicate analytic content) specific to landscape architectural maps.

Tufte's criteria were used as the basis for an analytic framework (Figure 2.1), which itself was used to examine landscape architectural maps in order to determine the visual techniques they use to convey analytic information. The objective of this framework was fourfold. First, Tufte's principles were used to understand whether or not, and to what extent, landscape architectural maps could be considered analytic. Second, it identified, categorized, and documented the visual techniques used by each map to communicate analytic content. Third, the framework isolated each technique by breaking it down into "elements," in order to understand the component parts of each technique, and how those parts are combined to convey specific analytic information. And fourth, the framework aggregated techniques for communicating analytic content and suggested their applicability to other types of landscape architectural images. Each of these objectives is discussed later in more detail.

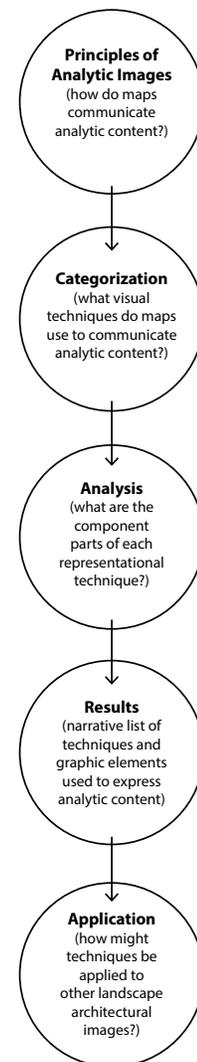


Figure 2.1 Analytic framework used to examine landscape architectural in order to determine visual techniques used to communicate analytic information.

Theoretical Foundation

First, it is important to understand this project in the broader context of landscape architectural research. In the text *Landscape Architecture Research: Inquiry, Strategy, Design*, the authors M. Elen Deming and Simon Swaffield outline nine specific “strategies of inquiry” as a way to categorize and understand landscape architectural research practices (Table 2.1). These strategies are situated along two primary research dimensions.

The first dimension describes a continuum between inductive and deductive approaches. The inductive approach describes research “grounded in the world of experience and empirical evidence,” and the deductive approach describes research that tests theories through a “formal processes of experimentation, evaluation, and argumentation” (Deming and Swaffield 2011, 7). Deming and Swaffield also propose an intermediary approach that they term “reflexive,” which describes a theoretical interaction between both inductive and deductive strategies.

The second dimension relates to the researcher’s epistemological approach. Deming and Swaffield define the positions along this axis as objectivist and subjectivist, with an intermediate position labeled constructionist. The objectivist position is typically related to the natural sciences and emphasizes maximizing “internal and external validity.” Opposite this is the subjectivist approach, which is focused on creating “systems of new knowledge and new realities” (Deming and Swaffield 2011, 8). In between these theories of knowledge is the constructionist position, which presumes that “knowledge is generated through the interaction between the investigators (and their society) and a reality (or

Table 2.1 Strategies of Inquiry in Landscape Architecture Research (from Deming and Swaffield 2011). This project is primarily situated in the “classification” and “evaluation” strategies.

	Inductive (theory building)	Reflexive (theory/practice interactions)	Deductive (theory testing)
Objectivist	Description	Modeling	Experimentation
Constructivist	Classification	Interpretation	Evaluation
Subjectivist	Engaged Action	Projective Design	Argumentation

realities) that exists but that can never be known independently of the presumptions of the investigators” (Deming and Swaffield 2011, 8-9).

The methodological approach to this project exists in the constructionist position, using a deductive approach to first test and evaluate Tufte’s theories on analytic images to see if they work when applied to landscape architectural maps. The framework also proposes using an inductive approach to categorize techniques that define how landscape architectural maps communicate analytic ideas. This classification process aims to create new knowledge by sorting observed patterns and themes into specific, describable categories.

Map Set Selection

In *Beautiful Evidence*, Tufte refers to maps as “the heart and soul of good practices in analytic graphics” (Tufte 2006, 130). Maps can have the characteristics of both a presentation and an exploratory image: they are at the same time, an analogous presentation of the world as it is, and also a graphic method to explore relationships and operations within the landscape (Corner 1999; Torres 2009). They are therefore an excellent image typology to analyze in order to understand the visual communication of analytic content. As such, landscape architectural maps were selected as a key image typology to be analyzed in order to understand how landscape architectural images in general communicate analytic content.

Criteria for map selection were primarily based on the availability of easily accessible and well known map sets containing a large number of similar images composed by the same author. These criteria allowed for consistency and reliability in comparisons between maps. The map author’s standing in the world of landscape architectural theory and imagery was also considered important. Using maps created by a well-known and respected author makes them identifiable and more readily accessible to this project’s target audience of professional landscape architects.

Additionally, map sets were chosen based on the availability of written supporting documentation for each set, relying on existing compilations, publications, and supplemental writings to provide background information about the image generation process and

rationale behind each map. Writings from both the authors themselves and from landscape architectural theorists were considered important supplemental information, as, in combination, they provided a more complete understanding of the maps being analyzed. This project seeks to further build upon the understanding cultivated by these earlier writings. As a result of this requirement for previous scholarship, recently constructed and published maps were not considered for analysis.

Initially, three sets were considered: the layer-maps exhibited in Ian McHarg's *Design With Nature* (1969), James Corner's mapped images from *Taking Measures Across the American Landscape* (1996), and Alan Berger's maps in *Reclaiming the American West* (2002). To allow for the comparison of data, it was determined that at least two of these map sets should be analyzed. Authors and maps from different times and of different graphic style and composition were preferred in order to provide a range of different graphic techniques to analyze. The intent was to explore the breadth of map representation in landscape architecture. Both Corner and Berger utilize similar styles and conventions in their maps, employing collage and eidetic montage as foundational elements in their mappings. Ultimately, Berger's maps were deemed too similar to Corner's in composition and style, and were therefore dropped from consideration. McHarg and Corner map sets were chosen for analysis.

These two map sets were chosen not only for how well they match the criteria above, but also for how much they contrast between one another. The two map sets convey different types of information, and contrast greatly in visual style and method. These differences provide two very different opportunities to evaluate how landscape architectural maps can communicate analytic content.

Ian McHarg's maps in *Design With Nature* primarily convey ecological and physiographical information: land qualities, geologic and soil features, vegetation types, and how those features interact with and dictate the suitability of human activity and settlement. His mappings "depict a synoptical landscape from above, based on layering and transparency, where various strata of information are given gradations based on their relative values" (Torres 2009, 54). When they were first published in 1969, McHarg's maps were one of the first forays into the visual layering of data sets in order to understand how different land

conditions might affect one another. Their composition is very much a product of the technology available at the time, being limited to a small number of manually printed colors, each one overlaid atop another. The method of printing and map construction available at the time was a major factor in how McHarg's maps were made and presented.

James Corner's maps, created and published nearly 30 years after McHarg's *Design With Nature*, show how landscape architectural theory and image creation has changed since then. Corner utilizes more of an art-based approach to create his maps, using collage and photomontage, in addition to cartographic information and projections, to convey the state of the landscape. This approach is much more esthetic than McHarg's, and is another method that attempts to convey an analysis of the landscape visually. Corner's process of combining collage, image extracts, and computer cartography also highlights the advancements made in graphic technology since the time of McHarg's analog maps.

In *Taking Measures Across the American Landscape*, Corner, along with co-author Alex MacLean, attempts to use maps coupled with photographs in "critical ways," to "explore and reveal hidden dimensions of the landscape and provide a commentary on power, measurement, the past and ways of looking, recording and conceiving" (Dee 2004, 18). Since publication, *Taking Measures* has been lauded as a seminal work in the landscape architectural profession, earning both the Institute of Architects International Book of the Year Award and an American Society of Landscape Architects Honor Award in 1997. Corner's maps continue to be influential for map composition in landscape architecture more than 20 years after their publication.

Both McHarg and Corner are well-known and respected figures in the field of landscape architecture, and their publications have been widely praised for the use of maps to convey landscape architectural ideas. Ian McHarg (1920-2001) was the founder of the Department of Landscape Architecture at the University of Pennsylvania, and his work, specifically the ecological studies documented and mapped in *Design With Nature*, helped to "redefine the design of new communities and regional planning" in the United States, in addition to influencing U.S. environmental policy (The Cultural Landscape Foundation). James Corner (1961-) is a practicing landscape architect and theorist, former

chair of the Department of Landscape Architecture at the University of Pennsylvania School of Design, and principal at and founder of the landscape architecture firm James Corner Field Operations. He has been recognized with many design awards, including the 2010 National Design Award and the 2004 American Academy of Arts & Letters Award in Architecture. In addition, he is well-known for his many writings and essays on landscape architectural theory and representation.

Specifically, McHarg and Corner's books provide multiple maps for analysis, and are already widely used in landscape architectural practice, teaching, and theory. As both *Design With Nature* and *Taking Measures* are currently in-print publications, they are easily accessible to landscape architecture professionals and lay-people alike, and along with the maps, they provide ample supporting documentation about both the evidence used to create the maps, and the integrity of their content.

Twenty (20) images from each map set were selected for analysis using Tufte's principles, for a total sample size of forty (40) images. While both map sets contain over 20 images that could be analyzed, in both cases some images were omitted from consideration because they were very similar to other images in composition, style, and subject. It was determined that analyzing these similar maps would not provide significantly new or different data, and were therefore ultimately left out of the sample map sets. This number of sample maps also allowed for a diverse selection of images from both map sets to be analyzed, while still keeping the sample size small enough to be completed in the limited time available for image analysis.

The twenty maps in each map set were given an identifying reference number, each one beginning with a letter to denote whether it belonged to the Corner map set (C), or the McHarg map set (M). Maps were then numbered from 1 to 20 in the order that they appear in their respective publication (*Design With Nature* or *Taking Measures Across the American Landscape*). All images selected for analysis are documented in Appendix A.

Map Set Analysis

Each map was evaluated using Tufte's principles as the basis for analysis, with the goal being to understand the analytic content present

in each map, and then to further break down that content into its visual component parts, which include the visual elements and processes used to specifically communicate analytic information.

Tufte's Principles 1 through 4 were used in this analysis specifically. This limited scope of inquiry was chosen in order to isolate and focus on the graphic aspects of landscape architectural maps, which are more readily expressed in Tufte's first four principles. Principle 5 (*thoroughly describe the evidence*) was not prevalently seen as a graphic element in landscape architectural maps. Instead, landscape architectural maps often exhibit this principle in different ways – through supplemental texts and other presentation methods, for example. As such, Principle 5 was dropped from the framework as an essential criterion, although it was still considered and noted when it occurred as a part of an image, or appeared in supplemental texts and documentation. Principle 6 (*Analytical presentations ultimately stand or fall depending on the quality, relevance, and integrity of their content*) was determined to be unmeasurable, and was also dropped as an essential criterion.

Analysis of each map was achieved through the careful consideration of the following three questions for each map:

1. Does the map exhibit (or show evidence of the use of) specific analytic principle(s) proposed by Tufte, and if so, which one(s)?
2. What is the analytic content that is being communicated in the map?
3. What are the visual elements and processes (techniques) that are used to represent the analytic content?

The intent of these questions were to understand how exactly each map was graphically communicating analytic content, and to understand what type of analytic content it was representing (and by association, which of Tufte's principles it was utilizing). The first question isolated which specific principle (or principles) a specific graphic technique was attempting to address. The second question then further examined what the analytic content of the map was (what was being communicated), and the third question helped to understand and describe the visual technique(s) (elements and processes) used in the map to communicate analytic content. This process resulted in indentifying a

total of six analytic representational techniques. Each of these techniques were identified in at least 50% of images (10 out of 20), in at least one of the two map sets.

A narrative description of the visual techniques used to communicate analytic content and examples from the map sets documenting these findings was compiled and are presented in the following chapter. The end result, for each technique, was a written and visual description documenting the techniques used to communicate analytic content. The framework also had the added benefit of confirming whether or not the map being analyzed did indeed contain analytic content, as determined by Tufte's principles, and to what degree. The result of the analysis was a list of techniques that are used in specific landscape architectural maps (from the Corner and McHarg sets) to communicate analytic content.

3 Results and Analysis

Identified Techniques

The Corner and McHarg map sets were each visually evaluated to distinguish techniques used to graphically represent analytic content in maps. Six (6) such graphic techniques were identified, all of them having occurred in at least 50% percent of the maps of at least one of the two map sets. Four other techniques were considered, but they either did not occur with a high enough frequency to adequately evaluate and describe, or it was later decided that they did not fulfill the definition of a technique. The identified techniques comprise a broad range of graphic qualities and help to break down the visual language used to represent analytic content in landscape architectural maps. These techniques have been defined under two broad categories that describe their use in analytic maps: compositional and evocative techniques. **Table 3.1** shows the distribution of each technique for each map in both the Corner and McHarg map sets. Each technique is composed of one or more graphic elements that make up the component parts of a technique. These techniques, the elements that define them, and how they are applied to communicate analytic information are explored in detail in this chapter.

Compositional Techniques

The first category of techniques, **compositional**, describes techniques that affect the way a map is fundamentally constructed or arranged, and in turn, how it structures analytic content within the map, and includes the following techniques:

- Contrast: specific map features are compared and contrasted against one another through the use of visually dissimilar elements, primarily through the use of color and pattern.

Analytic Representational Techniques

		Compositional Techniques			Evocative Techniques		
		Contrast	Series	Scales	Broken Frames	Multiple Views	Extracted Image Fragments
Corner Map Set	C-01	X			X	X	X
	C-02	X		X	X	X	X
	C-03	X			X		
	C-04	X			X		
	C-05	X			X		
	C-06			X		X	
	C-07	X		X		X	X
	C-08			X	X	X	X
	C-09		X	X			X
	C-10			X			X
	C-11			X	X		X
	C-12	X		X	X		X
	C-13		X	X	X	X	X
	C-14	X			X		X
	C-15	X			X	X	
	C-16	X			X		
	C-17		X	X		X	X
	C-18					X	
	C-19					X	
	C-20		X	X	X	X	X
McHarg Map Set	M-01	X	X				
	M-02	X					
	M-03	X	X	X			
	M-04	X					
	M-05	X					
	M-06	X	X				
	M-07	X	X	X		X	
	M-08	X	X				
	M-09	X	X	X			
	M-10	X	X	X		X	
	M-11	X					
	M-12	X	X			X	
	M-13	X	X				
	M-14	X	X				
	M-15	X	X				
	M-16	X	X			X	
	M-17	X	X			X	
	M-18	X	X				
	M-19	X	X				
	M-20	X	X			X	

Table 3.1 Distribution of the six identified analytic representational techniques in each map in the Corner and McHarg map sets. Each map is viewable in appendix A under the name and order listed in this table.

- Series: specific map features are arranged through the use of repeating elements in spatial or temporal succession.
- Varied Scale: specific map features are composed at different scales and juxtaposed against each other.

Contrast

This technique incorporates the use of contrasting graphic elements to differentiate discrete parts of a map. Four specific graphic elements are used in various combinations to achieve contrast in an analytic map: hue, chroma, value, and pattern. Three of the four elements used to show contrast come from the color theory of Albert Henry Munsell, which is visually summarized in **Figure 3.1**. Contrast was observed as a major technique in 10 of 20 maps in the Corner set and in 20 of 20 maps in the McHarg set. **Table 3.2** shows the distribution of the contrast technique throughout both map sets, including corresponding graphic elements.

Hue refers to color, or more specifically, the quality by which one color can be distinguished from another color (Munsell 1905, 14). Hue is applied as an element in creating contrast in several ways. It can be employed as a set of distinct, easily recognizable colors (e.g. primary colors, secondary colors), or as a progression of colors (e.g. warm to cold). These applications of hue are used to separate and distinguish between multiple discrete features within a map.

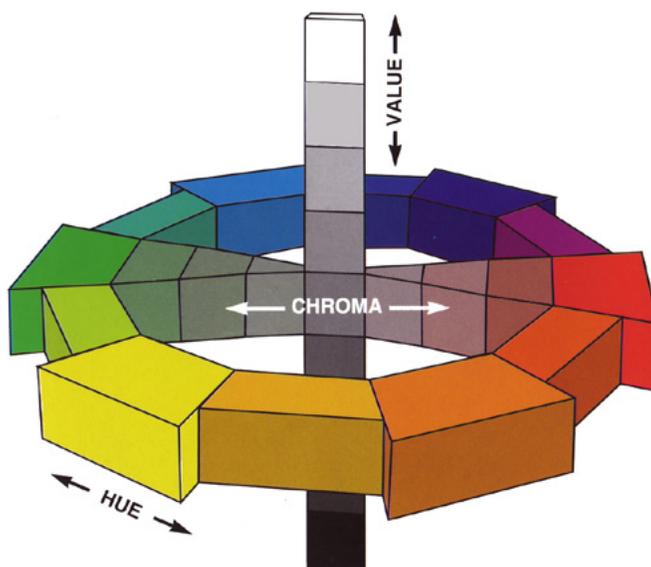
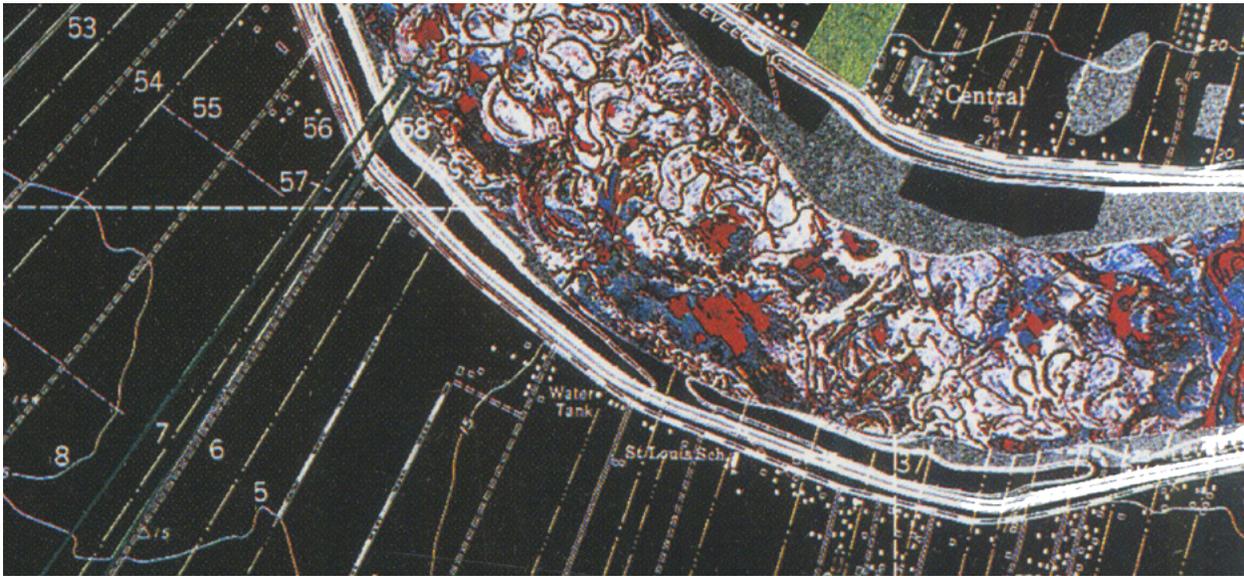


Figure 3.1 Relationships between hue, chroma, and value, as described by Albert Henry Munsell.

		Elements of "Contrast" Technique			
		Hue	Saturation	Value	Pattern
Maps (Corner Set + McHarg Set)	C-01	X			
	C-02		X		
	C-03		X		
	C-04	X			
	C-05	X			
	C-07	X			
	C-12		X		
	C-13		X		
	C-14	X			
	C-15	X			X
	C-16	X			
	M-01			X	
	M-02			X	
	M-03			X	X
	M-04	X			
	M-05	X			
	M-06			X	
	M-07			X	
	M-08	X			
	M-09	X			
M-10			X		
M-11			X		
M-12	X		X		
M-13	X			X	
M-14	X		X		
M-15	X		X		
M-16	X				
M-17	X			X	
M-18	X		X		
M-19	X		X		
M-20	X		X		

Table 3.2 Distribution of the contrast technique throughout both map sets, including corresponding graphic elements (hue, saturation, value, and pattern).

Chroma (also called saturation) is the purity or intensity of a color. In practical terms, a saturated color will appear brighter and richer, while a desaturated color will appear dull and grayish. The application of chroma in an analytic map allows the mapmaker to highlight specific, important elements by saturating one feature to emphasize it. Simultaneously desaturating surrounding features increases the effect by intensifying the contrast between the two features even more.



Value is the lightness or darkness of a color. Lighter values of a given color are called tints, while darker values of a given color are called shades. In application, value creates a gradient that moves from light to dark, independent of hue. This can be used to represent different yet related features (i.e. different categories of the same variable, like temperature, or elevation).

Lastly, patterns can be used as a contrasting element, consisting of hatching, halftones, or other repeated non-representational two-dimensional symbols. Patterns work in much the same way that hue does, by contrasting two dissimilar entities against one another. Unlike hue, patterns are inherently spatial: a graphic pattern is only visible when it is repeated consistently over a specific area of the map. Patterns are also dependent on scale: there must be enough repeated elements for the viewer to register them as a pattern. If the scale is too large, the pattern is illegible and will not work as a contrasting element.

Contrast, as a graphic technique, is typically applied to analytic maps in two distinct ways: first, it can be used to separate discrete yet related features that are part of a set, and second, it can be used to highlight a specific, important features.

An example of the first application is James Corner's map *Long-Lots along the Mississippi River* (Map C05, Figure 3.2), which depicts the shifting floodplains of the Mississippi through the use of red, blue, and white hues. These colors perhaps represent flood stages throughout

Figure 3.2 Excerpt from Map C05, *Long-Lots along the Mississippi River* by James Corner (Corner and MacLean 1996, 63).

time or season, but Corner does not elaborate on this point. Each distinct color is easily distinguishable from the other, allowing the viewer of the map to better understand the stages and temporality of the flood cycle. The shifting configurations created by the use of different hues lend an understanding of time to the viewer, by representing not only yearly flood cycles, but also by visually showing how the river is not one static channel; it moves and changes over time.

The second application of this technique contrasts subtle and exaggerated elements, viewed and compared against their immediate context, to highlight a specific element. Corner uses this technique to focus a viewer's attention on specific rail routes (**Map C02, Figure 3.3**) by using saturated red lines, which, when viewed against the subtle, desaturated black and white map context, jump out at the viewer.

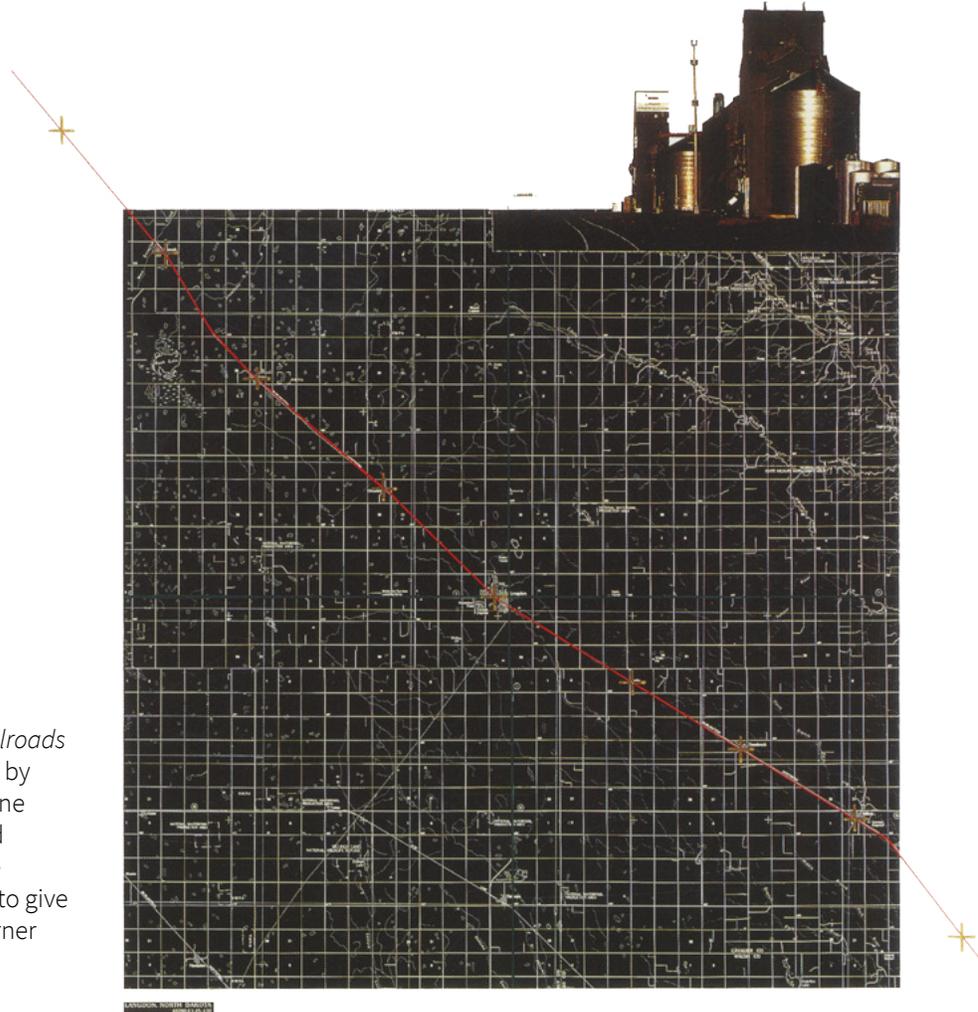


Figure 3.3 Map C02, *Railroads Across the Northern Plains* by James Corner. The red line representing the railroad is contrasted against the desaturated background to give it visual importance (Corner and MacLean 1996, 55).

Series

Another compositional technique used in analytic maps is the arrangement of elements into a series, defined as a “number of things... of the same class coming one after another in spatial or temporal succession” (Merriam-Webster). The arrangement of elements into a series is used in two ways: one to show progression or temporality concerning the subject of the map, and two as an organizational way to compose the physical map in order to present information in an ordered, logical way.

In the Corner map set, this technique is used to demonstrate the idea of progression by juxtaposing several iterative images against one another. The viewer is able to view each image as a part of an overall trend (as a part of the series), and therefore make inferences about the substance of the map. Corner also uses this technique to show change over time, with images in a series changing along a given timeline. The McHarg map set uses this technique differently to accurately describe large data sets: through the repetition of the same or similar maps (with slight spatial changes between each one), McHarg is able to highlight specific data sets while at the same time comparing them to one another. This technique prompts the viewer to make correlations between the different maps, and therefore understand how each data set is interrelated. Series was observed as a major technique in 4 of 20 maps in the Corner set and in 16 of 20 maps in the McHarg set.

Corner’s use of series to communicate temporal and spatial data can be seen in the map *Field Plots* (**Map C13, Figure 3.4**). The map itself shows the spacing, marking, and dimensions of a flower field. Superimposed over the top of map, a series of images describes the planting calendar of the field. This series consists of rectangular images of differing widths, spaced in order from left to right. In this example Corner uses the series technique to show both a spatial succession (with one species of plant following another) as well as a temporal one (showing planting timing from early through late season crops). The duration of a planted crop is also alluded to through the width of each image, and perhaps the planting/working time indicated by the gaps in-between each image. This use of series adds a temporal dimension to the map that would not exist otherwise. It is also interesting to note that this interpretation of the map is aided by Corner’s writing which is associated

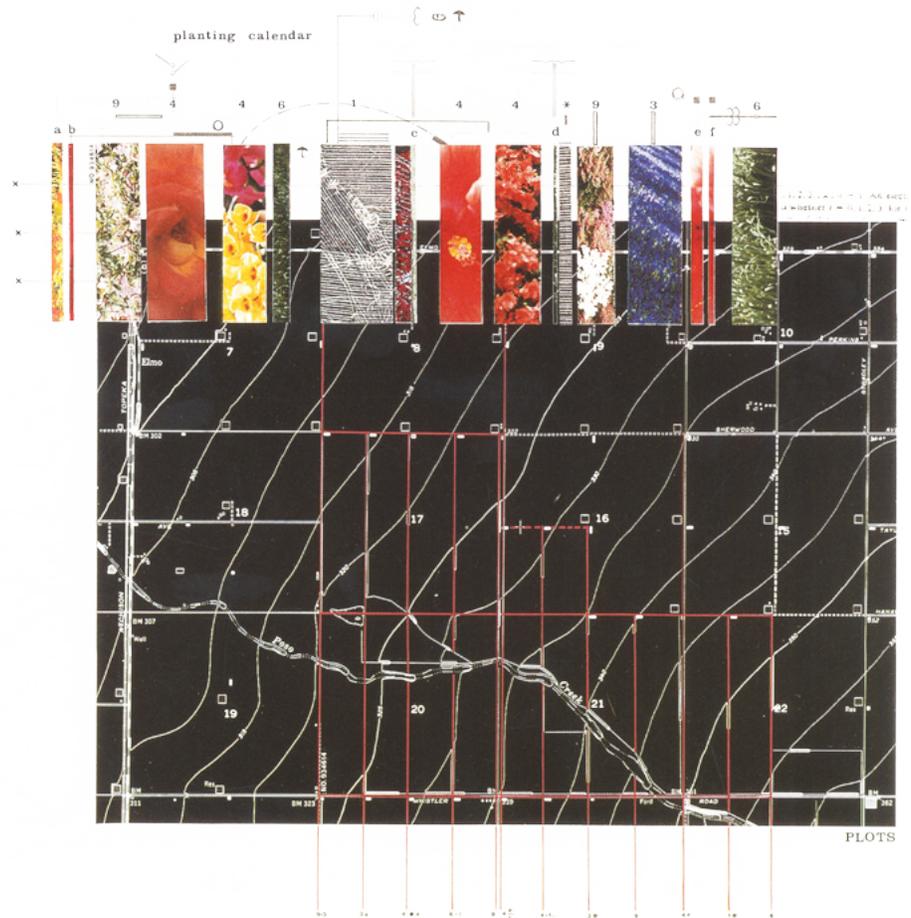


Figure 3.4 Map C13, *Field Plots* by James Corner. An example of the use of series to communicate temporal and spatial data (Corner and MacLean 1996, 113).

with the map in *Taking Measures*. This interpretation of the planting series would be difficult to grasp without the supplemental information provided by Corner.

Corner also uses series in his map of *Longhouse Cave* (Map C17, Figure 3.5). In this map, Corner records the change in daylight within the cave through the use of a sequence to record the movement of the sun and how it changes over time. The black shapes along the left- and right-hand edges of the map represent the changing sunlight and shadows within the cave as the sun rises and sets. Corner repeats the series, once for the winter sun, and once for the summer sun. The annotated lines that accompany each series provide a timeline for the viewer to compare against, and to denote when the sun rises and sets. This use of a temporal series serves two purposes for the viewer: first, it allows comparisons between times of day. “How does the sun’s position change from early morning to late afternoon? What parts of the cave are in shade, and



Figure 3.5 Map C17, *Longhouse Cave* by James Corner. The black shapes along the left- and right-hand edges of the map represent the changing sunlight and shadows within the cave as the sun rises and sets (Corner and MacLean 1996, 141).

when?” In addition to answering questions about change over the course of a day, the map allows the viewer to also juxtapose seasonal changes between winter and summer. This information, combined with the plan view map of the cave, allows the viewer to understand why parts of the cave remain unoccupied, and why other parts are inhabited.

The maps in the McHarg set, in contrast to the Corner set, use series in a different way. McHarg’s maps are often composed of multiple small maps, combined together in a spatial series to create one larger composite map. An example of this is McHarg’s map-series of Staten Island (**Map M08, Figure 3.6**). Each map in the series uses the same base showing the landmass that makes up Staten Island, with the only changes between each map being a different, yet related, set of data. In this way, McHarg is able to compare and contrast various related spatial data sets, including existing conditions, slope, and limitations.

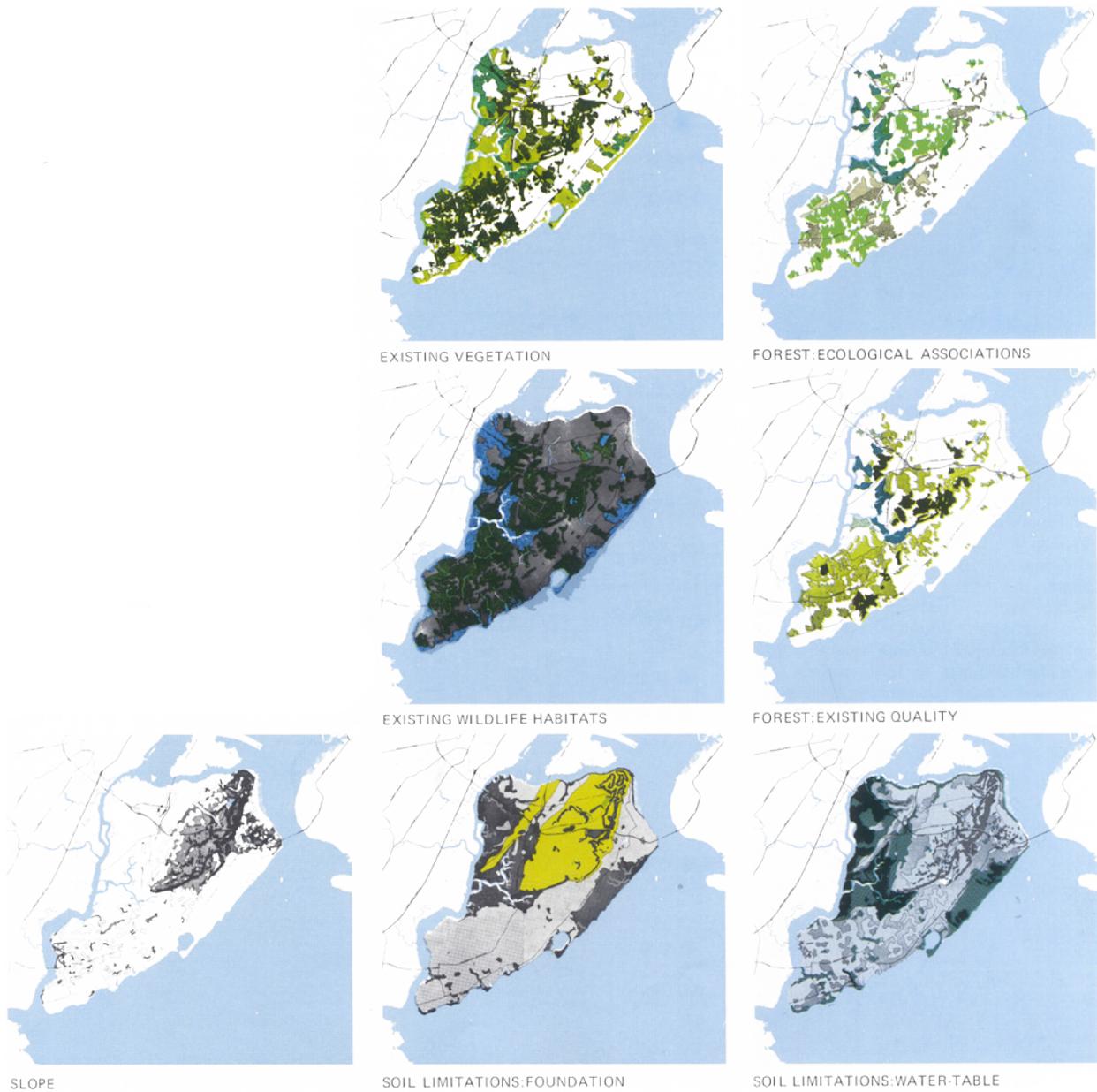


Figure 3.6 Map M08 by Ian McHarg. A series of maps are plotted together, enabling various related spatial data sets to be compared (Mcharg 1969, 107).

Varied Scale

The final compositional technique describes the use of varied scales juxtaposed against each other to highlight important information, or to compare and examine elements. This is accomplished by controlling the scale that particular features of a map are experienced at, which in turn changes the amount of information that is visible to the viewer. This alteration of scale allows the mapmaker to either show a wide variety of fine-grain information up close, or to zoom out to force the viewer to focus instead on overall patterns rather than minute details. When multiple scales are combined within the same map, the viewer is able to compare and contrast between the two, ultimately resulting in a more analytic map. Varied Scale was observed as a major technique in 10 of 20 maps in the Corner set and in 4 of 20 maps in the McHarg set.

This technique varies depending on how it is applied to any specific map. One application is to use multiple scales within the same map, in order to focus on one specific aspect at a fine-grained level of detail, while at the same time highlighting an overall pattern at a coarser-grained level of detail. This exhibition of multiple, yet concurrent scales allows the mapmaker to include various levels of detail within the same map. Scale is also used to modify how much information is available to the viewer, hiding or omitting unimportant information so that important information might be highlighted.

Corner's map *Pivot Irrigators II* (**Map C10, Figure 3.7**) is an example of multiple scales being present in one map. This map depicts "giant, mile-long water-sprinkler arms" (Corner and MacLean 1996, 91) that rotate around a central pivot. This type of irrigation results in fields that appear as large circles when viewed from high above. The inclusion of multiple scales allows Corner to show multiple aspects of pivot irrigation within the same map. The large, superimposed map shows pivot irrigation circles in great detail (the large circles inscribed into the map with a radius-line extending from the center), showing exactly how the fields are carefully prepared with under-drainage layers, and precisely where irrigation lines are placed. At the same time, portions of the map zoom out to show the pervasive pattern that the act of pivot irrigation makes on the farming landscape. This is specifically visible along the top edge of the map where the red and white circles contrast against a black

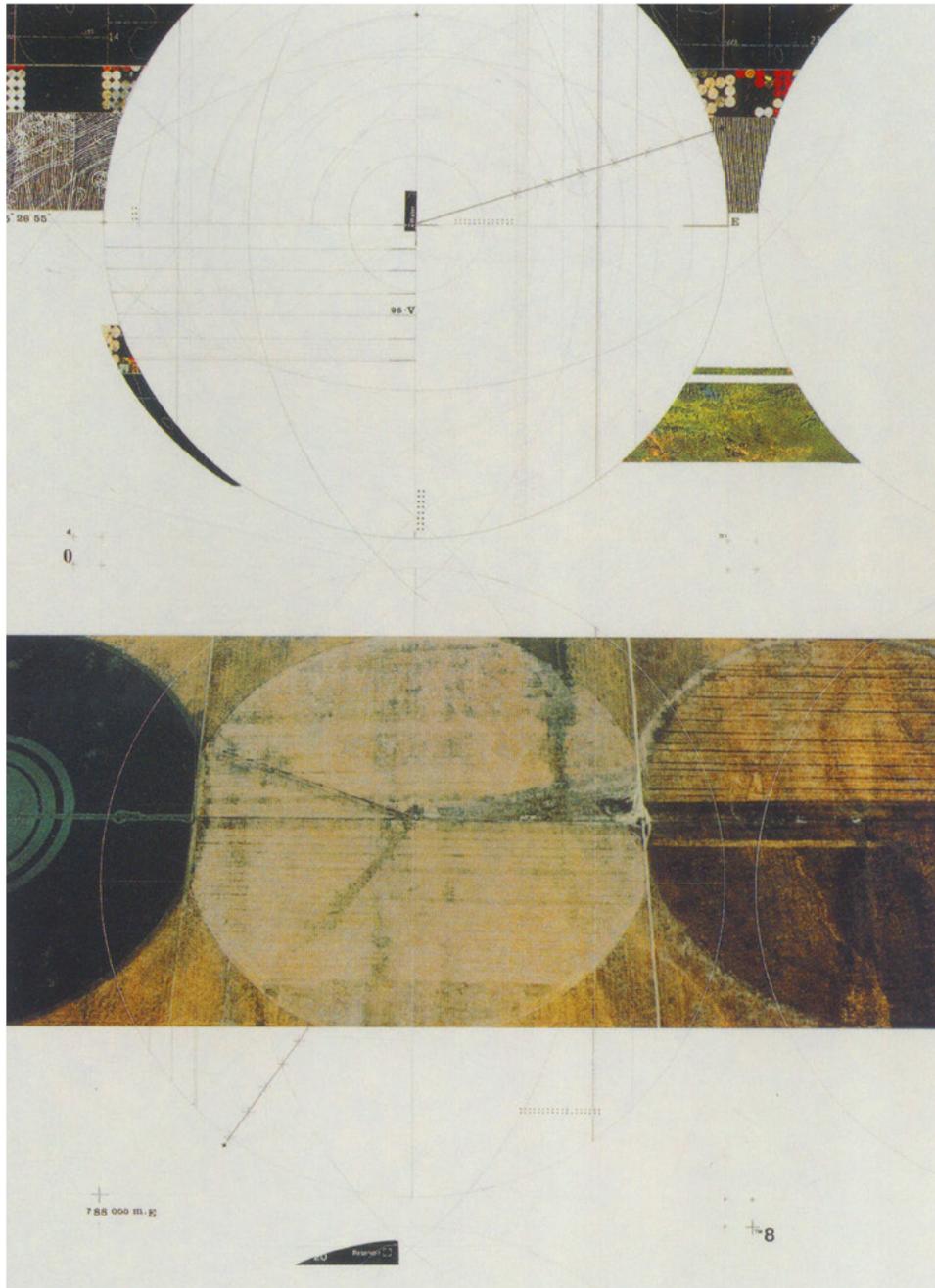
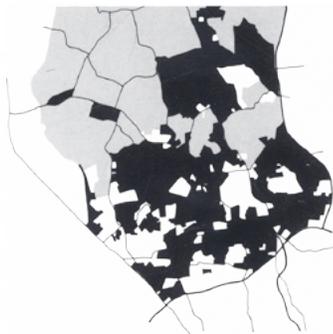


Figure 3.7 Map C10 *Pivot Irrigators II* by James Corner. Multiple scales increase information density, communicating both site conditions and overall patterns (Corner and MacLean 1996, 91).



1963 LAND USE

Figure 3.8 Map M03 by Ian McHarg. The larger map shows detail, allowing the smaller maps to show less information, heightening the importance of what is visible (McHarg 1969, 62).



1963 UNIMPROVED LAND VALUE
IN FIVE VALUES, \$1,000 to \$7,000



CURRENT SUBDIVISION ACTIVITY



SEWERS AND HIGHWAYS

background. By including both scales, Corner is able to communicate more information with the map.

McHarg uses varied scales in combination with the series technique to adjust the amount of information that is communicated by each map. In map M03, (**Figure 3.8**), the larger map shows detail, while the smaller maps are abstracted to show less information, heightening the importance of what is visible. By including both scales in the maps presented, McHarg is able to highlight and communicate specific information, while still including enough context that the viewer can understand that both scale maps are representative of the same place.

Evocative Techniques

The second category of techniques, **evocative**, describes techniques that are added as a non-structural part of the map which are meant to heighten meaning or add context, and include the following techniques:

- Broken Frames: the map includes features that extend outside of the defined frame or outside edge of the map.
- Multiple Views: the map uses multiple viewpoints or perspectives as supplemental elements to the primary plan view.
- Extracted Image Fragments: the map includes image fragments from sources that are supplemental or tangentially related to the map.

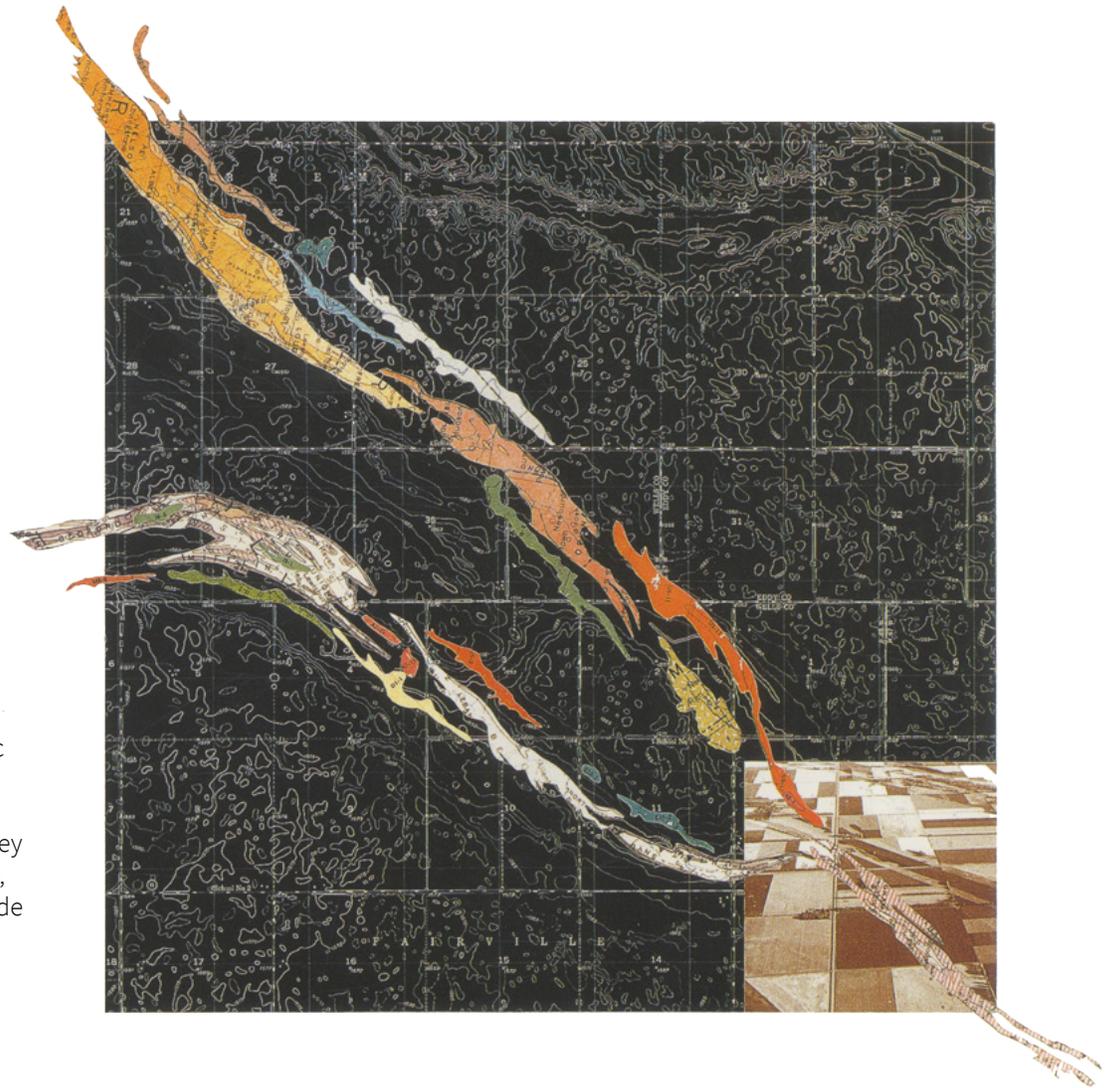


Figure 3.9 Map C01
Pedological Drift by
James Corner. Geologic
formations extend
outside of the map's
frame, signaling that they
do not stop at the edge,
but instead reach outside
of the defined scope of
the map (Corner and
MacLean 1996, 53).

Broken Frames

The technique of framing creates a discernable edge, which bounds the map, creating one (or more) identifiable image(s). This in and of itself is not an analytic representation technique; framing a map turns it into a definable object, but it does not exhibit any of the analytic principles set forth by Tufte. However, the act of “breaking” the frame changes this. When broken frames are used as a representational technique, elements within the map extend outside of the defined frame. Corner often uses this evocative technique in his maps to hint that the reality of the map continues outside of what is represented within the map. Broken Frames was observed as a major technique in 13 of 20 maps in the Corner set. It was not observed in the McHarg set.

An example of this technique in practice is Corner’s map entitled *Pedological Drift* (**Map C01, Figure 3.9**). The map juxtaposes the residual soils from historic geologic forces against the human-made survey grid imposed on the landscape. The ridges extend outside of the map’s frame, signaling that they do not stop at the edge, but instead reach outside of the defined scope of the map. Belanger and Urton, speaking about ambiguous frames as a graphic technique, note that it can “alter expectations, allow for greater freedom of interpretation, and pique the imagination regarding possibilities beyond the edge of the composition” (Belanger and Urton, 119). Corner’s breaking of the frame in *Pedological Drift* does just this: it tells the viewer that the map presented is just an abstraction of the real world, and signals that the cultural, geologic, and natural forms portrayed in the map are not isolated to this one particular place and time.

Multiple Views

Aerial perspective views, linear perspective views, and sectional views are used as supplemental elements to the typical plan view in both the Corner and McHarg map sets. The use of multiple views in addition to a map’s typical plan view is a technique that is used to evocatively enhance the understanding of the map’s context. Each view, in offering a different vantage point, provides new information that is not typically comprehensible or available in the context of plan view alone. Multiple Views was observed as a major technique in 10 of 20 maps in the

		Elements of "Multiple Views" Technique		
		Aerial	Perspective	Section
Maps (Corner Set + McHarg Set)	C-01	X		
	C-02		X	
	C-07	X	X	X
	C-08	X	X	
	C-13		X	
	C-15		X	
	C-17		X	
	C-18			X
	C-19		X	X
	C-20		X	
	M-07			X
	M-10		X	
	M-12			X
	M-16		X	
	M-17		X	
	M-20		X	

Table 3.3 Distribution of the multiple views technique throughout both map sets, including corresponding graphic elements (aerial, perspective, and section).

Corner set and in 6 of 20 maps in the McHarg set. **Table 3.3** shows the distribution of the multiple views technique throughout both map sets, including corresponding graphic elements.

There are three views that are observable as elements in the Corner and McHarg map sets: aerial perspectives, linear perspectives, and section views. Aerial perspective views (also known as bird's-eye views) are elevated, oblique, and often distant views, presented to the viewer as if they were floating or flying above the subject of the image. Aerial perspective views provide a large amount of context about the surrounding environs of a map. Linear perspectives are an attempt to recreate an eye-level view of the subject, by presenting what a place or scene looks like from the perspective of a person. As compared to an aerial perspective, linear perspectives lose the ability to represent the overall context of a place, but gain the ability to represent immediate appearance and scale. Section views are used to show hidden or unviewable infrastructure that is buried or obscured as well as showing the relational scale between humans and the environment. Section lines cut through an object to show how it is formed or constructed. These three views are the main elements that are used for the Multiple Views technique, at least as observed in the two map sets. These views all perform similar functions to Corner's "projection" graphics (discussed in-

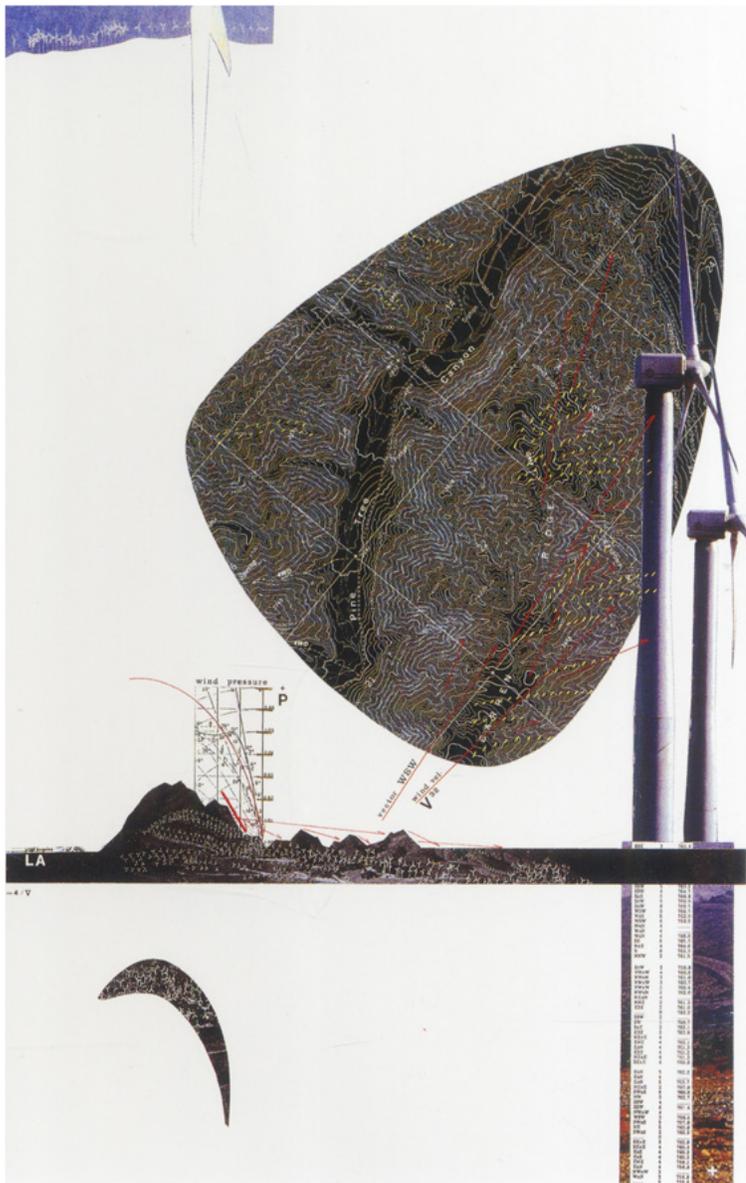


Figure 3.10 Map C07 *Windmill Topography* by James Corner. Multiple views are used in combination to add context and information density to the map (Corner and MacLean 1996, 83).

depth in Chapter 1) in that they are used to graphically document specific elements of the landscape.

A good example of the multiple views technique is Corner's map entitled *Windmill Topography* (Map C07, Figure 3.10). This map represents the mountains and ridgelines in California, which are used as the site for wind turbine farms. The site's unique combination of high mountains and desert leads to "dramatic contrasts in air temperature and wind pressure" (Corner and MacLean 1996, 83). This condition creates atmospheric inversions and strong winds, which makes it an ideal site for wind energy production.

The map offers multiple, alternative viewpoints, giving the viewer multiple ways to understand the context of the location represented in the map. In the upper-right corner of the map, a perspective view shows how the clustered windmills appear to someone on-site. In addition, a section view, which cuts through the center of the map, translates the topography of the site and shows how the wind turbines are sited in relation to the elevation of the surrounding mountains. All of the views assembled and plotted to form the map help the viewer to understand the map in a way that would be difficult in plan view alone.

McHarg also uses a variation of this technique to add supplemental information to his maps. In the example in map M17 (**Figure 3.11**), McHarg presents a map that documents variables for “recreational suitability” in the Potomac River Basin. The map highlights discrete variables for fishing spots, locations of historic battlefields, historic buildings, caves and waterfalls, fossil sites, and hiking trails. The result is a map that seemingly limits the definition of “recreation” to fishing, hiking, and historic sites. To combat what might be considered a somewhat narrow viewpoint of the term “recreation”, McHarg also includes perspective view images of boaters and picnickers, which seemingly broadens the definition. The inclusion of these perspectives, while not a structural component of the map, allows the viewer to interpret the information presented in the map from a different viewpoint.

While both of these example maps use multiple views to present supplemental information to the viewer, their construction is ultimately different. Corner uses a collage method, piecing together various non-contiguous views, whereas McHarg’s perspectives are unmitigated photographs. This difference in construction might change the viewer’s interpretation of the map. Corner’s collage provides many different interpretations, but may ultimately obfuscate the core intent of the image. McHarg’s photographs are much more straightforward, but can only be interpreted in one or two ways.

Extracted Image Fragments

Belanger and Urton, in their article *Situating Eidetic Photomontage In Contemporary Landscape Architecture*, define extracted

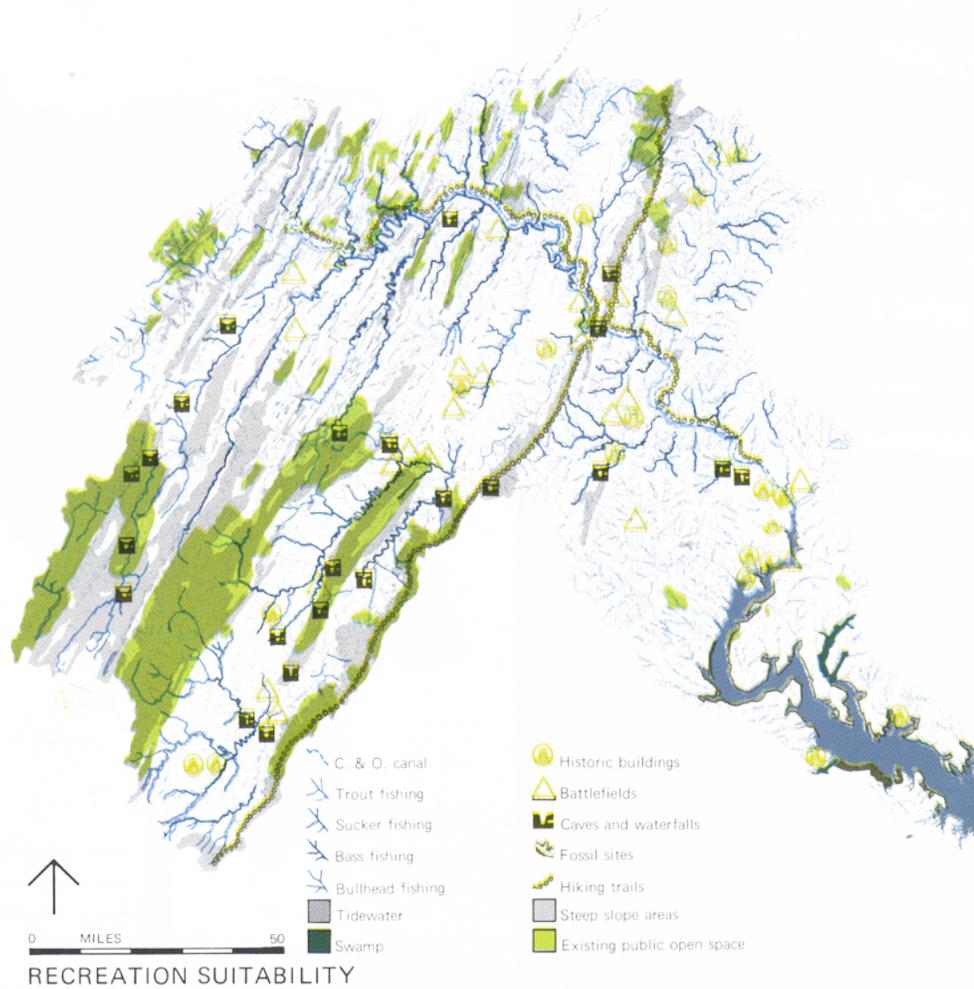


Figure 3.11 Map M17 by Ian McHarg. The inclusion of perspectives, while not a structural component of the map, allows the viewer to interpret the information presented in the map from a different viewpoint (McHarg 1969, 142).

image fragments as “photographic fragments that retain their individual character and add abstraction to a composition” (Belanger and Urton, 120). As evocative elements in maps, image fragments are used much like multiple views: as a supplemental element meant to add context or meaning to a map. Unlike the multiple views technique, extracted image fragments focus the viewer’s attention on one specific element, which is intended to help the viewer interpret one or more specific aspects of the map. Extracted image fragments offer the mapmaker the ability to highlight a concept or idea that would otherwise be difficult to comprehend by looking at the map alone. This technique was observed as a major technique in 12 of 20 maps in the Corner set. It was not observed in the McHarg set.

While not exclusive to maps as an image type, Corner uses extracted image fragments to great effect in many of his maps. These fragments, often collaged or extracted from another perspective, are “suggestive of objects or experiences likely to be encountered” (Belanger and Urton, 121).

One example of an extracted image fragment in Corner’s work is the use of a cutout, collaged image depicting a combine harvester at work in a field (**Map C15, Figure 3.12**). In addition to the information about crop and fallow rotations represented in the map, it focuses the viewer on the dynamic presence of human technology used to make and remake the landscape. This photographic fragment, removed from its own context, suggests a motive or intent on the part of the mapmaker: the map is not only about communicating specific analytic information about crop and soil types, but about how human interaction and technology shapes the natural world.

Compound Approaches

Each of the six analytic representational techniques presented (contrast, series, varied scale, broken frames, multiple views, and extracted image fragments) is the most basic application of one, specific, graphic technique. These techniques, however, are not mutually exclusive. In fact, various combinations of these techniques are often used together in order to create an accurate, comprehensible, and multi-dimensional map. Following are two examples where multiple techniques are used in

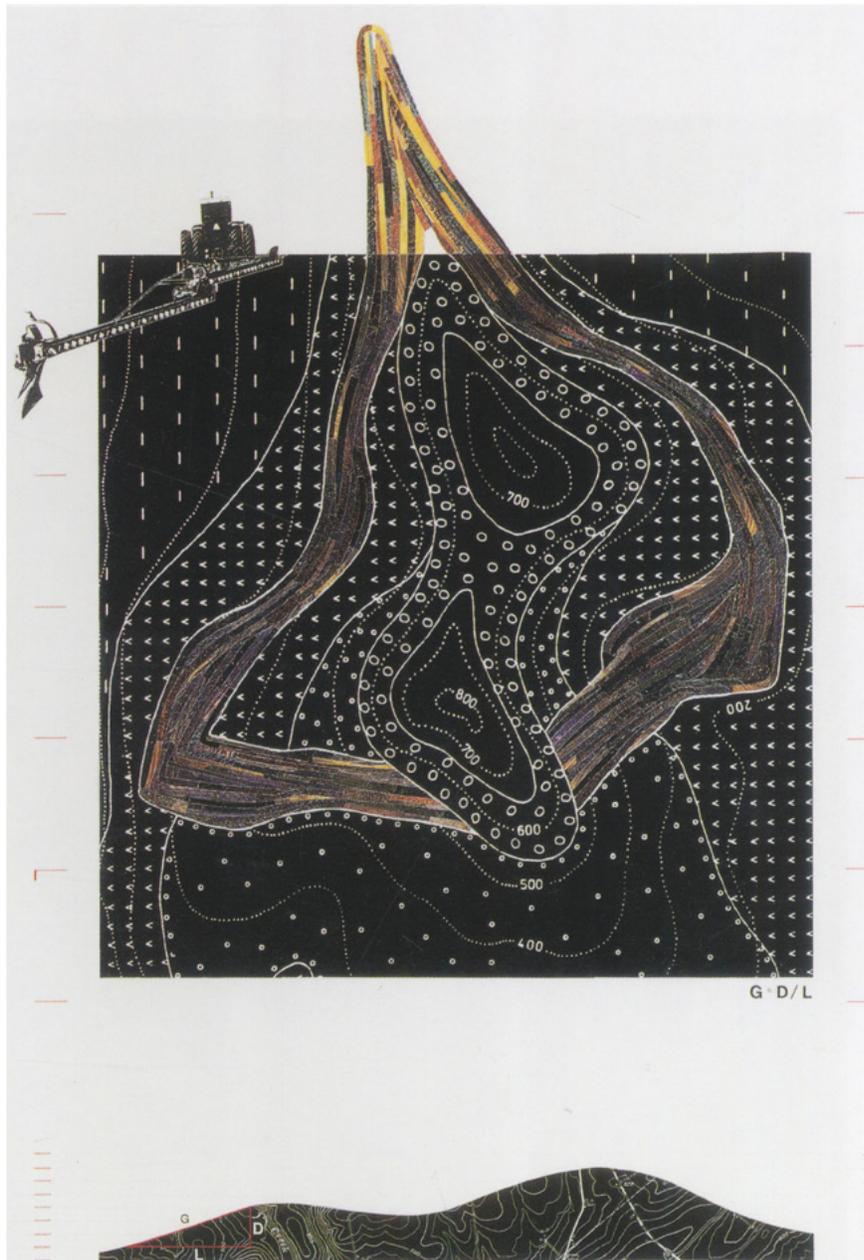


Figure 3.12 Map C15 *Contour Farming* by James Corner. The extracted image fragment (top left) of a combine harvester focuses the viewer on the dynamic presence of human technology used to make and remake the landscape (Corner and MacLean, 131).

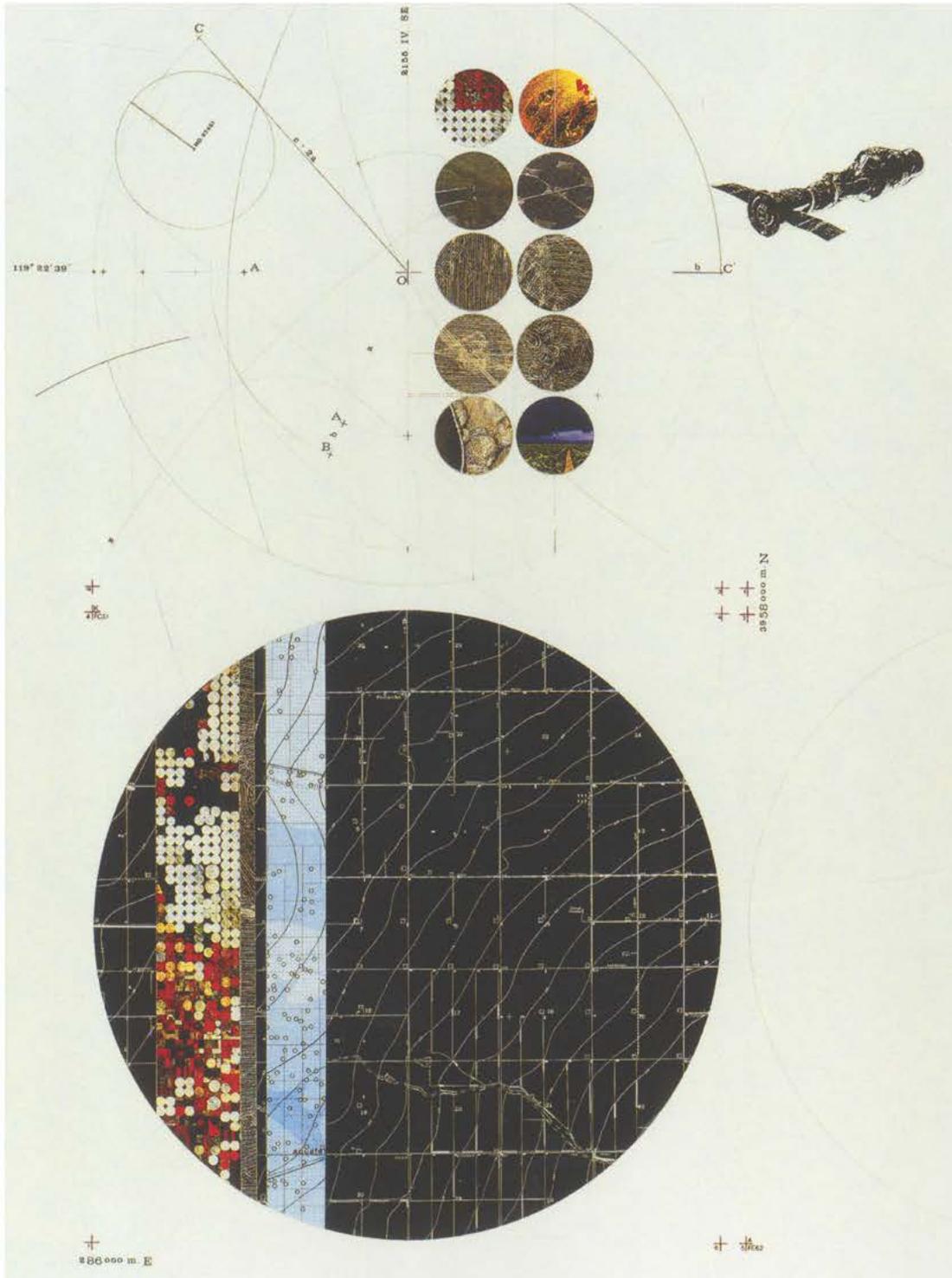


Figure 3.13 Map C09 *Pivot Irrigators I* by James Corner. This map highlights the use of several techniques coupled with one another to create more complex representation strategies (Corner and MacLean, 90).

one map - one from the Corner map set and one from the McHarg map set. Discussion will focus on how multiple techniques are used in each map, and how they work together to present analytic content.

Corner Map Set

The first example, Corner's map *Pivot Irrigators I* (**Map C09, Figure 3.13**), returns to the topic of farming in desert or semiarid environments through the use of large, central-pivot irrigated fields. In this map, Corner utilizes many of the identified representational techniques (specifically: contrast, series, scales, multiple views, and extracted image fragments), using both compositional and evocative techniques equally in order to attempt to communicate complex analytic ideas to the viewer.

The map is primarily presented as an area of circles. Each of these circles is a representation of a pivot-irrigator at varying scales. Large, detailed circles (drawn in black and white line work inscribed across the entire map) show an immediate context of how the forms are constructed to serve as crop fields, including the radius, diameter, central point, and irrigation arm. In a clever variation of scale, Corner includes a larger-scale map in the bottom half of the image within one of these small-scale circles, using it to present more information at a different scale, while at the same time highlighting its ubiquitous form. Smaller circles within this larger circle depict the many irrigation fields from high above, contrasting red and white hues in a repeating pattern on a desaturated background to represent active and inactive (wet and dry) fields. In the upper half of the map, a series of circles contain aerial and perspective views of fields in use at different scales, while still maintaining the motif of repeating circles to reinforce the omnipresent pattern. Corner also includes an extracted image fragment of a space satellite, although this reference is not readily apparent to the viewer unless also reading the text in *Taking Measures*: “as the water cools the circular area relative to its surroundings, space satellites sometimes use the resulting infrared temperature patterns as reliable registration marks for orientation” (Corner and MacLean 1996, 90).

This example highlights the use of several techniques coupled with one another to create more complex representation strategies.

For instance, Corner creates a series of images with varying scales and viewpoints to create something that is not easily identifiable as one specific technique, but rather a variation on, and combination of, all three (varying scales, multiple viewpoints, series). This example illustrates how the application of multiple techniques used together can create altogether new strategies in representation, and how they can be applied in various ways to communicate specific information and ideas. What should be readily apparent is that the six defined techniques, while an important step in helping to understand the component parts of analytic maps, do not represent the full breadth of graphic representation methods available to landscape architects.

This example also highlights Corner's propensity to use many of the identified techniques, although not always in a way that is necessarily legible to the viewer. Many of Corner's maps (especially out of the context provided by the text and captions in *Taking Measures*) are, at best, difficult to fully understand. This emphasizes an important idea that has come out of conducting this research: providing viewers the ability to interpret a map or analytic image, through a legend or otherwise, is important for the full disclosure of analytic content. This emphasizes the value of Tufte's Principle 5 (*thoroughly describe the evidence*) as a way to add informational depth to an image.

Corner uses techniques that are (in all likelihood) very revealing and helpful in understanding the context of any given site. However, while Corner's maps are full of analytic content, much of it is inaccessible to others because he does not provide an explicit interpretation of his maps for the viewer. Corner rarely provides legends for any of his maps, which requires the viewer to often guess as to his meaning. Most often, the explicit meaning of his maps is only available if captions and supporting documentation are read along with the map. Corner's maps rely heavily on an exploratory mode, leaving much up to speculation.

Much of what *is* legible to the lay-viewer in Corner's maps can be attributed to the use of cartographic conventions. The use of often-repeated, well-known visual applications (for instance, topography lines on a map) makes the need for a legend trivial, at least for those specific elements. In fact, Corner's maps are recognizable as maps (as opposed to collages or eidetic photomontage, for example) specifically because he

uses these conventions. These elements are understood because they have been repeated over and over in maps, and viewers have been acclimatized to their use. Corner uses this to his benefit to cue the reader that they are looking at a map as opposed to another image typology.

McHarg Map Set

Ian McHarg's maps, in contrast to Corner's, almost exclusively eschew the use of evocative techniques. In the series of maps about Staten Island (**Map M07, Figure 3.14**), McHarg uses all three compositional techniques (contrast, series, and scale), and is representative of the style and composition of most other McHarg maps in the set. The map, a diagrammatic series of Staten Island in New York showing existing geologic and physiographic features, is composed of a series of smaller maps at different scales and viewpoints. This combined use of scale and series results in the map being easier to read: the larger map provides detailed information (e.g. recognizable land forms, street names) which is not visible in the other maps, yet because the form of each map is the same, the viewer can still easily understand the smaller maps in the same

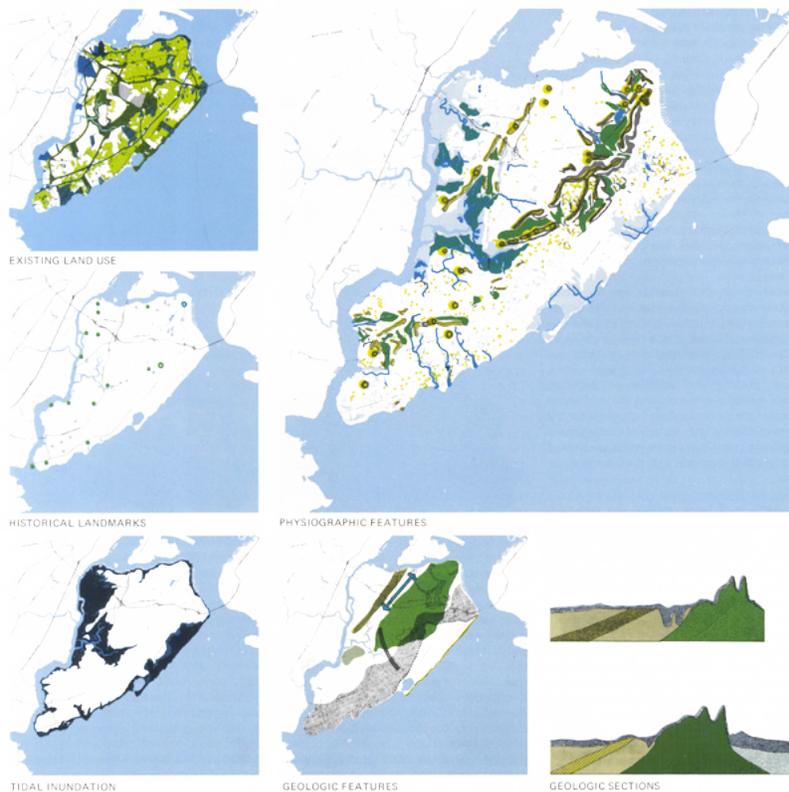


Figure 3.14 Map M07 by Ian McHarg. In this map, McHarg uses three compositional techniques (contrast, series, and scale), creating a map that is representative of the style and composition of most other McHarg maps in the set (McHarg 1969, 106).

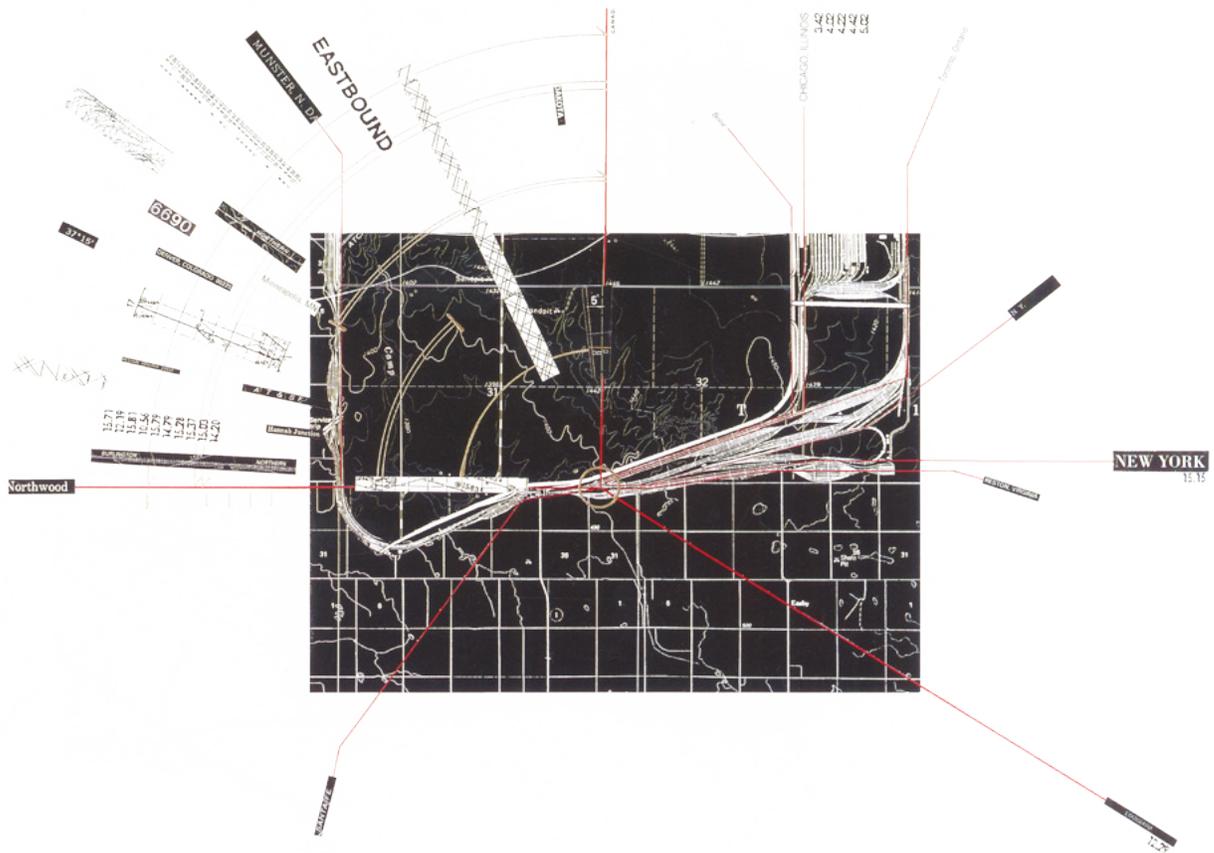
context. Contrast is the main technique used by McHarg to highlight differences in data sets (in this and other maps). Varied hues, chroma, values, and patterns are used to distinguish between discrete features within each map.

McHarg's maps potentially communicate less information than Corner's, in that they only provide the viewer with information about small, discrete data sets through the use of compositional representation techniques. Corner's use of evocative techniques in addition to compositional techniques provides additional, supplemental, information that is not easily expressed through the use of compositional techniques alone. However, it could also be argued that because McHarg only uses compositional techniques, his maps contain less visual clutter, which increases their legibility. Both methods provide dense information, but McHarg's maps are more focused: they show less, but are perhaps easier to understand.

Implications

With an understanding of these six basic techniques and how they can be applied to analytic maps, guidelines about how to communicate analytic content in landscape architectural images can begin to be constructed. One observation of the data suggests that, in the context of Tufte's principles of analytic design, some techniques are better than others at representing specific types of analytic content. Compositional techniques, for instance, excel at comparing, contrasting, and highlighting multivariate data sets (Tufte's Principles 1 and 3). Evocative techniques, on the other hand, are good at attempting to explain the context and meaning within an image (Tufte's Principle 2).

Tufte's Principle 4, "*completely integrate words, numbers, images, and diagrams,*" was more elusive within the images examined by this project. Words, numbers, and images were present in most images examined, but whether or not they were "completely" integrated is unclear. Often, the inclusion of words and numbers was perfunctory as a typical cartographic convention, not in an attempt to add additional meaning or understanding to the map. When words and numbers were included, they were often so obscure as to lose all meaning, or they lacked enough context to accurately understand their analytic function. Corner's



maps are a good example of this in practice. In *Rail Networks* (Map C12, Figure 3.15), several sets of numbers are evident. From the name of the map, one can guess that they have something to do with trains or rail lines. Perhaps they are distances? Route numbers? Train schedules? It is unclear from looking at the map, and the supplemental text provided by Corner does not help to answer the question.

Figure 3.15 Map C12 *Contour Farming* by James Corner. An obfuscating use of numbers and text. (Corner and MacLean, 107).

Words were often also offered to explain the map, offered as captions or explanatory text, but not within the image itself. The examined maps may well have been more legible if this information was included as a part of the image, in some other textual form. To assume a map will always be viewed within the context of a book or other text is not reliable, which necessitates the inclusion of legible text within the map or image.

It is also apparent that some analytic representation techniques are more fundamental than others, or at least are used more in the maps that were analyzed for this project. Contrast, as a technique, was used in over 75% of the maps analyzed, and played a major part in understanding

the analytic content in most maps. Extracted image fragments, however, was used much less frequently (not at all by McHarg), and was much more difficult to parse when it was used. This discrepancy could indeed be because contrast techniques are more useful for communicating analytic content, or it could just be a result of the two data sets chosen, and the preferred methods used by each individual mapmaker.

Also, as evidenced in the data collected by this project, multiple analytic representation techniques are used together in maps in order to create a complete analytic image. No single technique explored is able to communicate all of the principles of analytic design, and therefore no single technique is able to produce an analytic image when used alone. A combination of techniques is required for a true analytic image, as defined by the principles set forth by Tufte.

In the two explored map sets, a trend related to this emerges: the combination of techniques is dependent on the author of the maps. McHarg almost exclusively used compositional techniques to make his maps, while Corner was much more inclusive of all six techniques. This could be due to technological reasons (might it have been more difficult for McHarg to use evocative techniques without the use of computers to make his maps?) or because of the specific goal of creating the map (the desire to communicate a lot of complicated, overlapping cultural and physical information like Corner vs. the simple comparisons that McHarg makes). It is also likely that personal preference plays a large role in the making of maps (as well as other landscape architectural images). Both Corner and McHarg's prior experience and artistic leanings (or lack thereof) likely had a large impact on how and why their maps were made the way they were.

4 Discussion

Significance

It is important to note that the techniques described by this project are not new. Artists, mapmakers, and landscape architects have all used these visual methods as fundamental building blocks of images and maps for many years prior to this project categorizing them as “techniques.” The framework for understanding, describing, and categorizing these techniques is the hopeful contribution of this research. Being able to categorize and describe specific visual techniques will hopefully provide the start to a “visual language” that can be used in the future to further understand how these techniques help the visual dissemination of analytic content. It also suggests and reinforces the idea that there are many “valid” ways to accurately convey analytic content in landscape architectural images.

Ultimately, this research presents a replicable method that accomplishes two distinct tasks. One, it tests an evaluation tool from outside of landscape architecture (in this case, Tufte’s Principles of Analytic Design) and attempts to apply it to landscape architectural practice. And two, it presents a replicable method for breaking down landscape architectural images into component parts to better understand how those images communicate information, specifically within the discipline of landscape architecture. Both of these approaches provide a framework in theory testing and theory building for future exploration of graphic methods used in landscape architecture.

Limitations and Future Research

The results of this research are limited in that the sample size and the results were restricted to the analysis of two specific map sets. These sets, the maps of Ian McHarg and James Corner, provide two distinct data sets to test but are an incomplete survey of landscape architects and

representation methods. Further research could be conducted looking at larger and more diverse map sets from other landscape architects and mapmakers. This could result in the identification of different techniques, and the strengthening of the ‘visual lexicon’ that has been described and explored as a result of this project. Potential map sets for further investigation include the work of Anuradha Mathur and Dilip da Cunha in their book *Mississippi Floods: Designing a Shifting Landscape* (2001), Alan Berger’s maps in *Reclaiming the American West* (2002), and Kate Orrff’s maps in *Petrochemical America* (2014). A review of maps from outside of landscape architecture might also reveal some interesting insight into new visual methods and techniques.

Application in Other Landscape Architectural Image Typologies

The results from this project may be applicable to other image types within landscape architecture. Of particular interest to the author is the application of these graphic techniques to photorealistic digital composite perspective renderings (PDCPRs), otherwise referred to in layperson terms as “perspectives.” PDCPRs are widely used in landscape architectural practice today, not only because of how easy they are to produce, but because they “function exceedingly well as a means of communication and propaganda” (M’Closkey 2014, 122). PDCPRs are an essential product produced during the design development phase by the majority of high-profile landscape architecture firms, for both the purpose of representing design projects and design competitions. They show physical composition of form and space, how people are intended to use the site, atmospheric conditions, and what the site “feels like” to a visitor. These qualities are great for selling a concept to a client, and are the main reason that the digital composite rendering “remains the dominant mode of landscape representation around the world,” and one of the most recognizable representation forms within landscape architecture (Waldheim 2014, 11).

Landscape architects use PDCPRs to depict the site in a broad context, showing conceptual design concepts, experiences, context, and physical dimensions of the landscape. And yet the end result is often an image devoid of real analytic content. PDCPRs show the audience only

a glimpse of the site, ignoring complex systems that, while not explicitly visible, play a large role in shaping the landscape. PDCPRs typically do not readily show ecological systems, social systems, historical analysis, or temporal dimensions of landscape.

This information is currently communicated through other forms of representation in landscape architectural projects. Plans, sections, and elevations are used to present these other types of data. Unfortunately, these other representation methods are not always legible to the layperson, nor are they always disseminated to the public. Often, PDCPRs are the only public-facing images of a project, and they form the base of public opinion. This use of digital montage has led to visual forms that do not show the process of making or understanding the landscape, but rather focus on creating a finished picture. PDCPRs, as currently conceived in landscape architectural practice, do not successfully communicate the underlying contexts and information inherent in complex landscape systems.

There is a need expressed in the discourse about landscape architectural representation for new techniques that better represent analytic content. Currently, PDCPRs are viewed as an end product: something to be produced as an illustration after the analysis and design phases have been completed, or as a means of “self indulgence in the name of artistic expression” (Corner 1992, 184). By including analytic content in these images, they can serve as both presentation and exploratory images, which increases their value to both the designer and the client. This project has unveiled some techniques that have been shown to accurately communicate analytic content. The application of these techniques to PDCPRs is untested, but may be a promising approach to add more analytic content to images that typically do not serve this purpose.

This project only examines one aspect of the challenge of combining presentation and exploratory approaches into one image. More research is needed in order to comprehend the breadth and depth of visual techniques used in images, and to understand how these techniques can be applied in landscape architecture practice (and perhaps in other disciplines) in order to create images that are both informative and revealing.

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Appendix A

All of the twenty maps in each map set were given an identifying reference number, each one beginning with a letter to denote whether it belongs to the Corner map set (C), or the McHarg map set (M). Those maps are numbered from 1 to 20 in the order that they appear in their respective publication (*Design With Nature* or *Taking Measures Across the American Landscape*). They are listed in that order in this appendix.

Corner Map Set from *Taking Measures Across the American Landscape* (1996)

- Map C01.** *Pedological Drift* in Chapter 5: Measures of Land, pg. 53
- Map C02.** *Railroads across the Northern Plains* in Chapter 5: Measures of Land, pg. 55
- Map C03.** *Drumlin Fields* in Chapter 5: Measures of Land, pg. 59
- Map C04.** *Appalachian Ridge and Valley* in Chapter 5: Measures of Land, pg. 61
- Map C05.** *Long-Lots along the Mississippi River* in Chapter 5: Measures of Land, pg. 63
- Map C06.** *Hoover Dam and the Colorado River* in Chapter 6: Measures of Control, pg. 73
- Map C07.** *Windmill Topography* in Chapter 6: Measures of Control, pg. 83
- Map C08.** *Windmill Fields* in Chapter 6: Measures of Control, pg. 87
- Map C09.** *Pivot Irrigators I* in Chapter 6: Measures of Control, pg. 90
- Map C10.** *Pivot Irrigators II* in Chapter 6: Measures of Control, pg. 91

- Map C11.** *Games* in Chapter 7: Measures of Rule, pg. 103
- Map C12.** *Rail Networks* in Chapter 7: Measures of Rule, pg. 107
- Map C13.** *Field Plots* in Chapter 7: Measures of Rule, pg. 113
- Map C14.** *Dry-Farming Strip* in Chapter 8: Measures of Fit, pg. 125
- Map C15.** *Contour Farming* in Chapter 8: Measures of Fit, pg. 131
- Map C16.** *Navaho Spring-Line Fields* in Chapter 8: Measures of Fit, pg. 138
- Map C17.** *Longhouse Cave* in Chapter 8: Measures of Fit, pg. 141
- Map C18.** *Hopi Cosmography* in Chapter 9: Measures of Faith, pg. 157
- Map C19.** *Hopi Horizon Calendar* in Chapter 9: Measures of Faith pg. 158
- Map C20.** *Powers of Ten* in Chapter 9: Measures of Faith, pg. 171

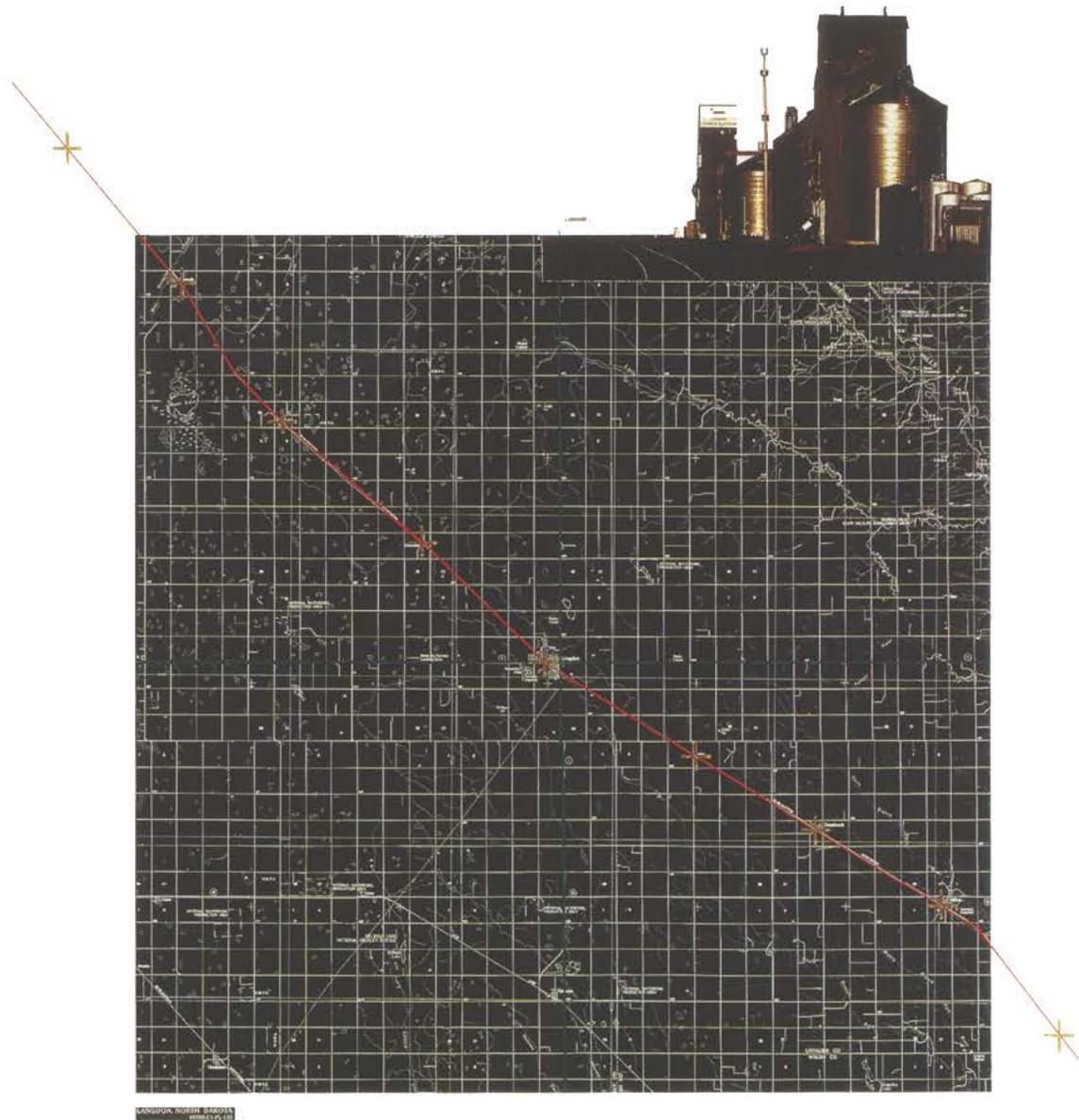
McHarg Map Set from *Design With Nature* (1969)

- Map M01.** in Chapter 7: Nature in the Metropolis, pg. 62
- Map M02.** in Chapter 7: Nature in the Metropolis, pg. 63
- Map M03.** in Chapter 9: A Response to Values, pg. 83
- Map M04.** in Chapter 9: A Response to Values, pg. 88
- Map M05.** in Chapter 9: A Response to Values, pg. 89
- Map M06.** in Chapter 11: Process as Values, pg. 105
- Map M07.** in Chapter 11: Process as Values, pg. 106
- Map M08.** in Chapter 11: Process as Values, pg. 107
- Map M09.** in Chapter 11: Process as Values, pg. 110
- Map M10.** in Chapter 11: Process as Values, pg. 112
- Map M11.** in Chapter 11: Process as Values, pg. 114
- Map M12.** in Chapter 13: The River Basin, pg. 129
- Map M13.** in Chapter 13: The River Basin, pg. 133
- Map M14.** in Chapter 13: The River Basin, pg. 134

- Map M15.** in Chapter 13: The River Basin, pg. 136
- Map M16.** in Chapter 13: The River Basin, pg. 137
- Map M17.** in Chapter 13: The River Basin, pg. 142
- Map C18.** in Chapter 14: The Metropolitan Region, pg. 156
- Map C19.** in Chapter 14: The Metropolitan Region, pg. 157
- Map C20.** in Chapter 16: The City: Process and Form, pg. 180



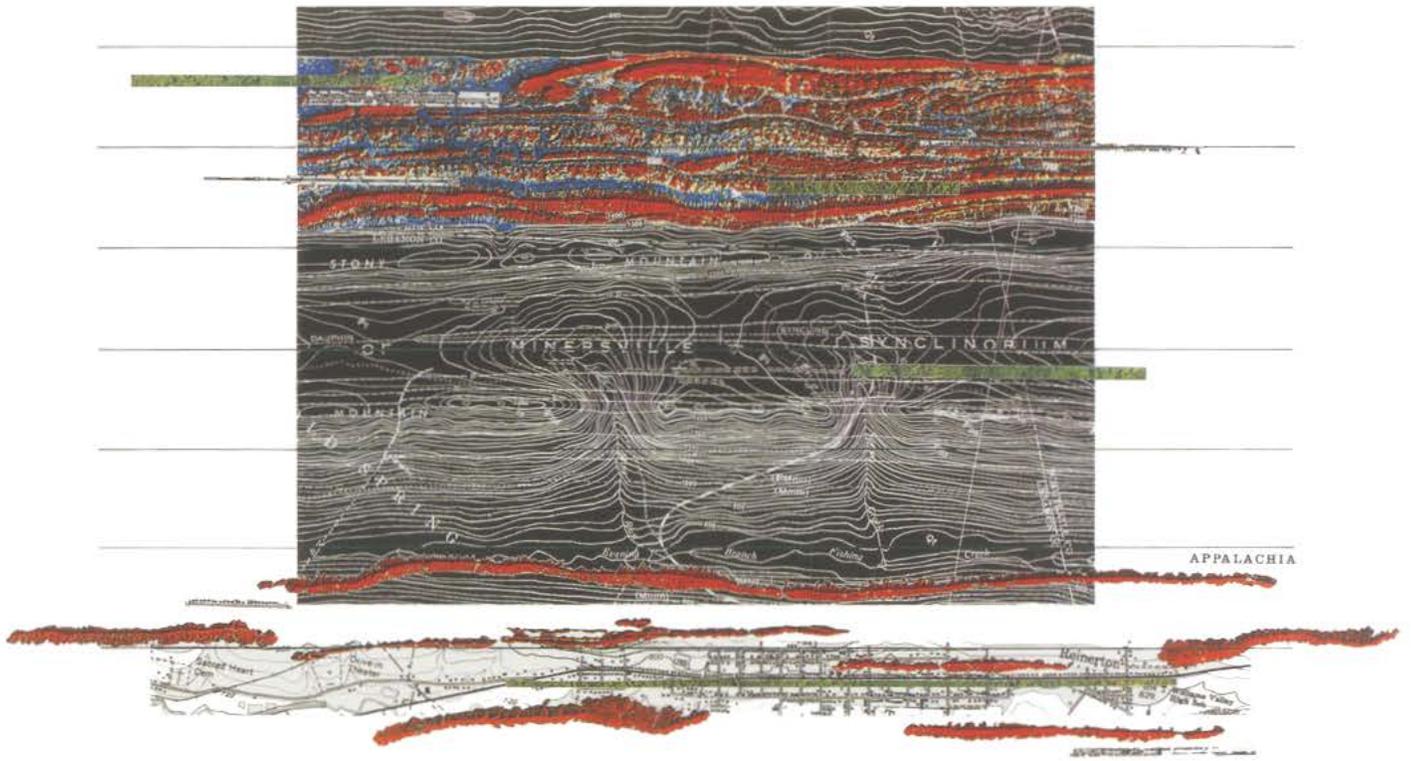
Map C01 *Pedological Drift in Taking Measures Across the American Landscape, Chapter 5: Measures of Land, pg. 53.*



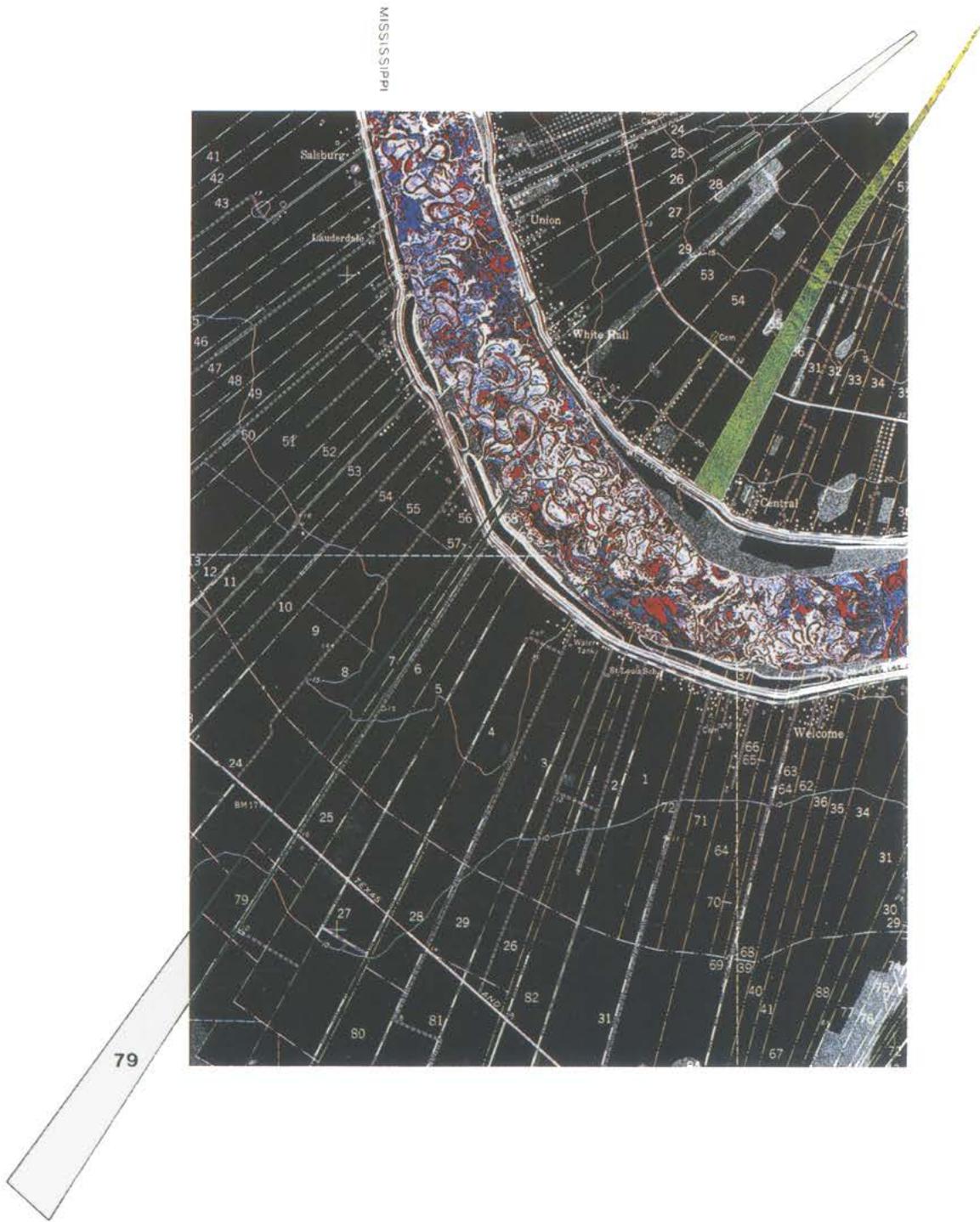
Map C02 *Railroads Across the Northern Plains in Taking Measures Across the American Landscape, Chapter 5: Measures of Land, pg. 55.*



Map C03 *Drumlin Fields in Taking Measures Across the American Landscape*, Chapter 5: Measures of Land, pg. 59.



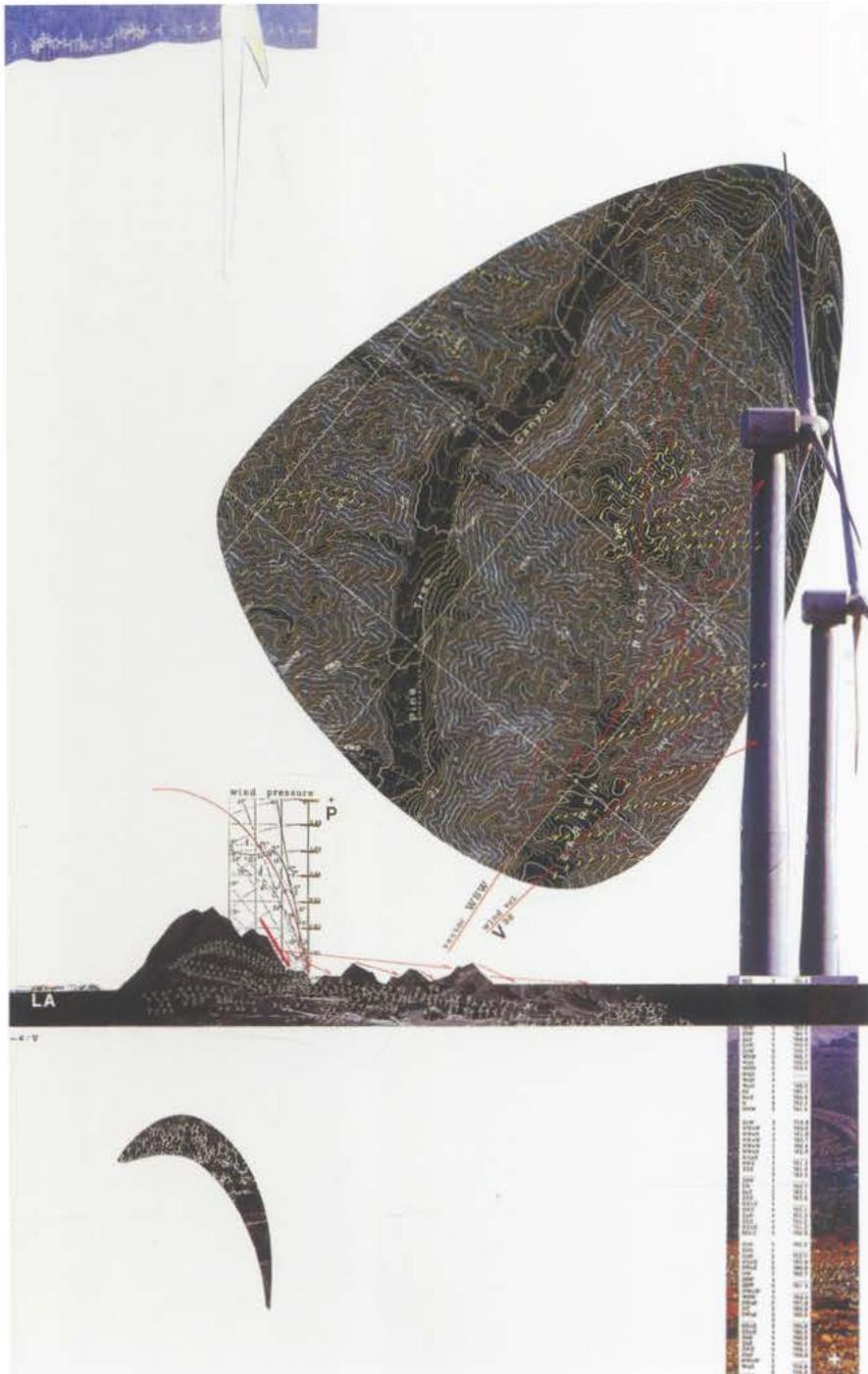
Map C04 *Appalachian Ridge*
in *Taking Measures Across the
American Landscape*, Chapter 5:
Measures of Land, pg. 61.



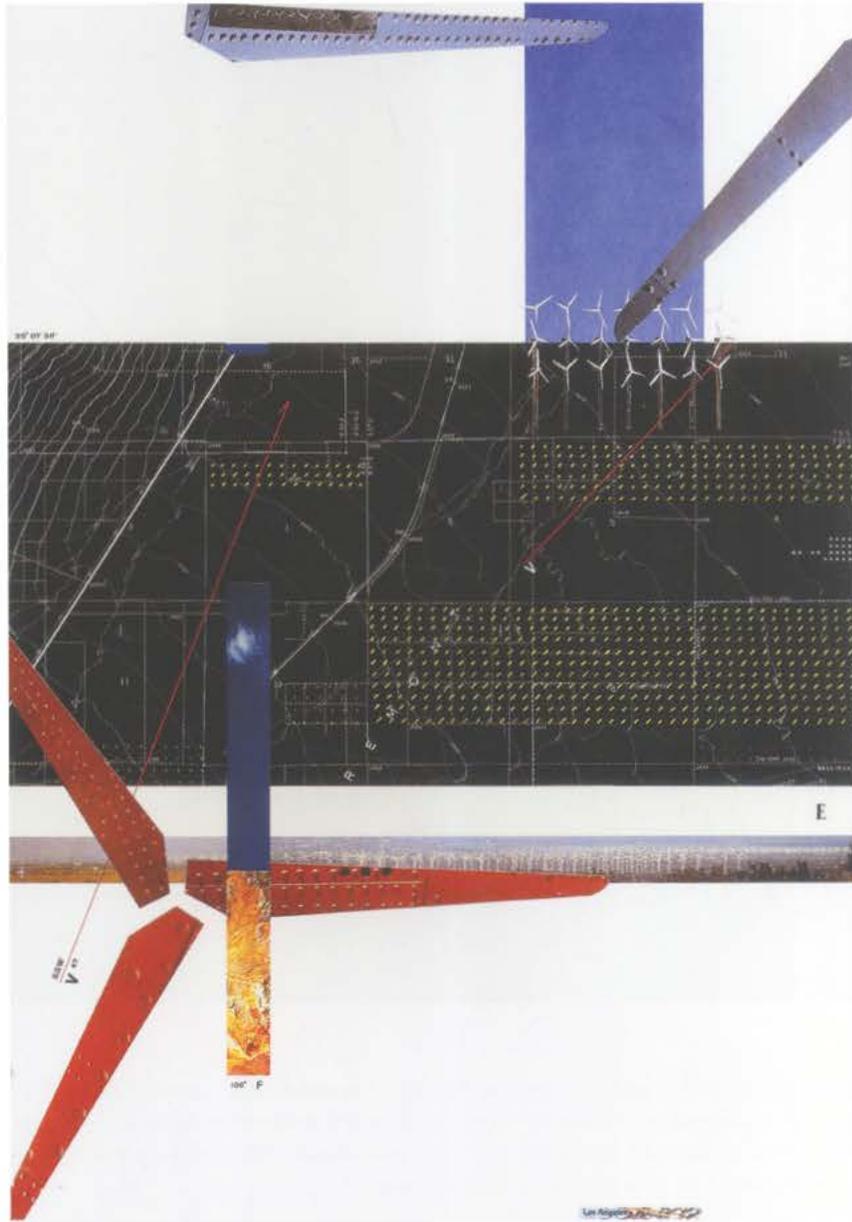
Map C05 in *Taking Measures Across the American Landscape*, Chapter 5: Measures of Land, pg. 63.



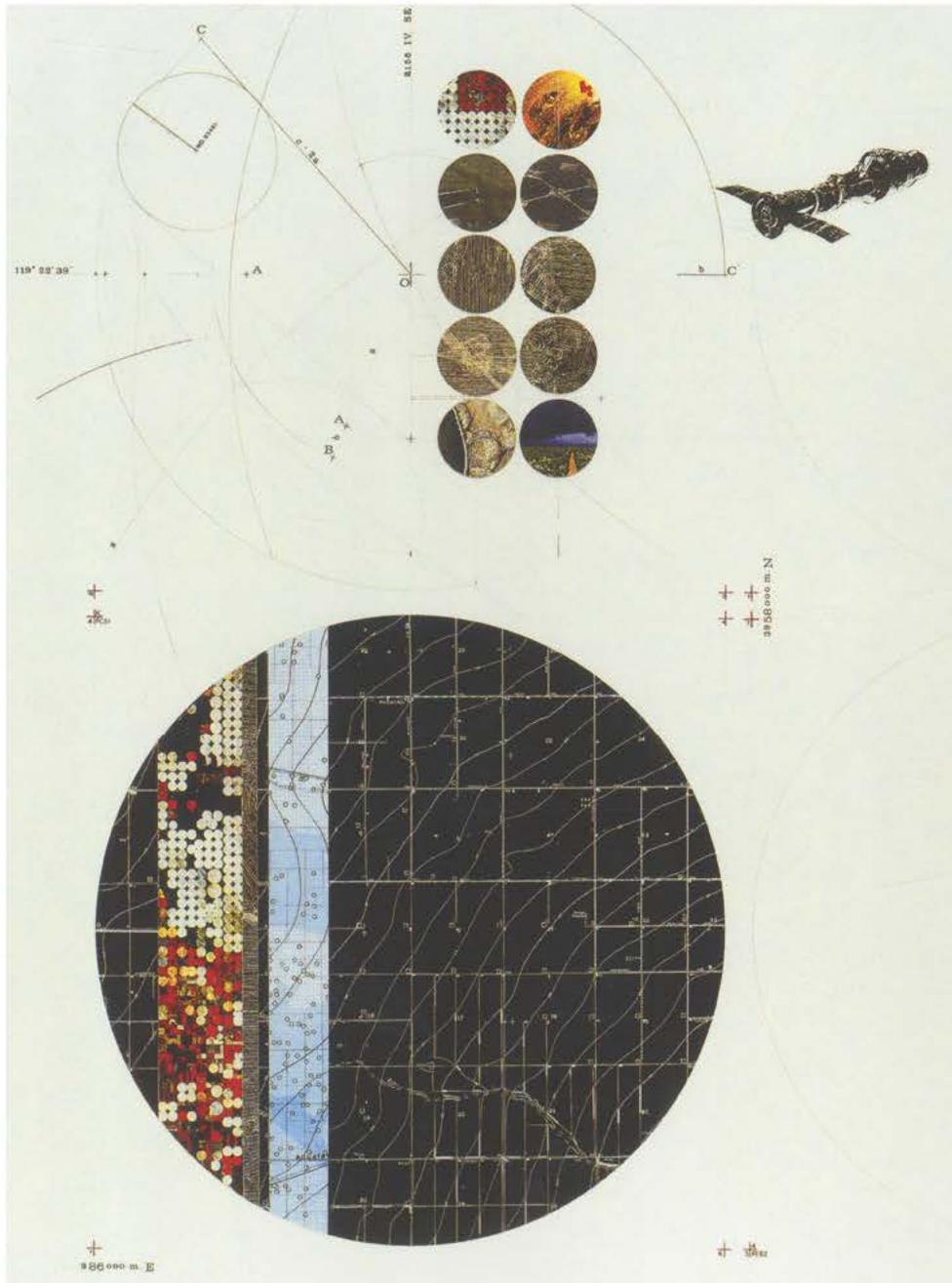
Map C06 Hoover Dam and the Colorado River in *Taking Measures Across the American Landscape*, Chapter 6: Measures of Control, pg. 73.



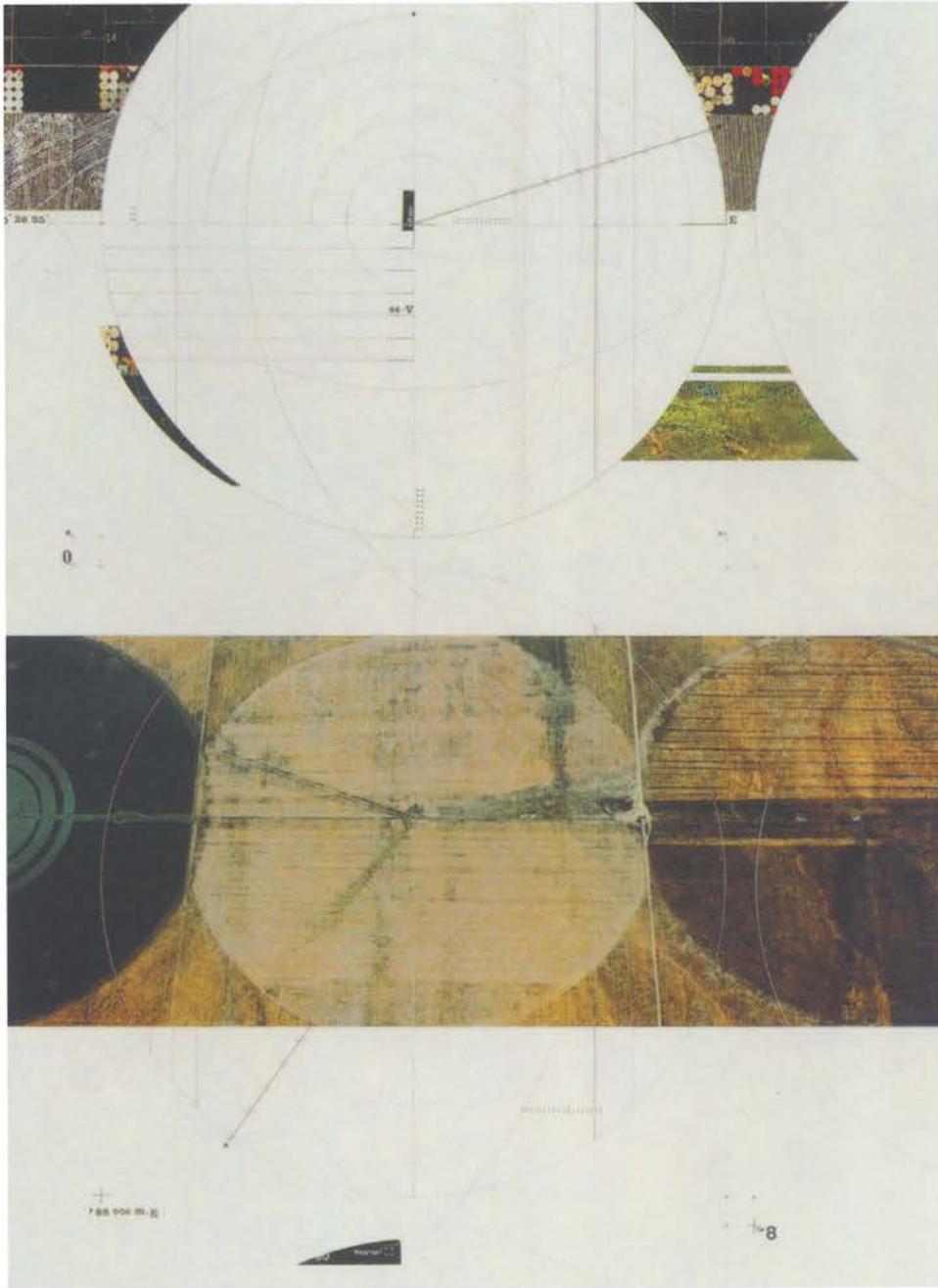
Map C07 *Windmill Topography*
in *Taking Measures Across the*
American Landscape, Chapter 6:
Measures of Control, pg. 83.



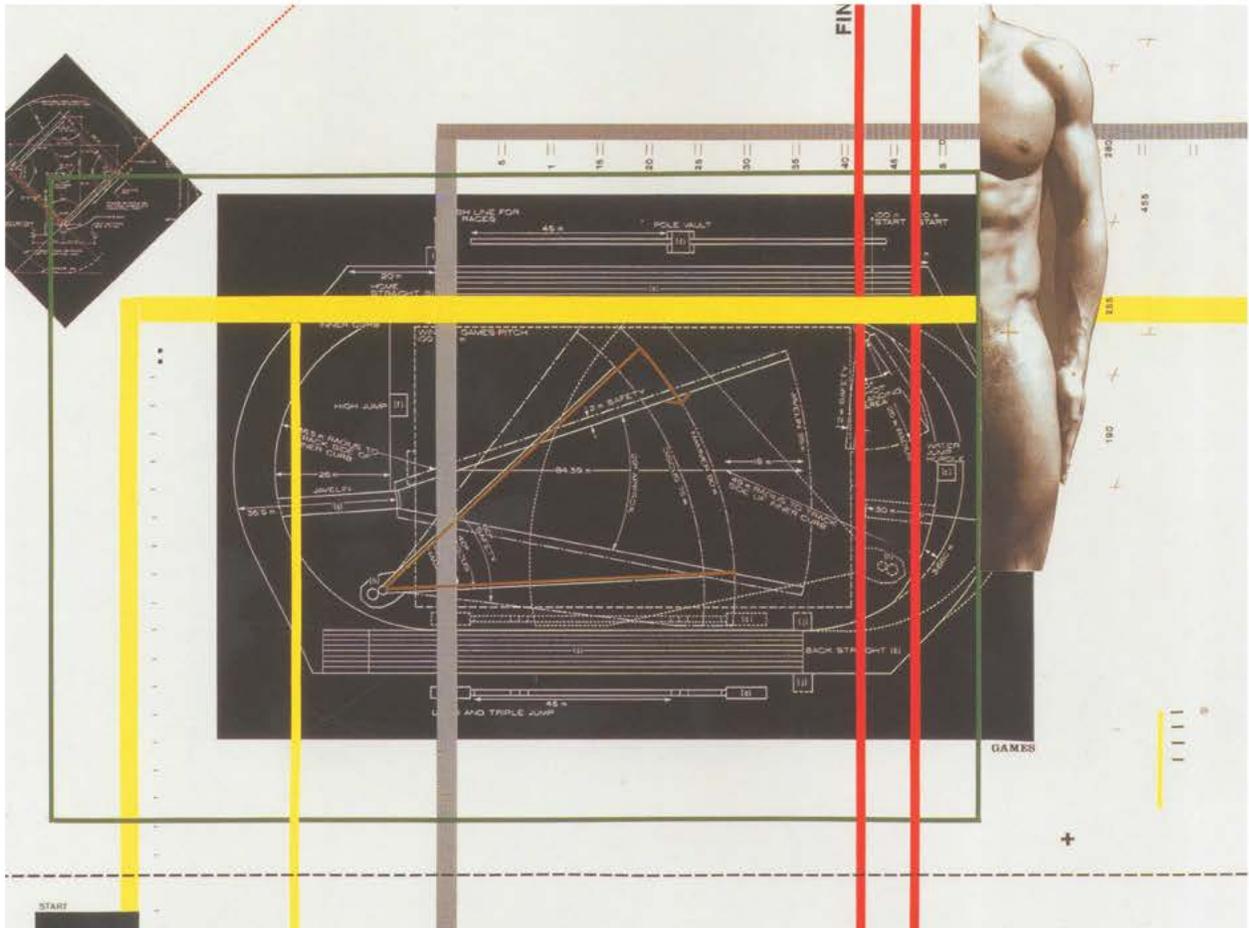
Map C08 *Windmill Fields* in *Taking Measures Across the American Landscape*, Chapter 6: Measures of Control, pg. 87.



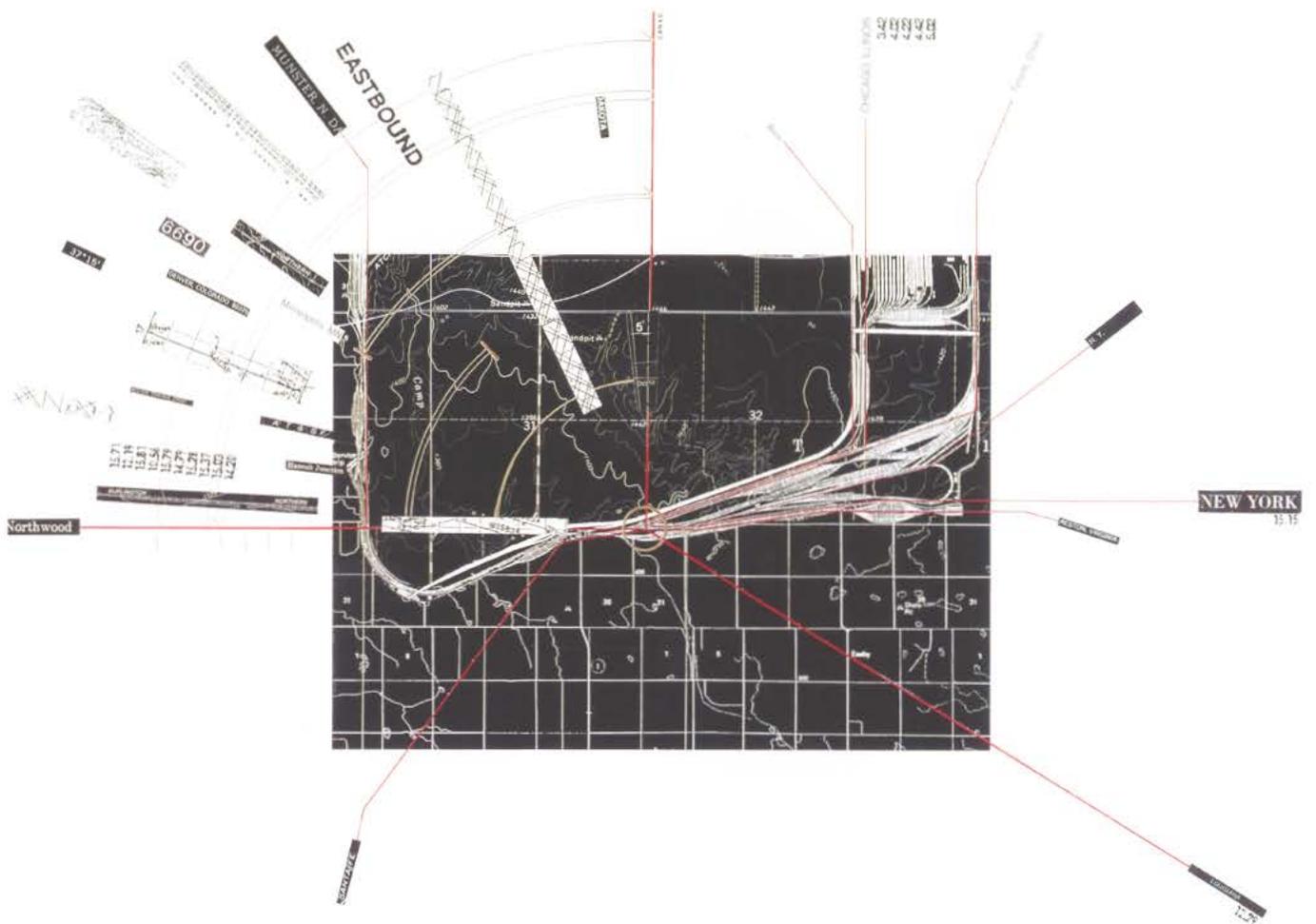
Map C09 *Pivot Irrigators I* in *Taking Measures Across the American Landscape*, Chapter 6: Measures of Control, pg. 90.



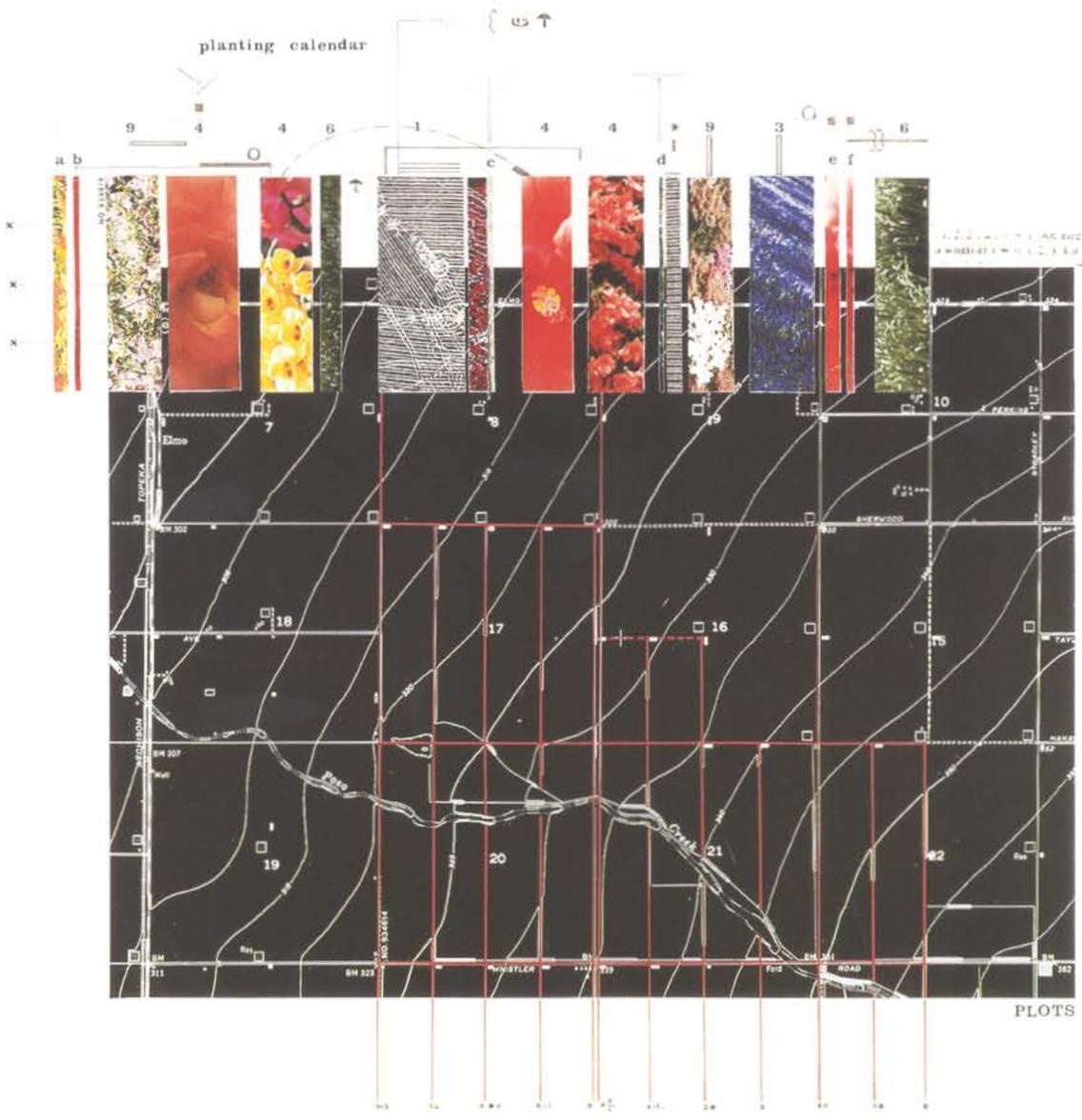
Map C10 *Pivot Irrigators II* in *Taking Measures Across the American Landscape*, Chapter 6: Measures of Control, pg. 91.



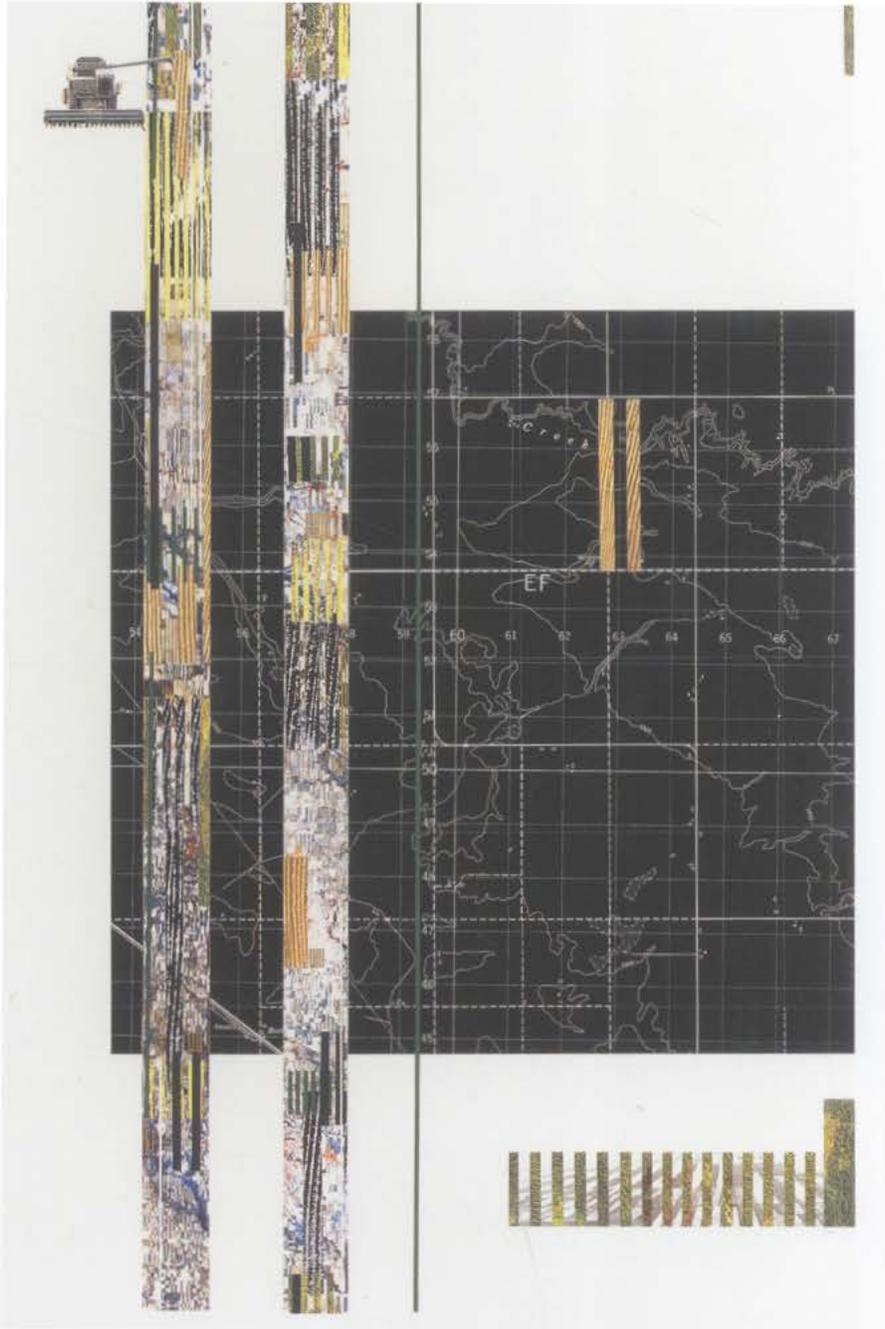
Map C11 Games in Taking Measures Across the American Landscape, Chapter 7: Measures of Rule, pg. 103.



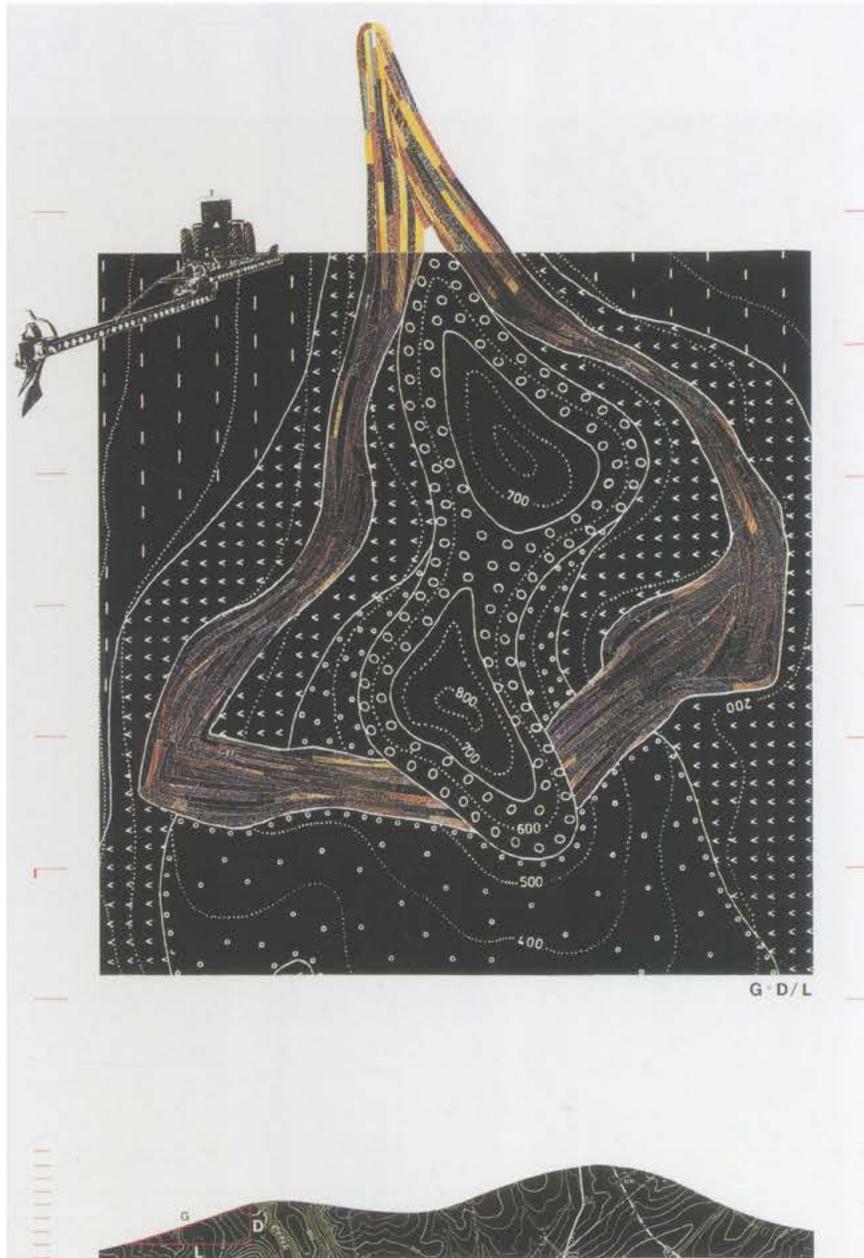
Map C12 Rail Networks in *Taking Measures Across the American Landscape*, Chapter 7: Measures of Rule, pg. 107.



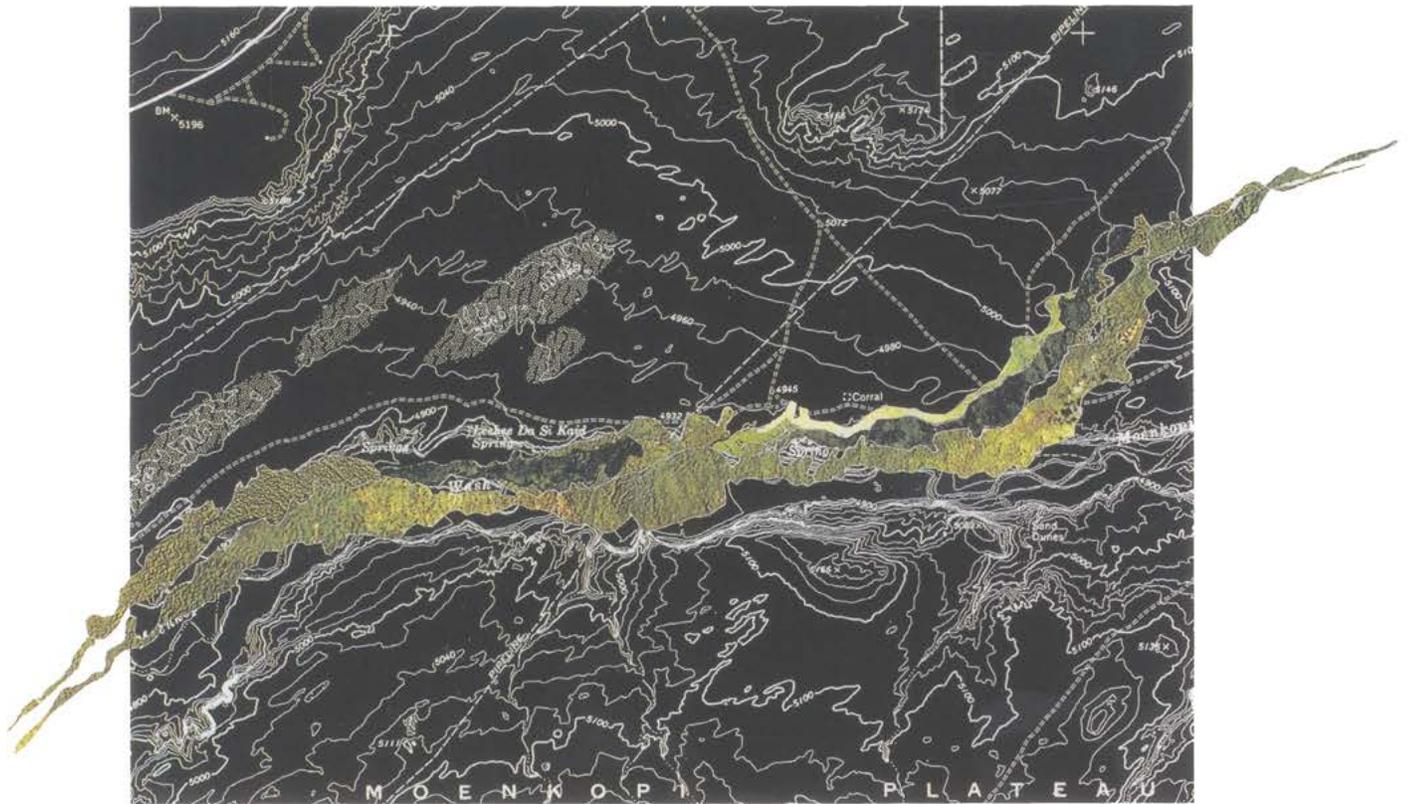
Map C13 *Field Plots in Taking Measures Across the American Landscape, Chapter 7: Measures of Rule, pg. 113.*



Map C14 *Dry-Farming Strip*
in *Taking Measures Across the
American Landscape*, Chapter 8:
Measures of Fit, pg. 125.



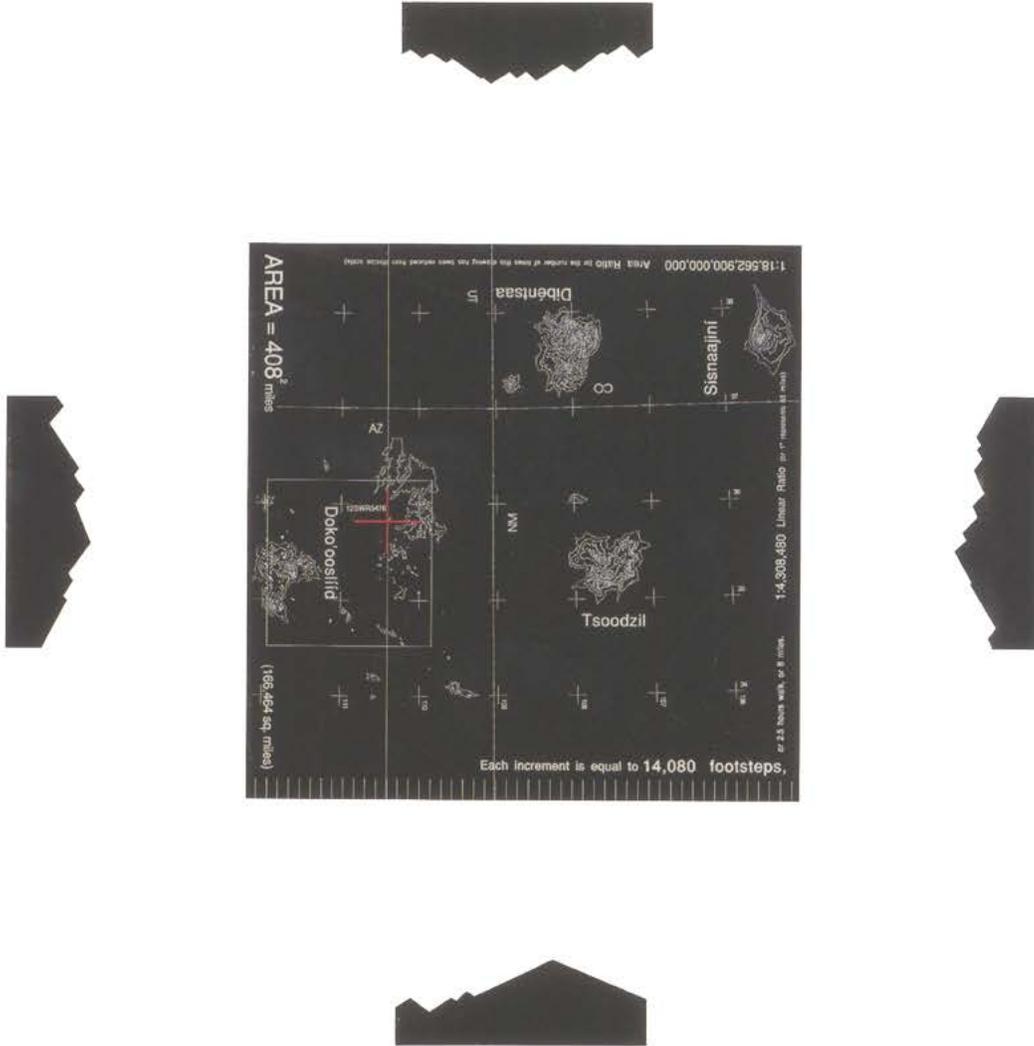
Map C15 *Contour Farming in Taking Measures Across the American Landscape, Chapter 8: Measures of Fit, pg. 131.*



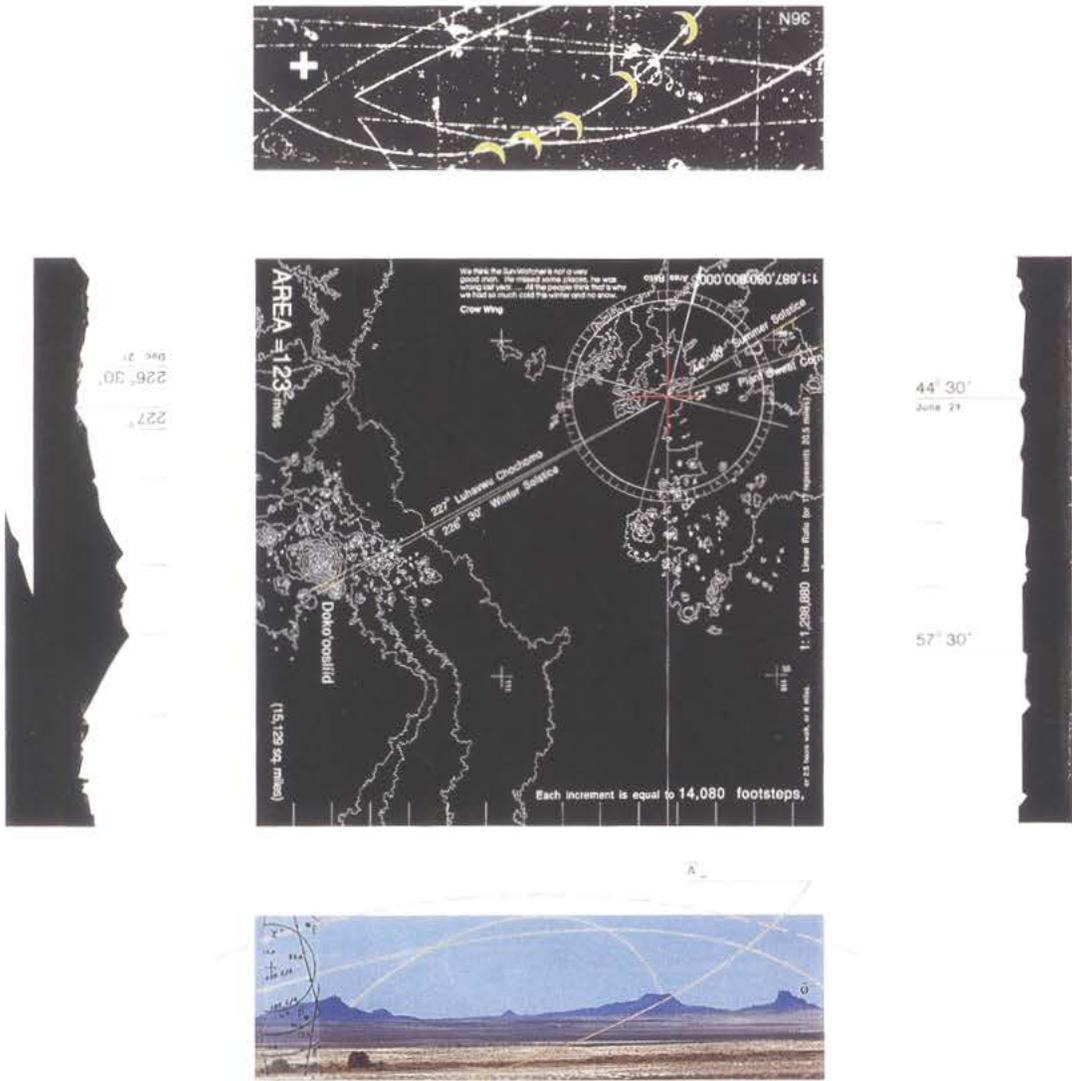
Map C16 Navaho Spring-Line Fields in *Taking Measures Across the American Landscape*, Chapter 8: Measures of Fit, pg. 138.



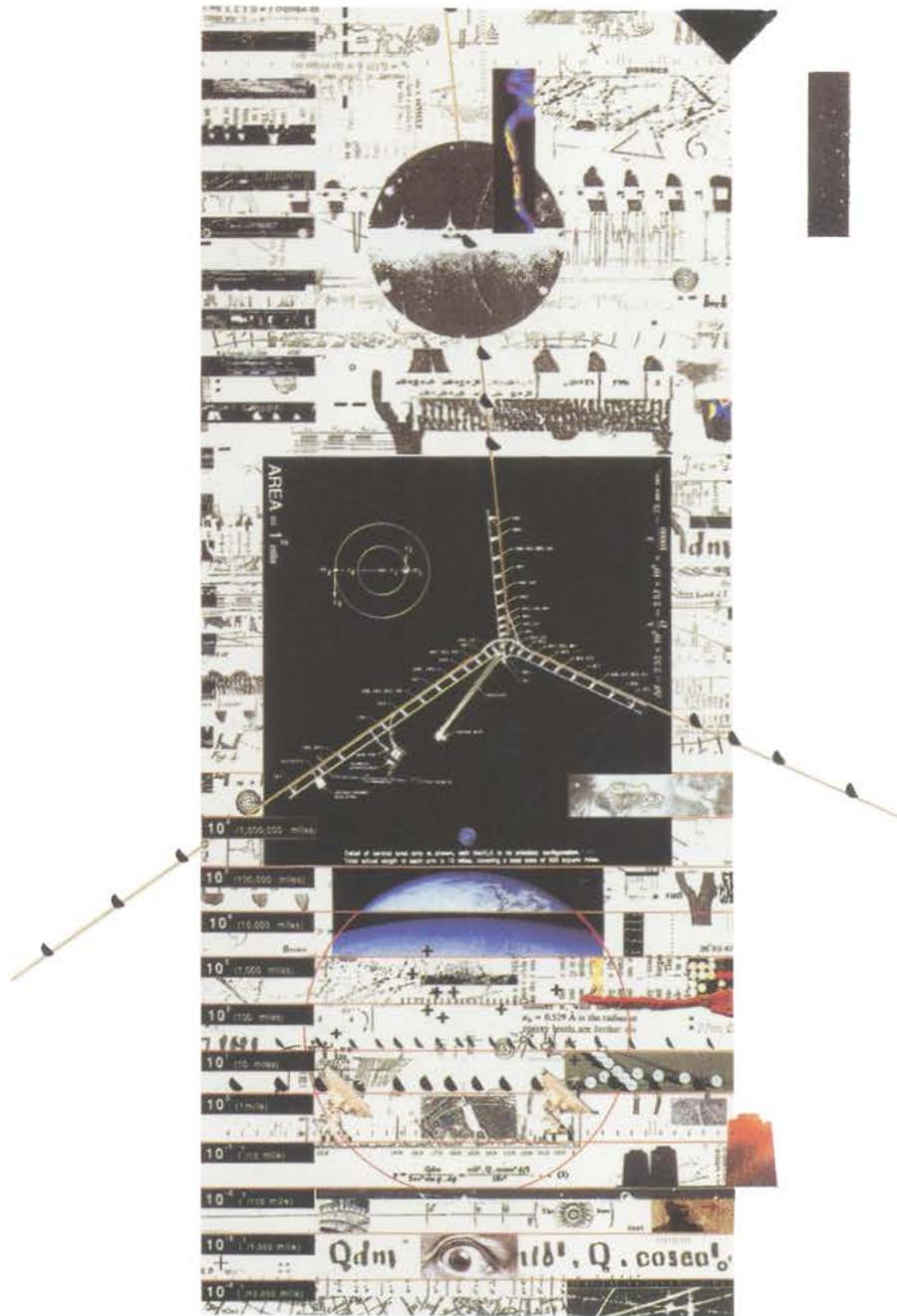
Map C17 Longhouse Cave in *Taking Measures Across the American Landscape*, Chapter 8: Measures of Fit, pg. 141.



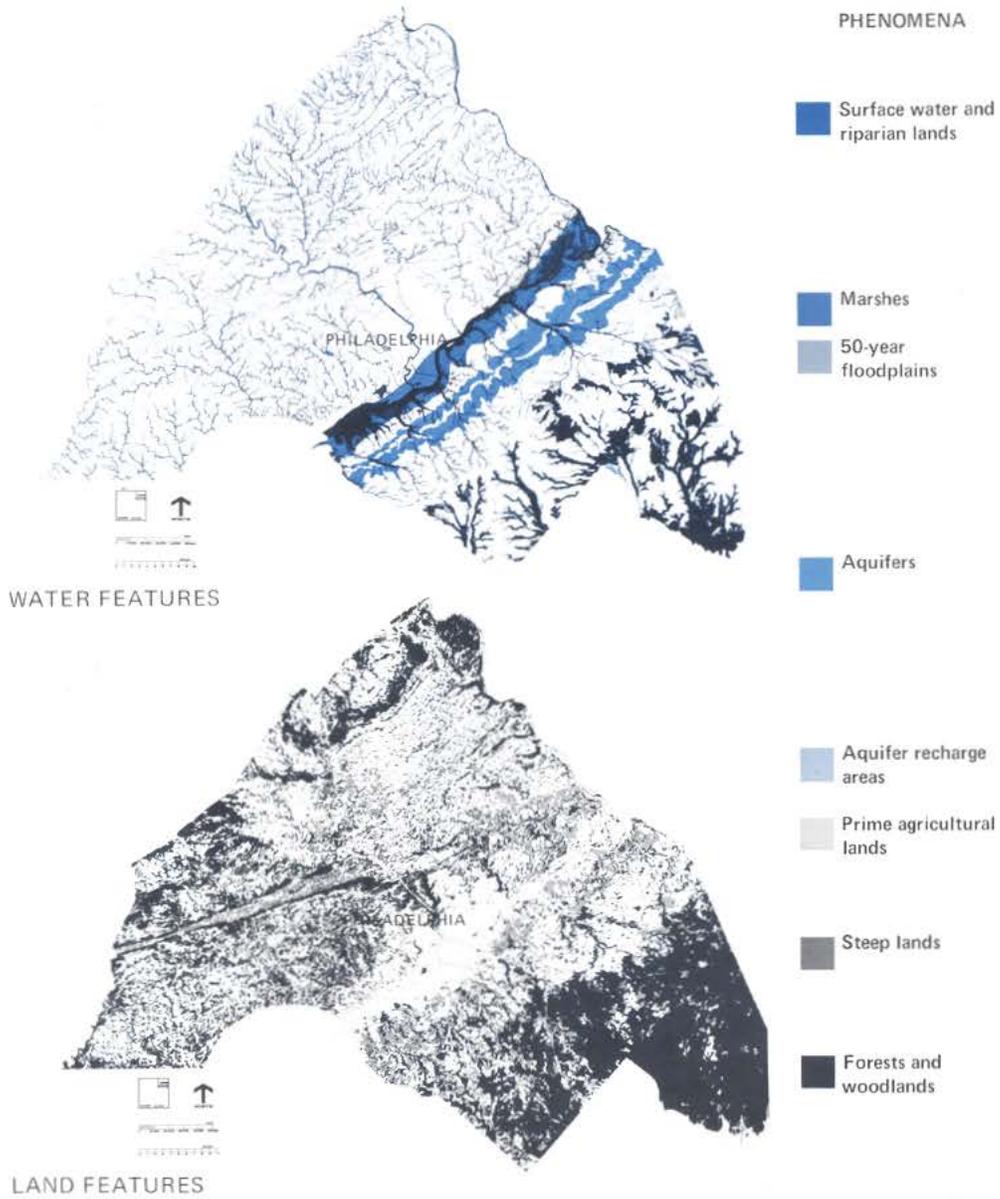
Map C18 *Hopi Cosmography* in *Taking Measures Across the American Landscape*, Chapter 9: Measures of Faith, pg. 157.



Map C19 Hopi Horizon Calendar in *Taking Measures Across the American Landscape*, Chapter 9: Measures of Faith, pg. 158.



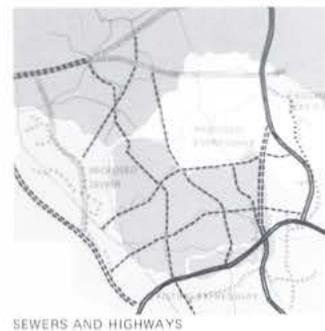
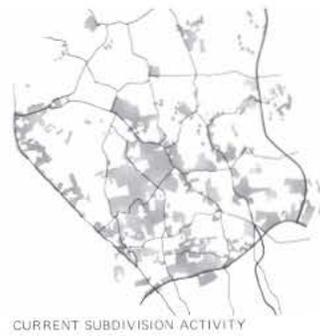
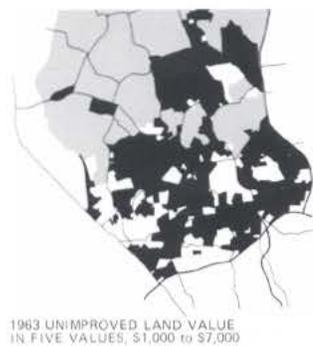
Map C20 Powers of Ten in Taking Measures Across the American Landscape, Chapter 9: Measures of Faith, pg. 171.



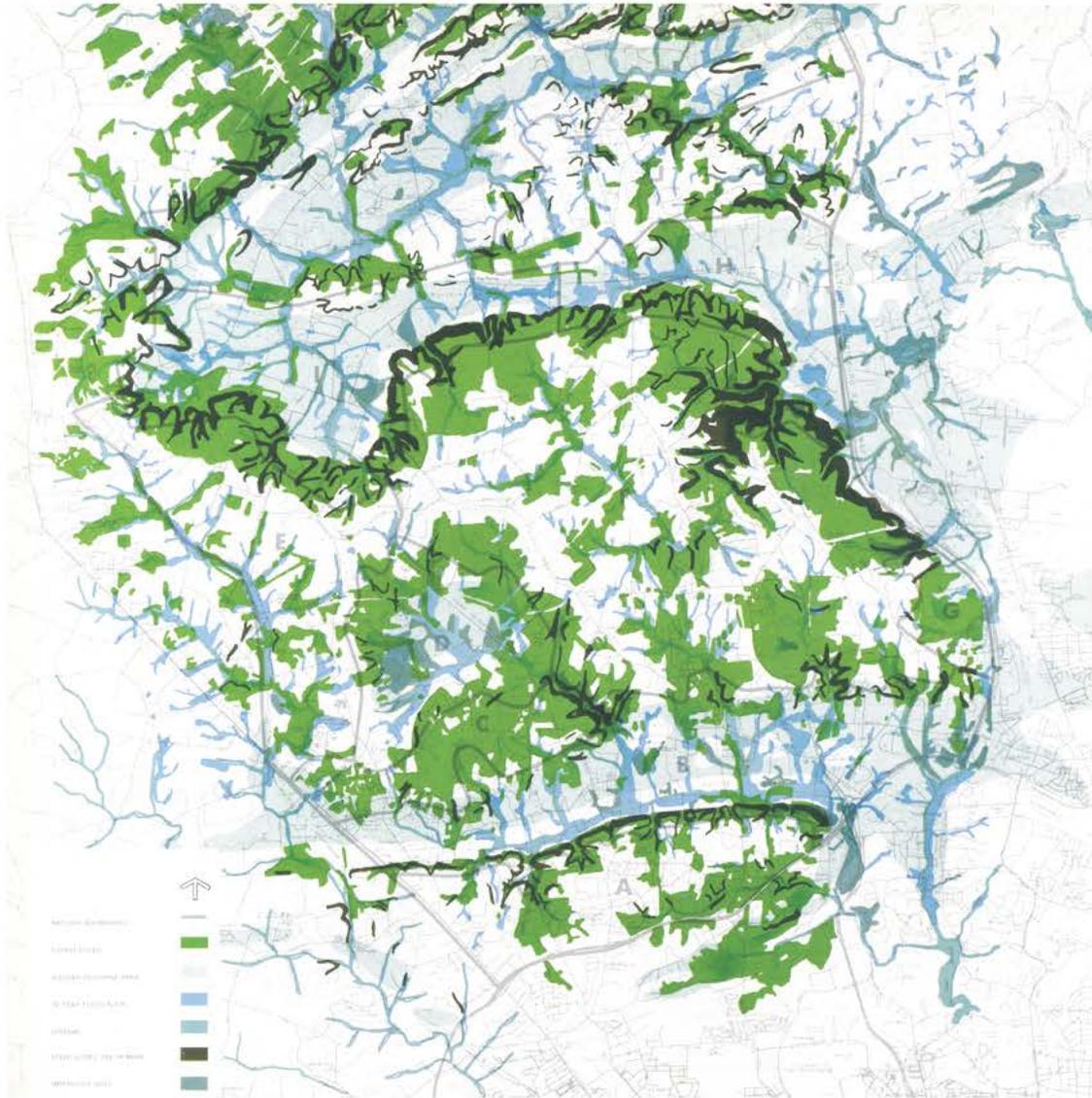
Map M01 in *Design With Nature*, Chapter 7: Nature in the Metropolis, pg. 62.



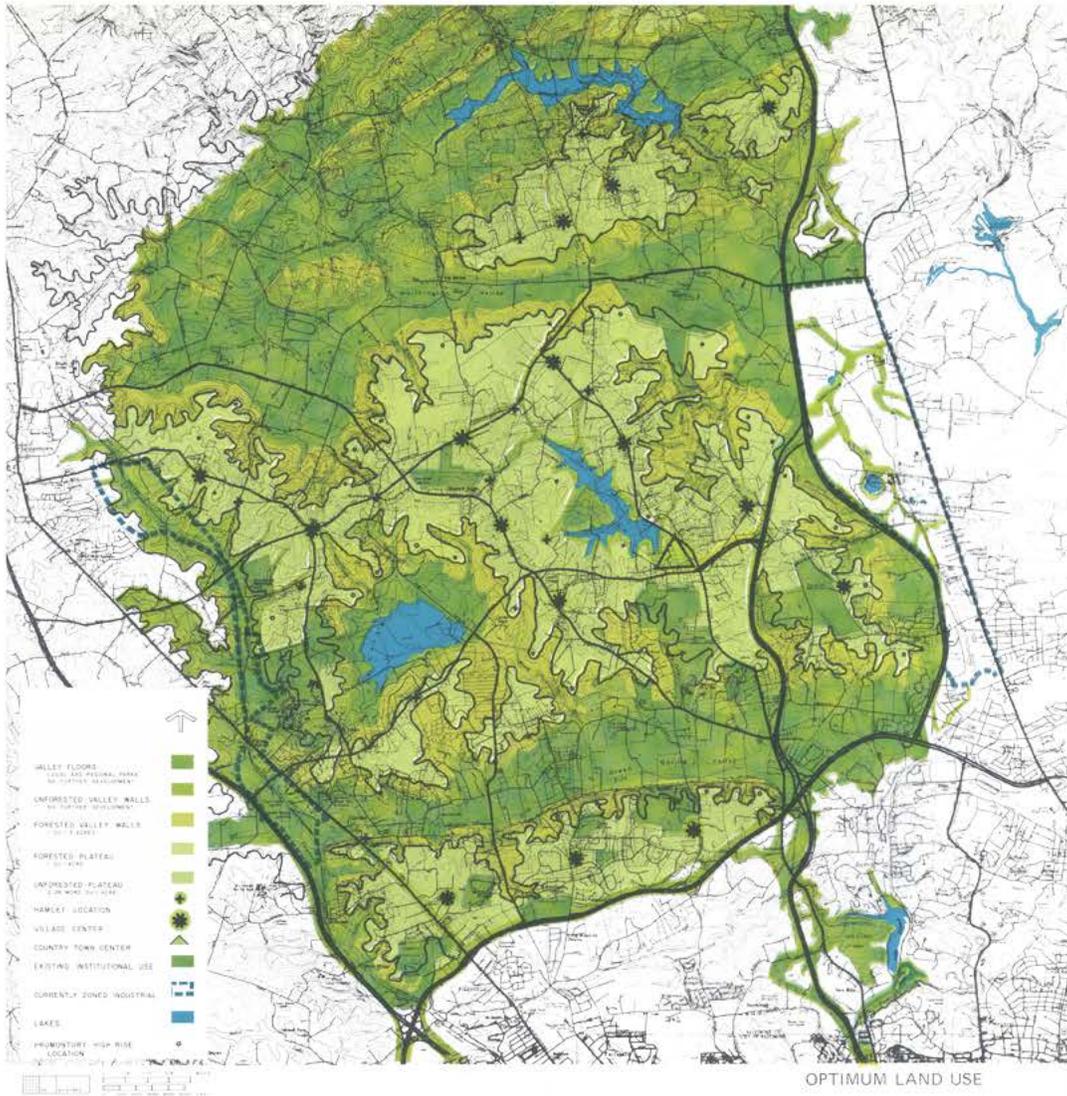
Map M02 in *Design With Nature*, Chapter 7: Nature in the Metropolis, pg. 63.



Map M03 in *Design With Nature*, Chapter 9: A response to Values, pg. 62.



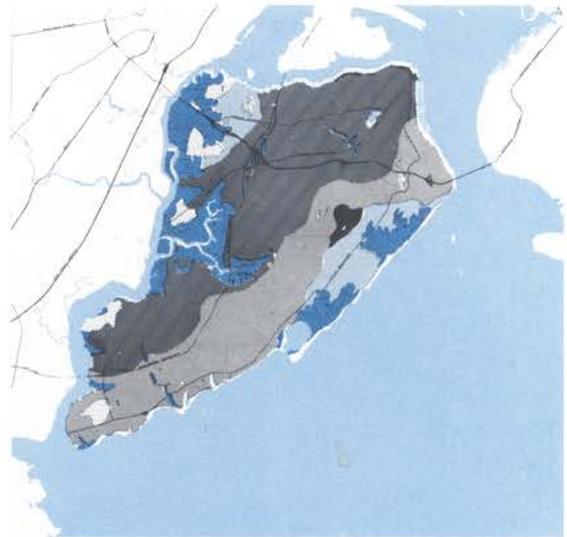
Map M04 in *Design With Nature*, Chapter 9: A response to Values, pg. 88.



Map M05 in *Design With Nature*, Chapter 9: A response to Values, pg. 89.



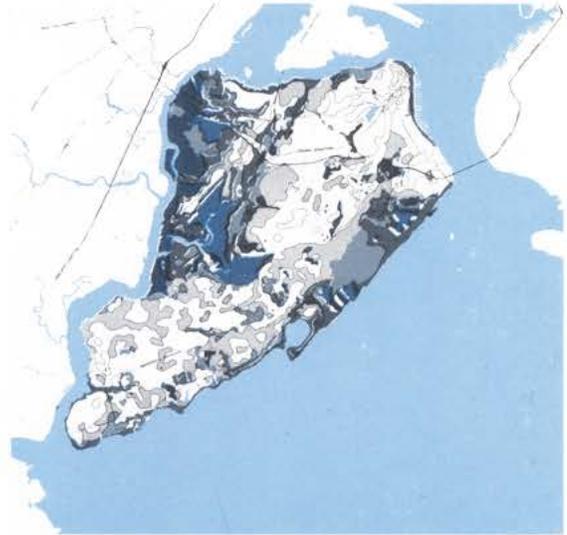
BEDROCK GEOLOGY



SURFICIAL GEOLOGY



HYDROLOGY



SOIL DRAINAGE ENVIRONMENTS

Map M06 in *Design With Nature*, Chapter 11: Process as Values, pg. 105.



EXISTING LAND USE



HISTORICAL LANDMARKS



PHYSIOGRAPHIC FEATURES



TIDAL INUNDATION

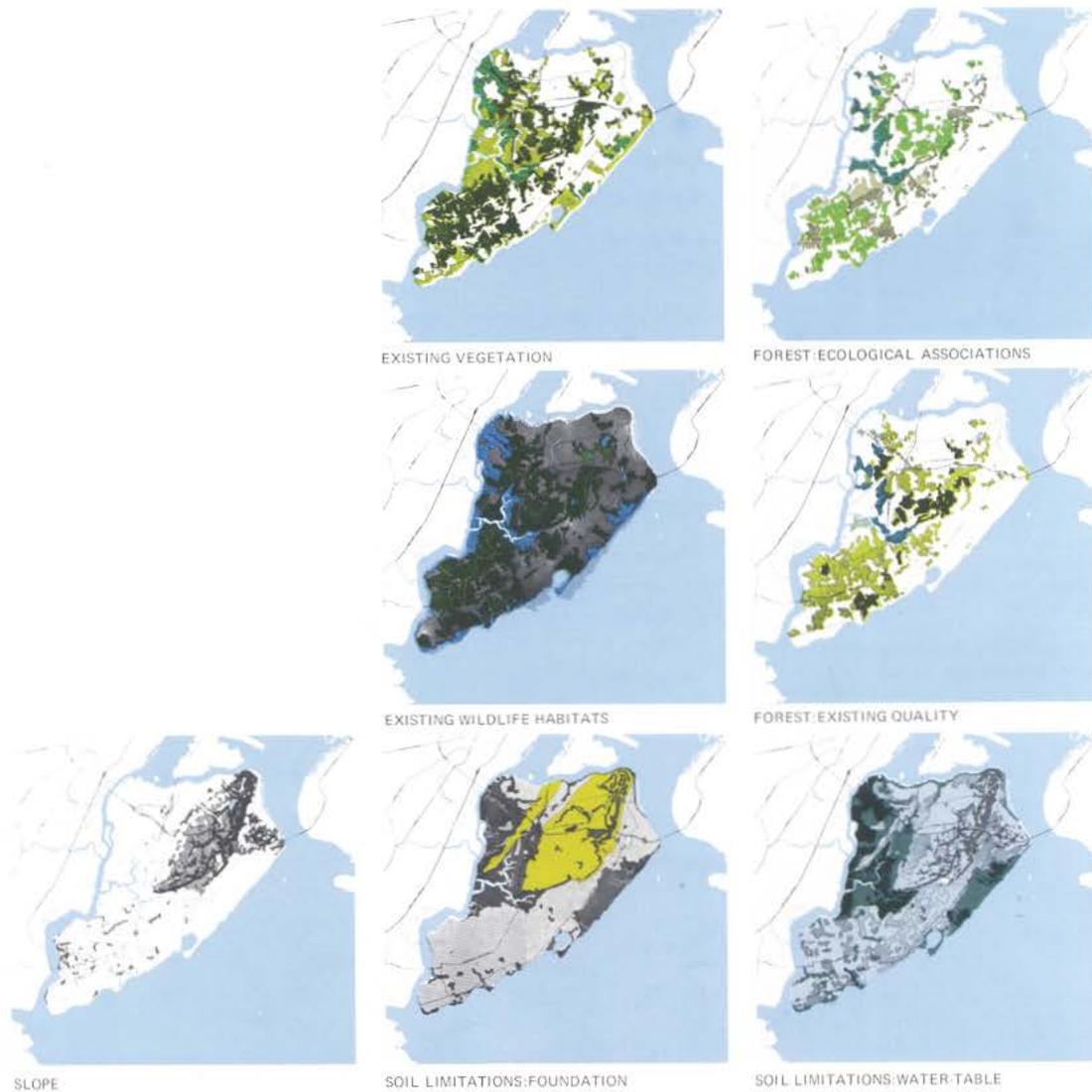


GEOLOGIC FEATURES



GEOLOGIC SECTIONS

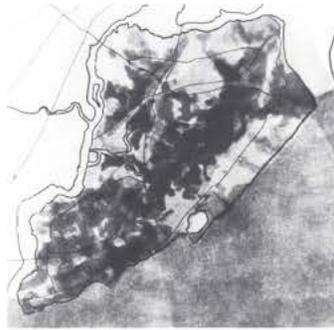
Map M07 in *Design With Nature*, Chapter 11: Process as Values, pg. 106.



Map M08 in *Design With Nature*, Chapter 11: Process as Values, pg. 107.



Map M09 in *Design With Nature*, Chapter 11: Process as Values, pg. 110.



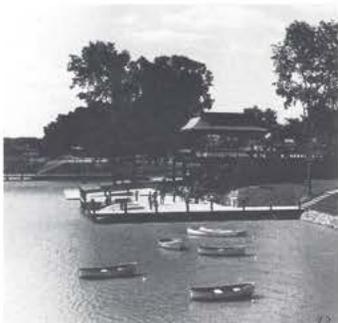
ACTIVE RECREATION SUITABILITY



PASSIVE RECREATION SUITABILITY

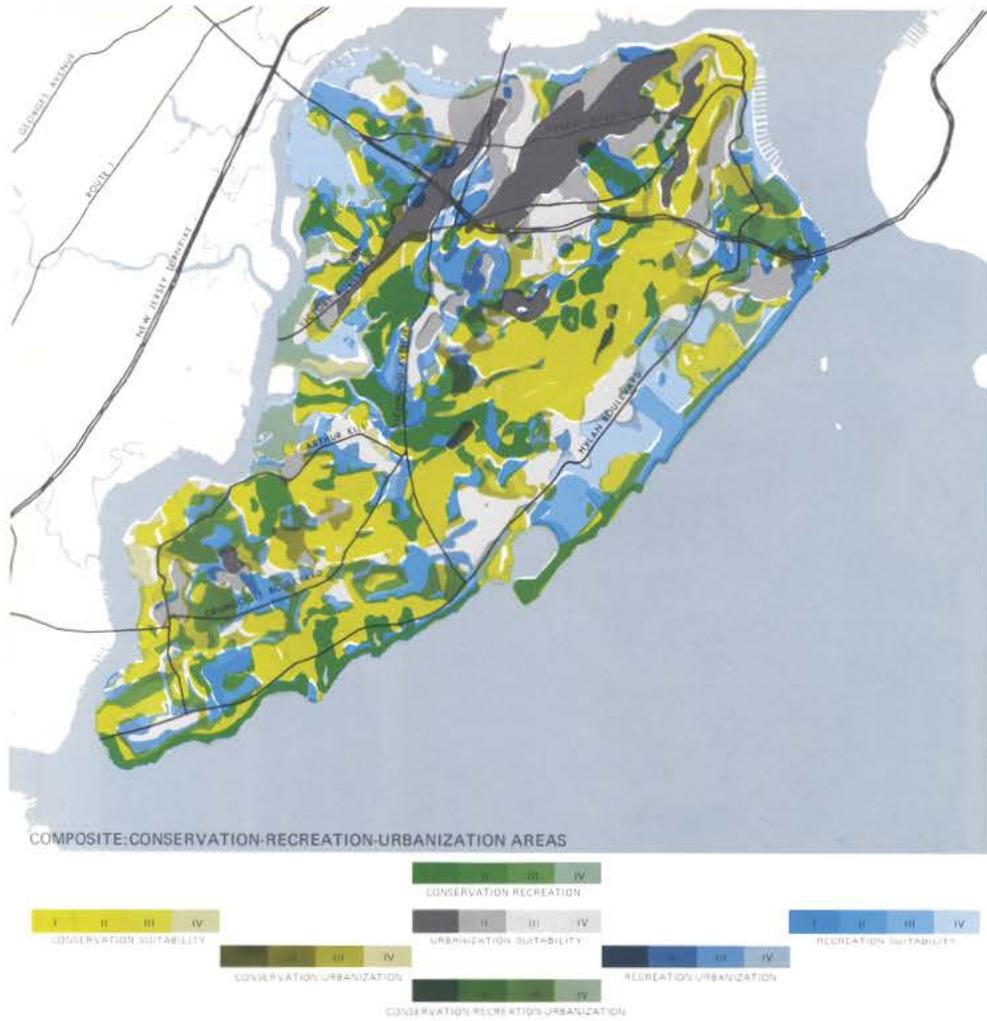


RECREATION AREAS

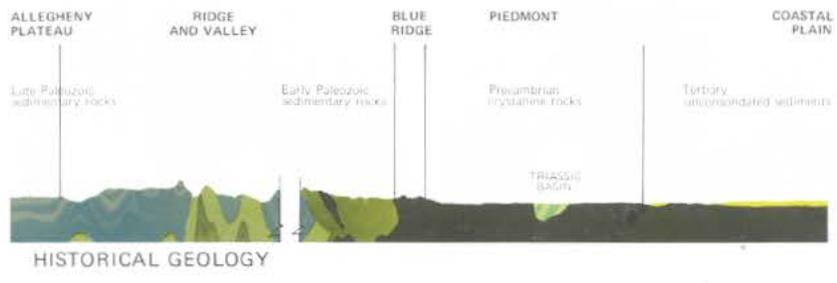
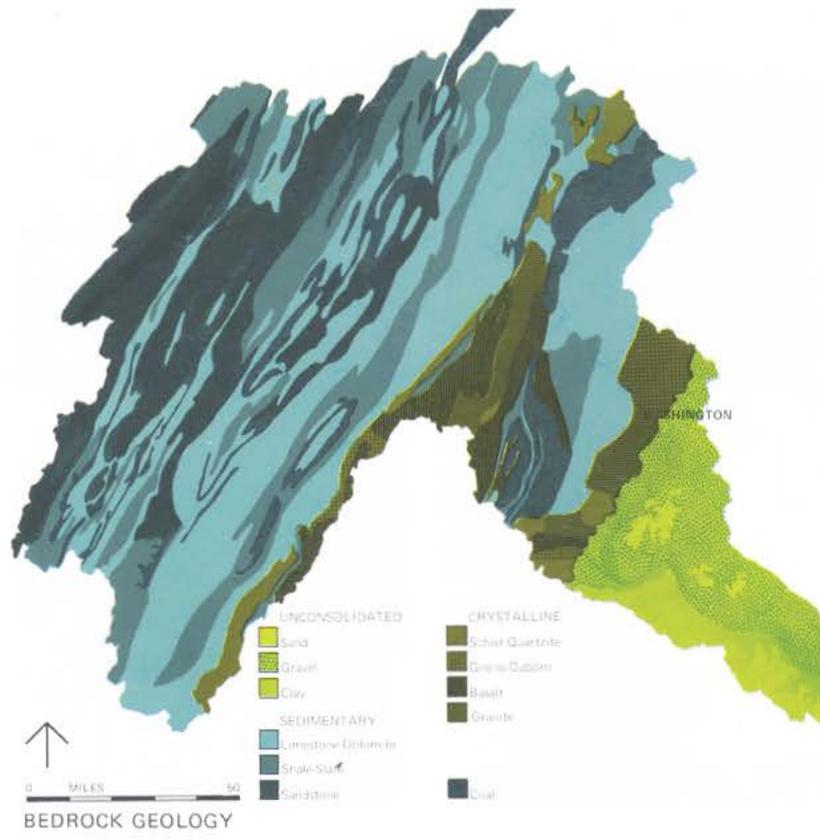


Landscape Architects COPE, LINDER AND WALMSLEY

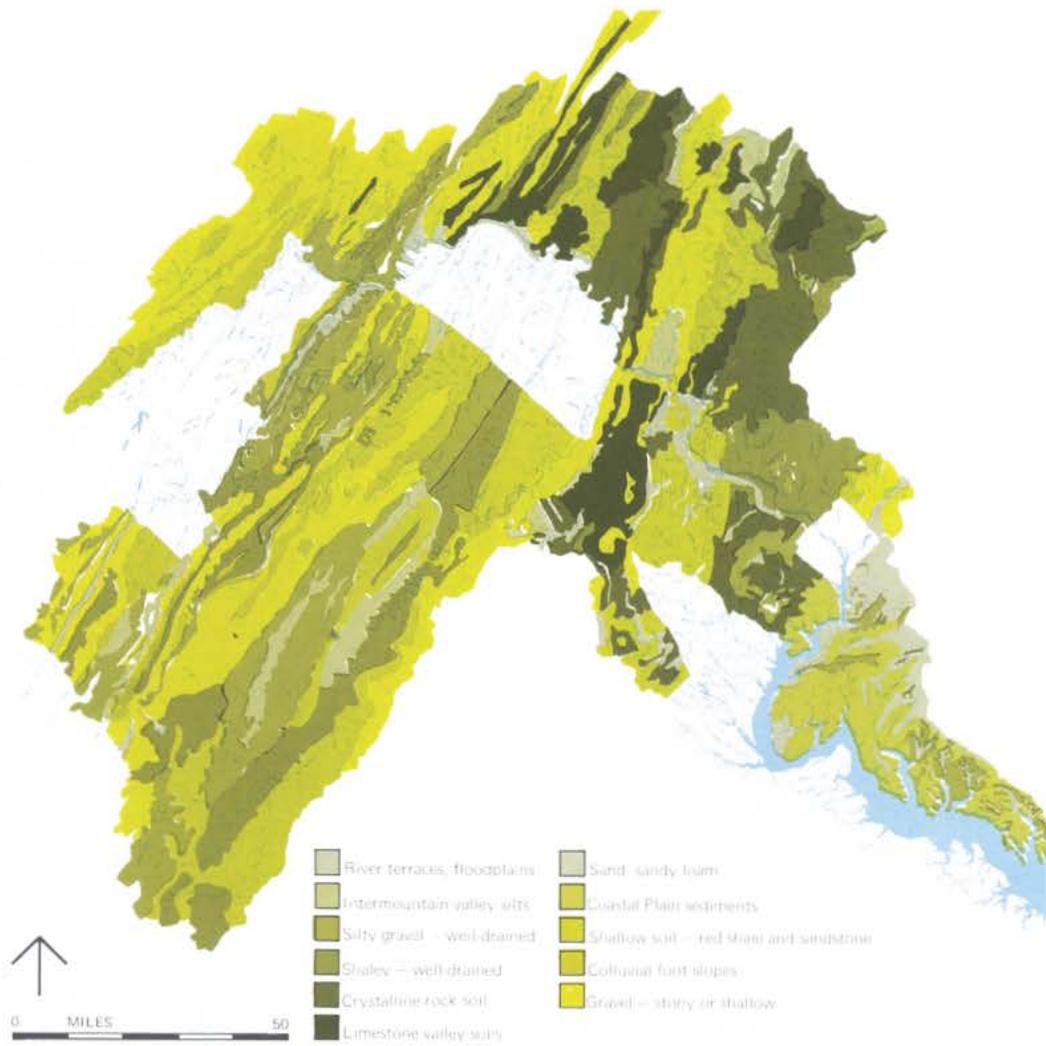
Map M10 in *Design With Nature*, Chapter 11: Process as Values, pg. 112.



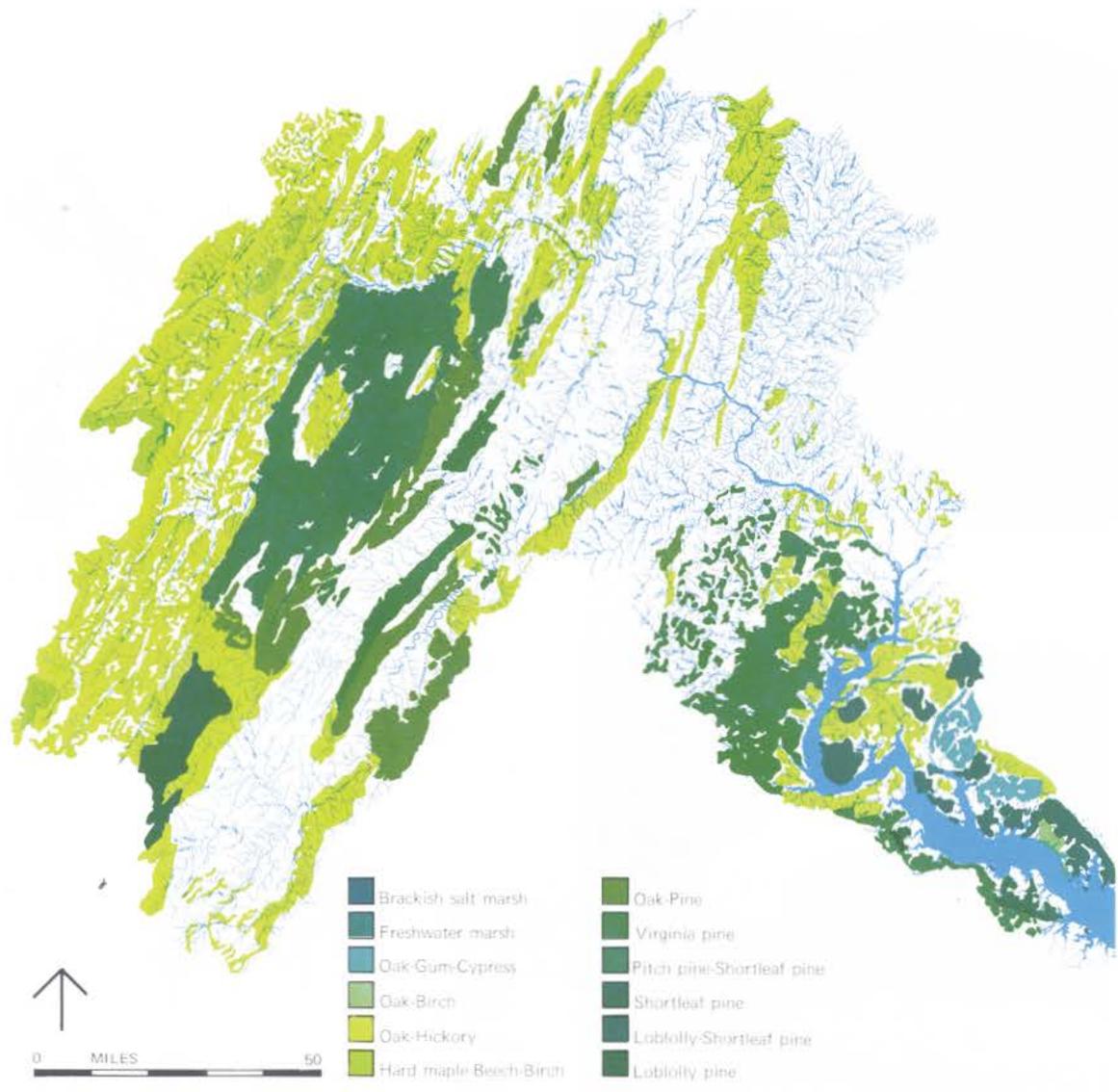
Map M11 in *Design With Nature*, Chapter 11: Process as Values, pg. 114.



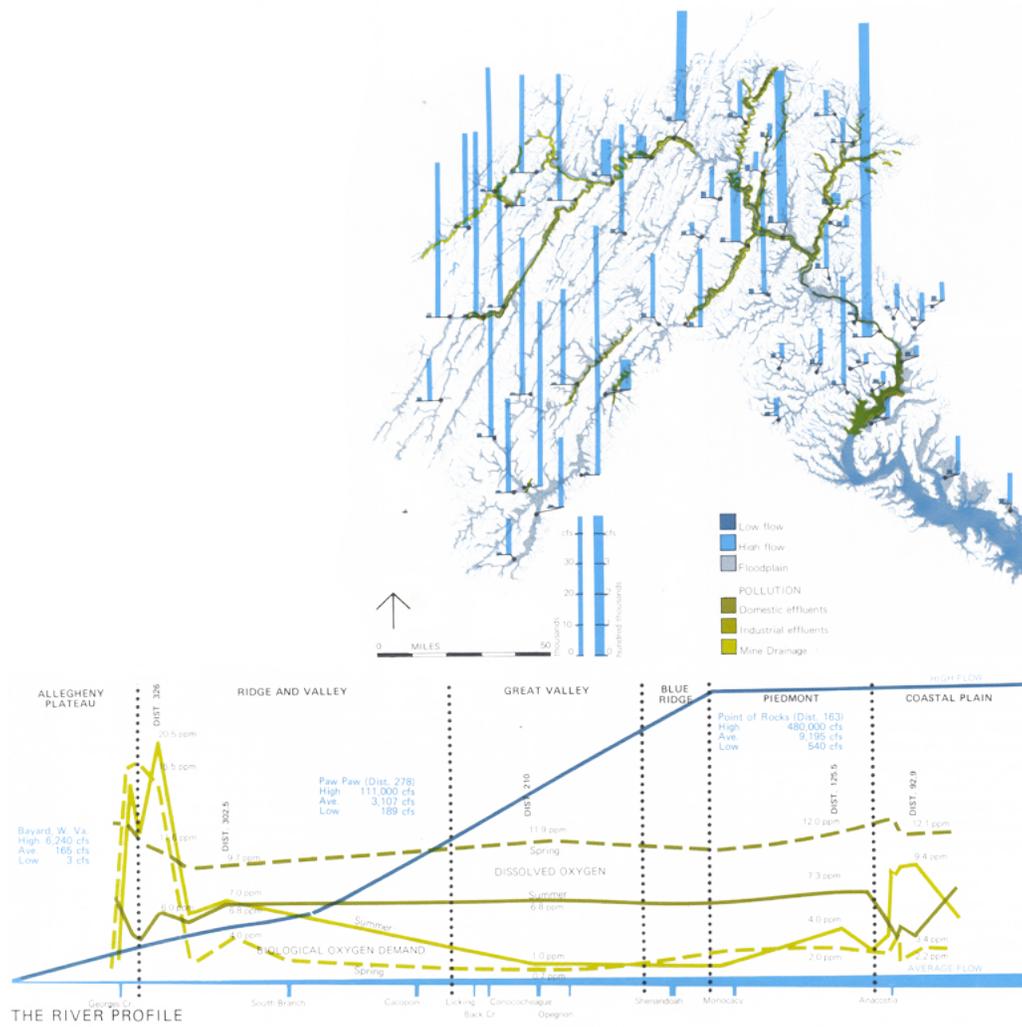
Map M12 in *Design With Nature*, Chapter 13: The River Basin, pg. 129.



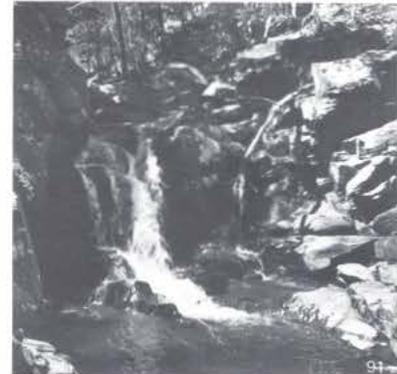
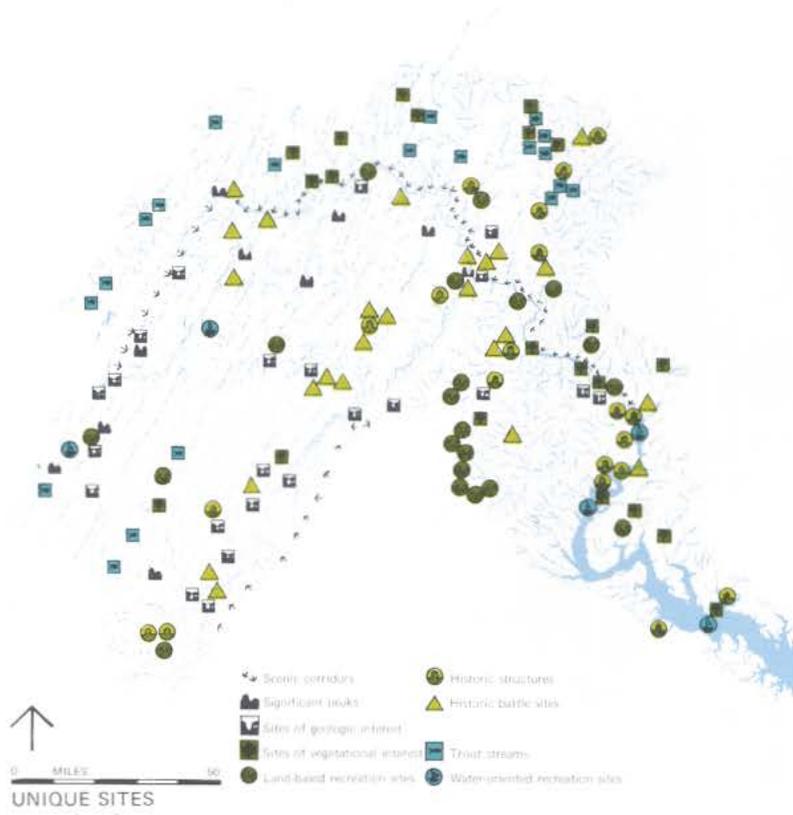
Map M13 in *Design With Nature*, Chapter 13: The River Basin, pg. 133.



Map M14 in *Design With Nature*, Chapter 13: The River Basin, pg. 134.



Map M15 in *Design With Nature*, Chapter 13: The River Basin, pg. 136.

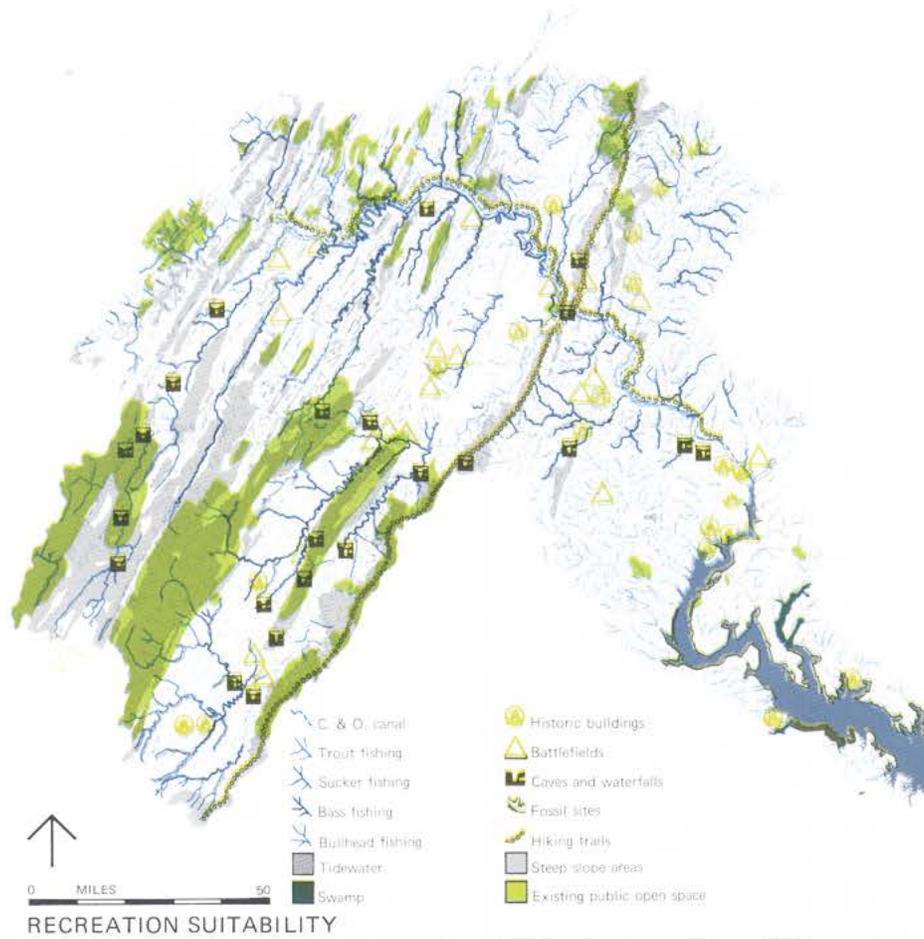


UNIQUE-NATURAL

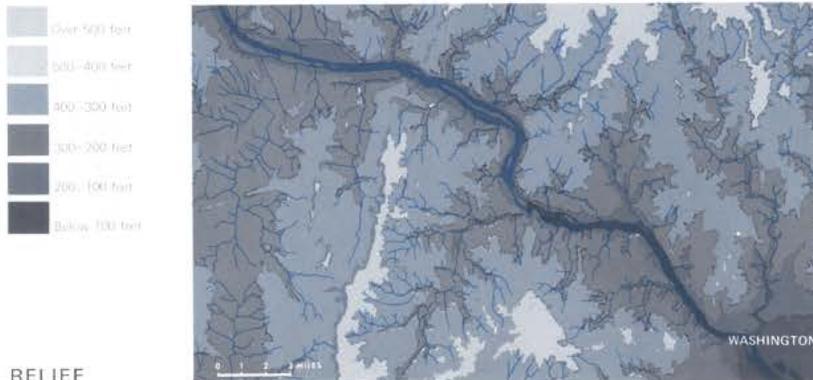


UNIQUE-CULTURAL

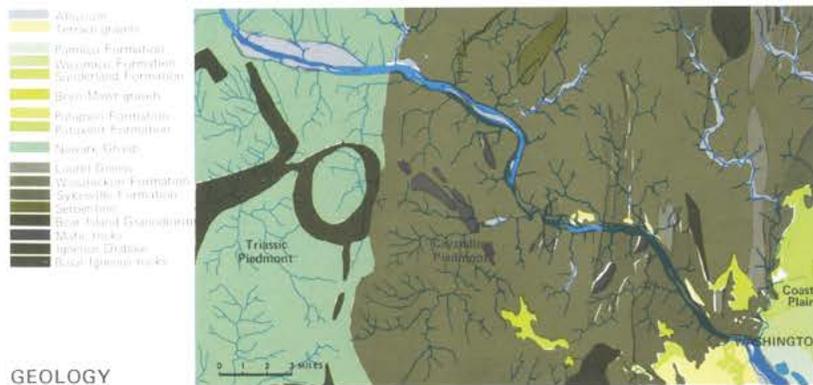
Map M16 in *Design With Nature*, Chapter 13: The River Basin, pg. 137.



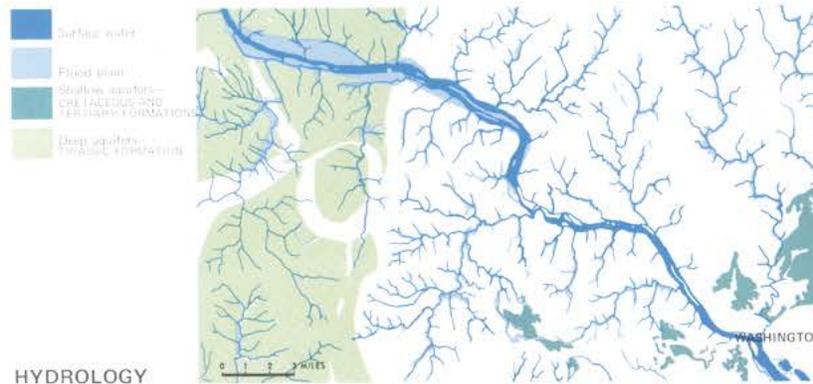
Map M17 in *Design With Nature*, Chapter 13: The River Basin, pg. 142.



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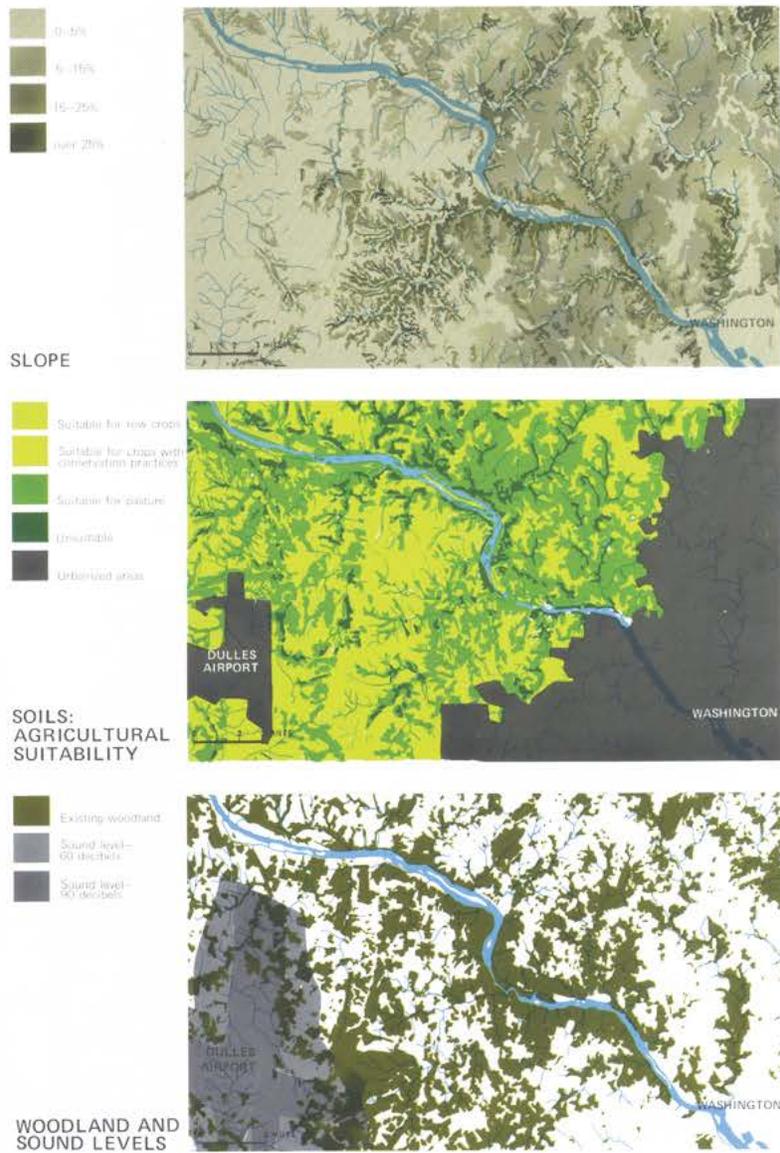


GEOLOGY



HYDROLOGY

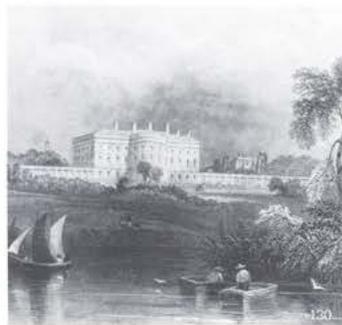
Map M18 in *Design With Nature*, Chapter 14: The Metropolitan Region, pg. 156.



Map M19 in *Design With Nature*, Chapter 14: The Metropolitan Region, pg. 157.



THE CAPITOL



THE WHITE HOUSE

Map M20 in *Design With Nature*, Chapter 16: The City: Process and Form, pg. 180.

End